# Attachment C:
## TRAFFIC MEMORANDA AND ANALYSES

# US 550 at US 160 Section 4(f) Evaluation
# ATTACHMENT C: TRAFFIC MEMORANDA AND ANALYSIS
# INDEX

| Date | Correspondence |
|---|---|
| September 17, 2010 | SEH Memorandum: US 160 FEIS Grandview Section—Year 2025 Traffic Analysis |
| September 17, 2010 | SEH Memorandum: Year 2030 Traffic Operations Analysis for Alternatives of the US 160 FEIS |
| December 23, 2010 | SEH Memorandum: Year 2030 Traffic Operations Analysis for the US 550 at US 160 Section 4(f) Alternatives |
| January 5, 2011 | SEH Memorandum: US 160 Section 4(f) Alternatives Considered in the Least Harm Analysis—The Degree to Which Each Alternative Meets the Purpose and Need for the Project |
| March 3, 2011 | Final Safety Analysis for the US 550 at US 160 Section 4(f) |

# SEH MEMORANDUM

# US 160 FEIS Grandview Section—Year 2025 Traffic Analysis

# September 17, 2010

MEMORANDUM

TO: Mike McVaugh, PE - CDOT Region 5

FROM: Philip T. Weisbach, PE
Jon E. Larson, PE

DATE: September 17, 2010

RE: US 160 FEIS Grandview Section – Year 2025 Traffic Analysis
SEH No. CODOT - 105181

## Executive Summary

Alternatives for the US 550 connection to the US 160 corridor were originally evaluated in the US Highway 160 from Durango to Bayfield Final Environmental Impact Statement (US 160 FEIS) dated May 2006. The US 160 Highway from Durango to Bayfield Record of Decision (US 160 ROD) documented selection of Grandview Alternative G Modified which included an interchange at US 160/US 550 approximately 0.6 miles east of the current intersection.

The technical traffic analysis data for this memo is included in the attached appendices at the end of this document.

The following traffic analysis was performed:

A. Evaluate the interchanges along US 160 as shown in the Alternative G Modified to confirm that the original work performed in the FEIS is valid;

B. Evaluate the option of an at-grade intersection at US 550 and US 160 Alternative G Modified connection in-lieu of an interchange.

The purpose and need for improvements to the US 160 corridor include increasing travel efficiency and capacity to meet current and future needs, while improving safety for the traveling public by reducing the number and severity of accidents, and controlling access.

## Evaluation Criteria

The interchange was evaluated to determine if it met operational level of service requirements as described in the Executive Summary of the FEIS, based on guidance in the AASHTO Policy on Geometric Design of Highways and Streets 2004 (AASHTO Green Book) and capacity analysis performed according to the methods described in the Highway Capacity Manual[1] (HCS). This memorandum deals with the capacity analysis and not design. Traffic volumes used in the analysis are year 2025 volumes documented in Appendix A, Traffic Report, Figure 8 of the US 160 FEIS.

The following criteria were used to determine the capacity need in the US 160 FEIS:

[1] Highway Capacity Manual - Special Report 209. Transportation Research Board. National Research Council. 2000.

- A Level of Service (LOS) D or better for an urban signalized intersection, including signalized intersections at single point urban interchanges (SPUI), and its individual legs during the peak hour in year 2025; and
- A LOS D or better for urban interchange merge, diverge, weaving, auxiliary lanes and freeway sections in the Grandview Section during the peak hour in year 2025.

Anything worse than LOS D for any urban intersection, leg or section is considered "failing", and not meeting the purpose and need. These same criteria were applied to the evaluation of the US 160 FEIS in this memorandum.

For the purposes of this analysis, US 160 is assumed to be east/west and US 550 is assumed to be north/south.

## Alternative (G Modified) Analysis – Figure 1, Tables 1 & 2

This evaluation was performed to validate the analysis in the FEIS. The Alternative G Modified from US 160 FEIS was evaluated using year 2025 traffic volumes from Figure 8 of the FEIS. The G Modified alternative includes four through lanes throughout the Grandview Section with an eastbound and westbound auxiliary lanes extending from the US 160 / US 550 / Grandview interchange to the west end of the Grandview Section. Single point urban interchanges are assumed at CR 233 (Three Springs) and SH 172 / CR 234. A SPUI is similar to a diamond interchange. However, where there are two intersections that control the ramps of a diamond interchange, there is only one intersection that controls the ramps of a SPUI. The SPUI interchange allows US 160 to pass over an intersection maintaining a free-flow condition for traffic on US 160 while the approach roads have a single signalized intersection underneath the overpass to meter traffic on and off of US 160. The freeway segment and ramp merge/diverge analysis includes the same assumptions as the US 160 FEIS. The analysis worksheets are contained in Appendix A for reference.

**Alternative G Modified**

The results of the analysis (Figure 1) based on the Alternative G Modified interchange configuration show that the freeway segments and ramp merge/diverge operations are expected to operate at LOS D or better during the morning and evening peak periods. The results match the results from the US 160 FEIS.

**Conclusion**

Based on the analysis, the results support the finding that Alternative G Modified satisfies the purpose and need. The interchange geometry described in the FEIS is adequate to accommodate the projected volumes at LOS D or better.

## Alternative (G Modified) Analysis (At-Grade, Signalized Intersection) – Figure 2

The Alternative G Modified interchange location was evaluated as a signalized intersection using year 2025 traffic volumes from Figure 8 of the FEIS. The purpose of this analysis is to determine if an intersection at this location would meet the capacity LOS D requirements for the purpose and need in the FEIS.

The assumed lane configuration on US 160 at the intersection includes two left turn lanes, two through lanes, and one right turn lane in both directions. On the US 550 northbound approach, the lane configuration includes two left turn lanes, one through lane and one right turn lane. The US 550 southbound approach includes one lane each for the left turn, through and right turn movements.

The results of the analysis (Figure 2) show that the signalized intersection is expected to operate at LOS F in the morning and evening peak periods in the year 2025. Numerous individual movements are shown to exhibit LOS F during the morning and evening peak periods as well. This analysis supports the findings in the FEIS that an at-grade intersection as described will not meet the capacity requirements of the Purpose and need. The analysis worksheets are contained in Appendix B for reference.

In an attempt to improve the LOS to acceptable levels, additional lanes were added to particularly heavy movements and signal timing was optimized. Even with providing three lanes in each direction through the intersection on US 160 and analyzing triple left turn lanes, the LOS D evaluation criteria for signalized intersections and individual movements could not be achieved. Appendix B contains the LOS table to support these findings.

**Conclusion**

Based on the analysis, the results support the findings from the US 160 FEIS that an interchange is necessary for the Alternative G Modified to satisfy the capacity requirements of the purpose and need.

jel
Attachments
p:\ae\c\codot\105181\to #3 - us 160 interchange analysis\project___final memos_september 2010\1_us 160_feis 2025 analysis memo 09-17-2010_final.docx

# Preferred Alternative (G Modified) Analysis

## Comparison between US 160 FEIS and SEH[1]

### Table 1a Highway Segment

| US 160 Highway Segment | Eastbound | | | | Westbound | | | |
|---|---|---|---|---|---|---|---|---|
| | US 160 FEIS | | SEH | | US 160 FEIS | | SEH | |
| | AM Peak LOS | PM Peak LOS | AM Peak LOS | PM Peak LOS | AM Peak LOS | PM Peak LOS | AM Peak LOS | PM Peak LOS |
| West of US 550 (south) | B | D | B | D | C | D | C | D |
| US 550 (south) to CR 233 (west) | C | D | C | D | C | D | C | D |
| CR 233 (west) to SH 172/CR 234 | B | C | B | C | B | C | B | C |

### Table 1b Ramp Merge/Diverge and Weaving Area

| US 160 Highway Segment | Merge/Diverge Area | | | | Weaving Area | | | |
|---|---|---|---|---|---|---|---|---|
| | US 160 FEIS | | SEH | | US 160 FEIS | | SEH | |
| | AM Peak LOS | PM Peak LOS | AM Peak LOS | PM Peak LOS | AM Peak LOS | PM Peak LOS | AM Peak LOS | PM Peak LOS |
| **Eastbound** | | | | | | | | |
| Off-Ramp to US 550 (south) | B | C | B | C | | | | |
| On-Ramp from US 550 (south) | C | D | C | D | | | | |
| Off-Ramp to CR 233 (west) | C | D | C | D | | | | |
| On-Ramp from CR 233 (west) | B | C | B | C | | | | |
| Off-Ramp to SH 172/CR 234 | B | C | B | C | | | | |
| On-Ramp from SH 172/CR 234 | B | B | B | B | | | | |
| **Westbound** | | | | | | | | |
| Off-Ramp to SH 172/CR 234 | B | B | B | B | | | | |
| On-Ramp from SH 172/CR 234 | B | C | B | C | | | | |
| Off-Ramp to CR 233 (west) | B | C | B | C | | | | |
| On-Ramp from CR 233 (west) | N/A | N/A | N/A | N/A | | | | |
| Between CR 233 (west) On-Ramp and US 550 (south) Off Ramp | | | | | B | D | B | D |
| On-Ramp from northbound US 550 (south) (Loop) | B | C | B | C | | | | |
| On-Ramp from southbound US 550 (south) | B | C | B | C | | | | |

Note:

1) SEH used the same assumptions as the US 160 Final EIS for its analysis of the Preferred Modified G Alternative.

# Preferred Alternative (G Modified) Analysis

## Comparison between US 160 FEIS and SEH[1]

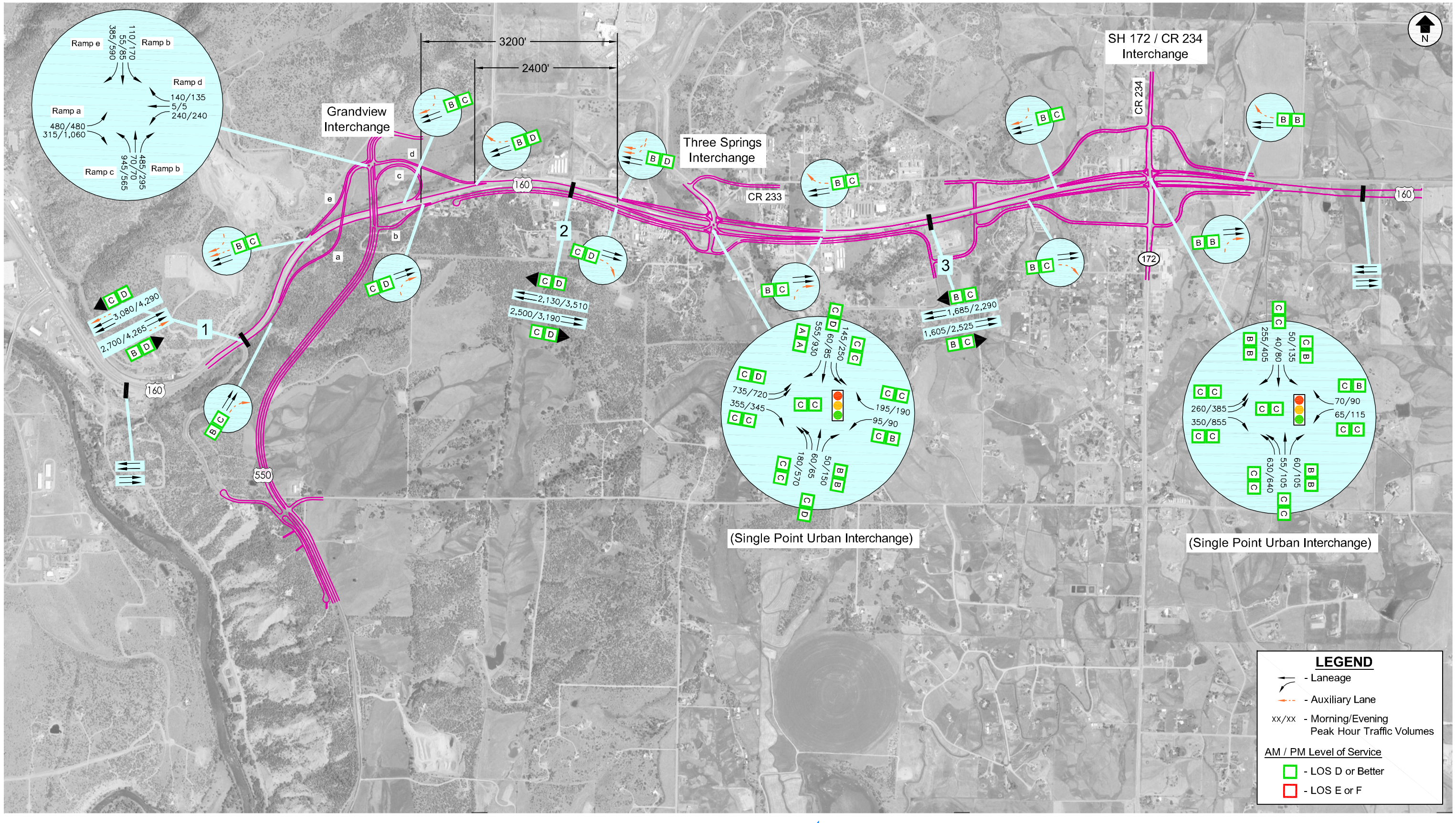
### Table 2. US 160 Analysis - Intersection Operations at Single-Point Interchange

| Intersection and Approaches | Year 2025 Traffic Volumes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | AM Peak Hour | | | | PM Peak Hour | | | |
| | US 160 FEIS | | SEH | | US 160 FEIS | | SEH | |
| | Delay[2] | LOS | Delay[2] | LOS | Delay[2] | LOS | Delay[2] | LOS |
| **SIGNAL CONTROL** | | | | | | | | |
| **SH 172/CR 234 & US 160** | **24.7** | **C** | **27.9** | **C** | **28.8** | **C** | **25.0** | **C** |
| Eastbound Left | *23.3* | *C* | *32.6* | *C* | *42.6* | *D* | *29.7* | *C* |
| Eastbound Right | *33.4* | *C* | *27.2* | *C* | *34.2* | *C* | *32.4* | *C* |
| Westbound Left | *22.3* | *C* | *34.1* | *C* | *35.6* | *D* | *29.6* | *C* |
| Westbound Right | *23.3* | *C* | *24.4* | *C* | *9.0* | *A* | *18.6* | *B* |
| Northbound Left | *28.7* | *C* | *32.5* | *C* | *10.6* | *B* | *23.0* | *C* |
| Northbound Through | *28.3* | *C* | *24.2* | *C* | *40.6* | *D* | *28.6* | *C* |
| Northbound Right | *8.0* | *A* | *14.6* | *B* | *22.4* | *C* | *10.7* | *B* |
| Southbound Left | *22.8* | *C* | *24.9* | *C* | *9.3* | *A* | *19.9* | *B* |
| Southbound Through | *28.0* | *C* | *23.9* | *C* | *38.5* | *D* | *27.8* | *C* |
| Southbound Right | *9.3* | *A* | *17.3* | *B* | *39.8* | *D* | *13.5* | *B* |
| **Three Springs Blvd/CR 233 & US 160** | **18.7** | **B** | **22.4** | **C** | **17.5** | **B** | **24.7** | **C** |
| Eastbound Left | *22.3* | *C* | *30.2* | *C* | *34.8* | *C* | *53.7* | *D* |
| Eastbound Right | *30.5* | *C* | *30.8* | *C* | *18.7* | *B* | *20.6* | *C* |
| Westbound Left | *17.9* | *B* | *21.3* | *C* | *25.0* | *C* | *14.7* | *B* |
| Westbound Right | *23.4* | *C* | *23.4* | *C* | *16.1* | *B* | *34.7* | *C* |
| Northbound Left | *21.2* | *C* | *30.9* | *C* | *17.0* | *B* | *23.0* | *C* |
| Northbound Through | *37.6* | *D* | *31.0* | *C* | *38.8* | *D* | *42.3* | *D* |
| Northbound Right | *9.2* | *A* | *11.1* | *B* | *15.6* | *B* | *19.7* | *B* |
| Southbound Left | *21.0* | *C* | *30.5* | *C* | *15.1* | *B* | *20.4* | *C* |
| Southbound Through | *37.6* | *D* | *31.0* | *C* | *38.8* | *D* | *42.3* | *D* |
| Southbound Right | *0.1* | *A* | *0.8* | *A* | *0.7* | *A* | *2.4* | *A* |

Notes:

1) SEH used the same assumptions as the US 160 Final EIS for its analysis of the Preferred Modified G Alternative.

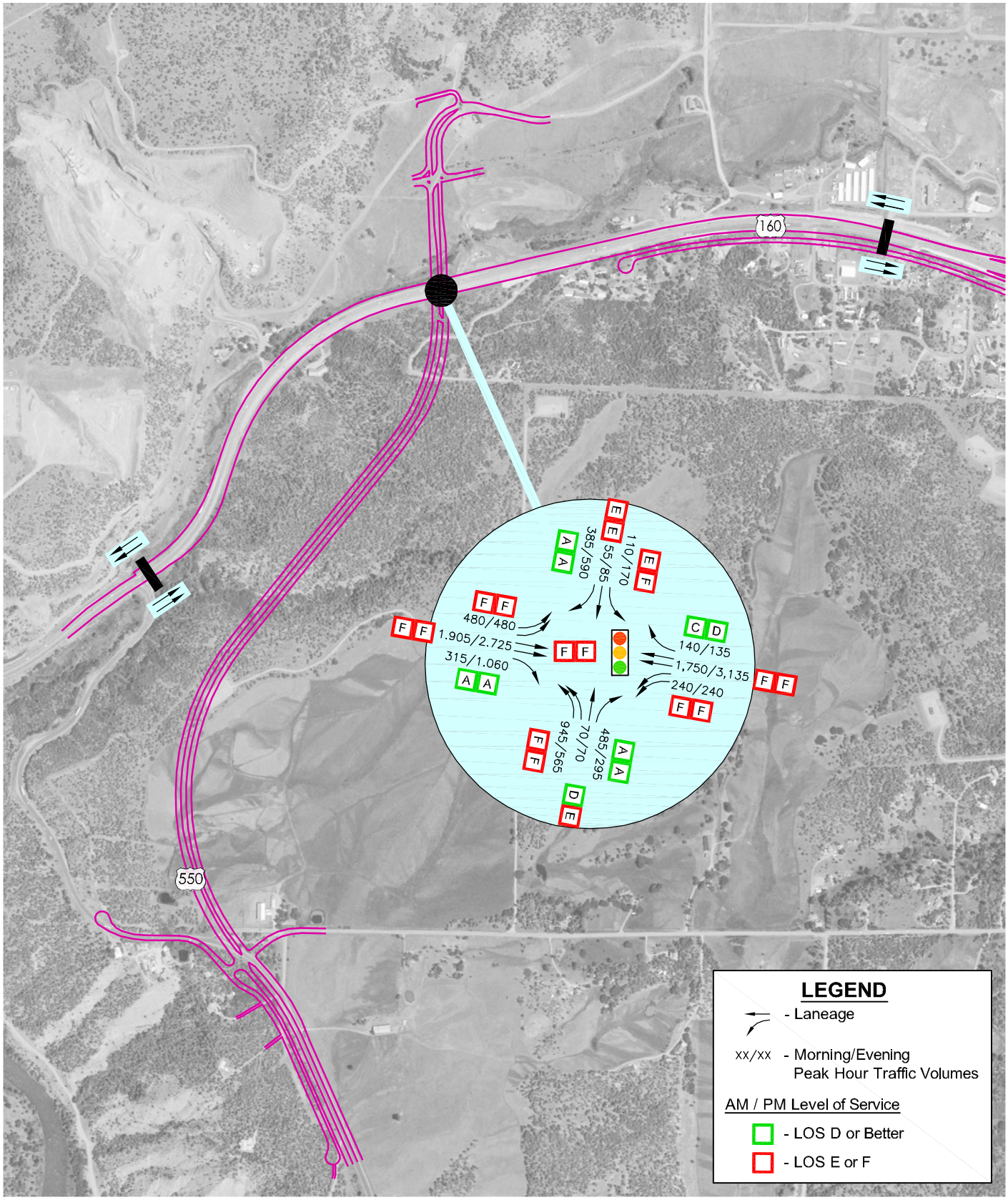
2) Delay measured as seconds per vehicle




# Year 2025 Traffic Volumes

US 160 FEIS Grandview Section - Year 2025 Analysis
US 160 Preferred Alternative (Modified G) Analysis

| Scale | 1"=1500' | Date | 4/28/10 | Drawn by | NWS | Job # | 105181 | Figure | 1 |
|---|---|---|---|---|---|---|---|---|---|




SEH

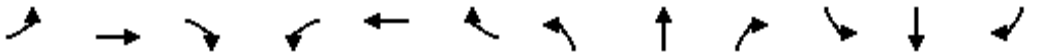
US 160 FEIS Grandview Section - Year 2025 Analysis
Preferred Alternative (G Modified) Analysis (At-Grade, Signalized Intersection)

| Scale | 1"=1000' | Date | 4/28/10 | Drawn by | NWS | Job # | 105181 | Figure | 2 |
|---|---|---|---|---|---|---|---|---|---|

# Appendix A

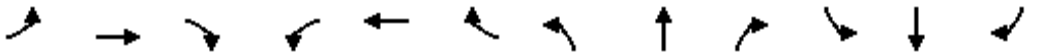
## Alternative G Modified

Interchange Evaluation Worksheets



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 260 | 0 | 325 | 65 | 0 | 70 | 630 | 55 | 60 | 50 | 40 | 255 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | 9.0 | 9.0 | 8.5 | 9.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 274 | 0 | 342 | 68 | 0 | 74 | 663 | 58 | 63 | 53 | 42 | 268 |
| RTOR Reduction (vph) | 0 | 0 | 250 | 0 | 0 | 54 | 0 | 0 | 35 | 0 | 0 | 19 |
| Lane Group Flow (vph) | 274 | 0 | 92 | 68 | 0 | 20 | 663 | 58 | 28 | 53 | 42 | 249 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 | | | 5 | | | 1 6 | | | 1 6 |
| Actuated Green, G (s) | 13.7 | | 24.2 | 13.7 | | 24.2 | 24.2 | 25.6 | 47.8 | 24.2 | 25.6 | 47.8 |
| Effective Green, g (s) | 13.7 | | 24.2 | 13.7 | | 24.2 | 24.2 | 25.6 | 39.3 | 24.2 | 25.6 | 39.3 |
| Actuated g/C Ratio | 0.15 | | 0.27 | 0.15 | | 0.27 | 0.27 | 0.28 | 0.44 | 0.27 | 0.28 | 0.44 |
| Clearance Time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | | 9.0 | 8.5 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 523 | | 426 | 269 | | 426 | 923 | 530 | 691 | 476 | 530 | 691 |
| v/s Ratio Prot | c0.08 | | | 0.04 | | | c0.19 | 0.03 | | 0.03 | 0.02 | |
| v/s Ratio Perm | | | 0.06 | | | 0.01 | | | 0.02 | | | c0.16 |
| v/c Ratio | 0.52 | | 0.22 | 0.25 | | 0.05 | 0.72 | 0.11 | 0.04 | 0.11 | 0.08 | 0.36 |
| Uniform Delay, d1 | 35.1 | | 25.5 | 33.6 | | 24.4 | 29.8 | 23.8 | 14.5 | 24.8 | 23.6 | 17.0 |
| Progression Factor | 0.90 | | 1.06 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.0 | | 0.3 | 0.5 | | 0.0 | 2.7 | 0.4 | 0.0 | 0.1 | 0.3 | 0.3 |
| Delay (s) | 32.6 | | 27.2 | 34.1 | | 24.4 | 32.5 | 24.2 | 14.6 | 24.9 | 23.9 | 17.3 |
| Level of Service | C | | C | C | | C | C | C | B | C | C | B |
| Approach Delay (s) | | 29.6 | | | 29.1 | | | 30.5 | | | 19.2 | |
| Approach LOS | | C | | | C | | | C | | | B | |

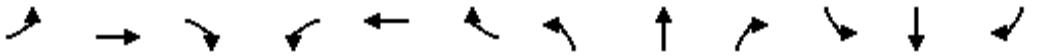
| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 27.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.54 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 27.0 |
| Intersection Capacity Utilization | 50.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 385 | 0 | 795 | 115 | 0 | 90 | 640 | 105 | 105 | 135 | 80 | 405 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 405 | 0 | 837 | 121 | 0 | 95 | 674 | 111 | 111 | 142 | 84 | 426 |
| RTOR Reduction (vph) | 0 | 0 | 358 | 0 | 0 | 60 | 0 | 0 | 53 | 0 | 0 | 71 |
| Lane Group Flow (vph) | 405 | 0 | 479 | 121 | 0 | 35 | 674 | 111 | 58 | 142 | 84 | 355 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 | | | 5 | | | 1 6 | | | 1 6 |
| Actuated Green, G (s) | 20.1 | | 32.9 | 20.1 | | 32.9 | 32.9 | 22.0 | 47.1 | 32.9 | 22.0 | 47.1 |
| Effective Green, g (s) | 20.1 | | 32.9 | 20.1 | | 32.9 | 32.9 | 22.0 | 47.1 | 32.9 | 22.0 | 47.1 |
| Actuated g/C Ratio | 0.22 | | 0.37 | 0.22 | | 0.37 | 0.37 | 0.24 | 0.52 | 0.37 | 0.24 | 0.52 |
| Clearance Time (s) | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 767 | | 579 | 395 | | 579 | 1255 | 455 | 828 | 647 | 455 | 828 |
| v/s Ratio Prot | c0.12 | | | 0.07 | | | 0.20 | 0.06 | | 0.08 | 0.05 | |
| v/s Ratio Perm | | | c0.30 | | | 0.02 | | | 0.04 | | | c0.22 |
| v/c Ratio | 0.53 | | 0.83 | 0.31 | | 0.06 | 0.54 | 0.24 | 0.07 | 0.22 | 0.18 | 0.43 |
| Uniform Delay, d1 | 30.8 | | 26.0 | 29.1 | | 18.5 | 22.5 | 27.3 | 10.6 | 19.7 | 26.9 | 13.2 |
| Progression Factor | 0.94 | | 0.88 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.7 | | 9.5 | 0.4 | | 0.0 | 0.4 | 1.3 | 0.0 | 0.2 | 0.9 | 0.4 |
| Delay (s) | 29.7 | | 32.4 | 29.6 | | 18.6 | 23.0 | 28.6 | 10.7 | 19.9 | 27.8 | 13.5 |
| Level of Service | C | | C | C | | B | C | C | B | B | C | B |
| Approach Delay (s) | | 31.5 | | | 24.7 | | | 22.1 | | | 16.8 | |
| Approach LOS | | C | | | C | | | C | | | B | |

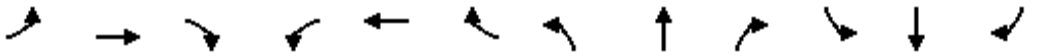
| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.0 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.64 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 75.6% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

c Critical Lane Group



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 735 | 0 | 355 | 95 | 0 | 195 | 180 | 60 | 50 | 145 | 60 | 555 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | 9.0 | 9.0 | 8.5 | 9.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 774 | 0 | 374 | 100 | 0 | 205 | 189 | 63 | 53 | 153 | 63 | 584 |
| RTOR Reduction (vph) | 0 | 0 | 300 | 0 | 0 | 85 | 0 | 0 | 26 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 774 | 0 | 74 | 100 | 0 | 120 | 189 | 63 | 27 | 153 | 63 | 584 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 | | | 5 | | | 1 6 | | | 1 5 6 |
| Actuated Green, G (s) | 27.9 | | 17.8 | 27.9 | | 17.8 | 17.8 | 17.8 | 54.2 | 17.8 | 17.8 | 90.0 |
| Effective Green, g (s) | 27.9 | | 17.8 | 27.9 | | 17.8 | 17.8 | 17.8 | 45.7 | 17.8 | 17.8 | 81.5 |
| Actuated g/C Ratio | 0.31 | | 0.20 | 0.31 | | 0.20 | 0.20 | 0.20 | 0.51 | 0.20 | 0.20 | 0.91 |
| Clearance Time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | | 9.0 | 8.5 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 1064 | | 313 | 549 | | 313 | 679 | 368 | 804 | 679 | 368 | 1433 |
| v/s Ratio Prot | c0.23 | | | 0.06 | | | 0.06 | 0.03 | | 0.04 | 0.03 | |
| v/s Ratio Perm | | | 0.05 | | | 0.08 | | | 0.02 | | | c0.37 |
| v/c Ratio | 0.73 | | 0.24 | 0.18 | | 0.38 | 0.28 | 0.17 | 0.03 | 0.23 | 0.17 | 0.41 |
| Uniform Delay, d1 | 27.7 | | 30.4 | 22.7 | | 31.3 | 30.6 | 30.0 | 11.1 | 30.3 | 30.0 | 0.6 |
| Progression Factor | 1.00 | | 1.00 | 0.93 | | 0.73 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 2.5 | | 0.4 | 0.1 | | 0.7 | 0.2 | 1.0 | 0.0 | 0.2 | 1.0 | 0.2 |
| Delay (s) | 30.2 | | 30.8 | 21.3 | | 23.4 | 30.9 | 31.0 | 11.1 | 30.5 | 31.0 | 0.8 |
| Level of Service | C | | C | C | | C | C | C | B | C | C | A |
| Approach Delay (s) | | 30.4 | | | 22.7 | | | 27.5 | | | 8.9 | |
| Approach LOS | | C | | | C | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 22.4 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 59.3% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 720 | 0 | 345 | 90 | 0 | 190 | 570 | 85 | 150 | 250 | 85 | 930 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | 9.0 | 9.0 | 8.5 | 9.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 758 | 0 | 363 | 95 | 0 | 200 | 600 | 89 | 158 | 263 | 89 | 979 |
| RTOR Reduction (vph) | 0 | 0 | 234 | 0 | 0 | 40 | 0 | 0 | 103 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 758 | 0 | 129 | 95 | 0 | 160 | 600 | 89 | 55 | 263 | 89 | 979 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 | | | 5 | | | 1 6 | | | 1 5 6 |
| Actuated Green, G (s) | 21.0 | | 31.9 | 21.0 | | 31.9 | 31.9 | 10.6 | 40.1 | 31.9 | 10.6 | 90.0 |
| Effective Green, g (s) | 21.0 | | 31.9 | 21.0 | | 31.9 | 31.9 | 10.6 | 31.6 | 31.9 | 10.6 | 81.5 |
| Actuated g/C Ratio | 0.23 | | 0.35 | 0.23 | | 0.35 | 0.35 | 0.12 | 0.35 | 0.35 | 0.12 | 0.91 |
| Clearance Time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | | 9.0 | 8.5 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 801 | | 561 | 413 | | 561 | 1217 | 219 | 556 | 1217 | 219 | 1433 |
| v/s Ratio Prot | c0.22 | | | 0.05 | | | 0.17 | 0.05 | | 0.08 | 0.05 | |
| v/s Ratio Perm | | | 0.08 | | | 0.10 | | | 0.04 | | | c0.62 |
| v/c Ratio | 0.95 | | 0.23 | 0.23 | | 0.29 | 0.49 | 0.41 | 0.10 | 0.22 | 0.41 | 0.68 |
| Uniform Delay, d1 | 33.9 | | 20.4 | 28.0 | | 20.9 | 22.7 | 36.8 | 19.6 | 20.3 | 36.8 | 1.1 |
| Progression Factor | 1.00 | | 1.00 | 0.52 | | 1.65 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 19.7 | | 0.2 | 0.3 | | 0.3 | 0.3 | 5.5 | 0.1 | 0.1 | 5.5 | 1.4 |
| Delay (s) | 53.7 | | 20.6 | 14.7 | | 34.7 | 23.0 | 42.3 | 19.7 | 20.4 | 42.3 | 2.4 |
| Level of Service | D | | C | B | | C | C | D | B | C | D | A |
| Approach Delay (s) | | 43.0 | | | 28.2 | | | 24.4 | | | 8.6 | |
| Approach LOS | | D | | | C | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 24.7 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.70 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 88.4% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | Grandview Ramp A |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | | Analysis Year | Year 2025 |

Project Description: US 160 FEIS Grandview Section - Year 2025 Analysis

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2700 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3055 |
| Ramp | 795 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 862 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =0.644 using Equation 5

$V_{12}$ = 2274 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 3055 | 6900 | No |
| $V_{12}$ | 2274 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 2193 | 6900 | No |
| $V_R$ | 862 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = 14.8 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.441 (Exhibit 25-19)

$S_R$= 52.1 mph (Exhibit 25-19)

$S_0$= 65.8 mph (Exhibit 25-19)

S = 55.0 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | Grandview Ramp A |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |

Project Description: US 160 FEIS Grandview Section - Year 2025 Analysis

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 4265 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 4826 |
| Ramp | 1540 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1670 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =0.563 using Equation 5

$V_{12}$ = 3445 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 4826 | 6900 | No |
| $V_{12}$ | 3445 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 3156 | 6900 | No |
| $V_R$ | 1670 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = 24.9 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.513 (Exhibit 25-19)

$S_R$= 50.8 mph (Exhibit 25-19)

$S_0$= 64.3 mph (Exhibit 25-19)

S = 54.0 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | Granview Ramp B |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

| Upstream Adj Ramp | Terrain Rolling | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| $V_u$ = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | $V_D$ = veh/h |

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1905 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2156 |
| Ramp | 595 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 645 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

### Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 2156 pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2801 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2801 | 4600:All | No |

### Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = 23.3 (pc/ m/ln)

LOS = C (Exhibit 25-4)

### Speed Estimation

$M_S$ = 0.337 (Exibit 25-19)

$S_R$= 53.9 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 53.9 mph (Exhibit 25-14)

Diverge Areas

### Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

### Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

### Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | Grandview Ramp B |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2725 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3084 |
| Ramp | 465 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 504 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 3084 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3588 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3588 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 29.5 (pc/ m/ln)

LOS = D (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.414 (Exibit 25-19)

$S_R$= 52.5 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 52.5 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp C |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

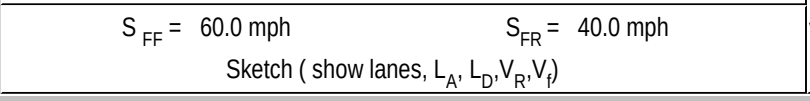
$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)



Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1750 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1980 |
| Ramp | 945 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1025 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1980 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3005 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3005 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 16.5 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.248 (Exibit 25-19)

$S_R$= 55.5 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 55.5 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp C |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 3135 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3547 |
| Ramp | 565 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 613 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 3547 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 4160 | See Exhibit 25-7 | No |
| $V_{R12}$ | 4160 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 25.7 (pc/ m/ln)

LOS = C (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.419 (Exibit 25-19)

$S_R$= 52.5 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 52.5 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp e |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

$L_{up}$ = 1700 ft

$V_u$ = 945 veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2695 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3050 |
| Ramp | 385 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 417 |
| UpStream | 945 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1025 |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.594 using Equation 1

$V_{12}$= 1813 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3467 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2230 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 18.9 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.309 (Exibit 25-19)

$S_R$= 54.4 mph (Exhibit 25-19)

$S_0$= 57.3 mph (Exhibit 25-19)

S= 55.4 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp E |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

$L_{up}$ = 1700 ft

$V_u$ = 565 veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 3700 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 4187 |
| Ramp | 590 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 640 |
| UpStream | 565 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 613 |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.594 using Equation 1

$V_{12}$= 2488 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 4827 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3128 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 25.8 (pc/ m/ln)

LOS = C (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.362 (Exibit 25-19)

$S_R$= 53.5 mph (Exhibit 25-19)

$S_0$= 55.7 mph (Exhibit 25-19)

S= 54.2 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | West of US 550 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2700 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 711 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1018 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1018 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 17.0 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | West of US 550 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 4265 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 1122 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1609 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1609 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 26.8 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | West of US 550 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 3080 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 811 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1162 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1162 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 19.4 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | West of US 550 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 4290 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 1129 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1618 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1618 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 27.0 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |
| Project Description | US 160 FEIS Grandview Section - Year 2025 Analysis | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2500 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2829 |
| Ramp | 1090 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1182 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 2829 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 2829 | 4600 | No |
| $V_{12}$ | 2829 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1647 | 4600 | No |
| $V_R$ | 1182 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 25.9 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.469 (Exhibit 25-19)

$S_R$= 51.6 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 51.6 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |
| Project Description | US 160 FEIS Grandview Section - Year 2025 Analysis | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 3190 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3610 |
| Ramp | 1065 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1155 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = 1.000 using Equation 0

$V_{12}$ = 3610 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 3610 | 4600 | No |
| $V_{12}$ | 3610 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 2455 | 4600 | No |
| $V_R$ | 1155 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = 32.6 (pc/ mi /ln)

LOS= D (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.467 (Exhibit 25-19)

$S_R$= 51.6 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 51.6 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | CR 223 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1410 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1596 |
| Ramp | 195 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 211 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1596 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 1807 | See Exhibit 25-7 | No |
| $V_{R12}$ | 1807 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 15.7 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.297 (Exibit 25-19)

$S_R$= 54.7 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 54.7 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | CR 223 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2125 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2405 |
| Ramp | 400 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 434 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

### Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 2405 pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2839 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2839 | 4600:All | No |

### Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 23.7 (pc/ m/ln)

LOS = C (Exhibit 25-4)

### Speed Estimation

$M_S$ = 0.340 (Exibit 25-19)

$S_R$= 53.9 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 53.9 mph (Exhibit 25-14)

Diverge Areas

### Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

### Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

### Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |
| Project Description | US 160 FEIS Grandview Section - Year 2025 Analysis | | |

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1685 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1907 |
| Ramp | 290 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 314 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 1907 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 1907 | 4600 | No |
| $V_{12}$ | 1907 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1593 | 4600 | No |
| $V_R$ | 314 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = 18.0 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.391 (Exhibit 25-19)

$S_R$= 53.0 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.0 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |
| Project Description | US 160 FEIS Grandview Section - Year 2025 Analysis | | |

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2290 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2591 |
| Ramp | 280 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 304 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 2591 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 2591 | 4600 | No |
| $V_{12}$ | 2591 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 2287 | 4600 | No |
| $V_R$ | 304 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 23.8 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.390 (Exhibit 25-19)

$S_R$= 53.0 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.0 mph (Exhibit 25-15)

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | US 550 to CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2500 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 658 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1414 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1414 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 23.6 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | US 550 to CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 3190 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 839 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1805 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1805 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 59.6 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 30.3 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | CR 233 to US 550 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |
| Description: | |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2130 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 561 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1205 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1205 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 20.1 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | CR 233 to US 550 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 3510 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 924 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1986 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1986 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 58.1 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 34.2 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Freeway Weaving Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency/Co.: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Dir of Travel: | US 160 Westbound |
| Weaving Location: | CR 233 On US 550 Off |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |
| Description: | US 160 FEIS Grandview Section - Year 2025 Analysis |

## Inputs

| | | |
|---|---|---|
| Freeway free-flow speed, SFF | 60 | mph |
| Weaving number of lanes, N | 3 | |
| Weaving segment length, L | 2070 | ft |
| Terrain type | Rolling | |
| Grade | | % |
| Length | | mi |
| Weaving type | A | Multilane or C-D |
| Volume ratio, VR | 0.49 | |
| Weaving ratio, R | 0.33 | |

## Conversion to pc/h Under Base Conditions

| | Non-Weaving V A-C | Non-Weaving V B-D | Weaving V A-D | Weaving V B-C | |
|---|---|---|---|---|---|
| Volume, V | 1053 | 38 | 342 | 697 | veh/h |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | |
| Peak 15-min volume, v15 | 277 | 10 | 90 | 183 | v |
| Trucks and buses | 5 | 5 | 5 | 5 | % |
| Recreational vehicles | 0 | 0 | 0 | 0 | % |
| Trucks and buses PCE, ET | 2.5 | 2.5 | 2.5 | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | 2.0 | 2.0 | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | 0.930 | 0.930 | 0.930 | |
| Driver population adjustment, fP | 1.00 | 1.00 | 1.00 | 1.00 | |
| Flow rate, v | 1191 | 42 | 386 | 788 | pc/h |

## Weaving and Non-Weaving Speeds

| | Weaving | Non-Weaving |
|---|---|---|
| a (Exhibit 24-6) | 0.15 | 0.00 |
| b (Exhibit 24-6) | 2.20 | 4.00 |
| c (Exhibit 24-6) | 0.97 | 1.30 |
| d (Exhibit 24-6) | 0.80 | 0.75 |
| Weaving intensity factor, Wi | 1.22 | 0.19 |
| Weaving and non-weaving speeds, Si | 37.47 | 57.00 |
| Number of lanes required for unconstrained operation, Nw (Exhibit 24-7) | | 1.62 |
| Maximum number of lanes, Nw (max) (Exhibit 24-7) | | 1.40 |
| Type of operation is | | Constrained |

## Weaving Segment Speed, Density, Level of Service and Capacity

| | | |
|---|---|---|
| Weaving segment speed, S | 45.45 | mph |
| Weaving segment density, D | 17.65 | pc/mi/ln |
| Level of service, LOS | B | |
| Capacity of base condition, cb | 4948 | pc/h |
| Capacity as a 15-minute flow rate, c | 4603 | pc/h |
| Capacity as a full-hour volume, ch | 4373 | pc/h |

## Limitations on Weaving Segments

| | Analyzed | If Max Exceeded Maximum | See Note Note |
|---|---|---|---|
| Weaving flow rate, Vw | 1174 | 2800 | a |
| Average flow rate (pcphpl) | 802 | 2300 | b |
| Volume ratio, VR | 0.49 | 0.45 | c |
| Weaving ratio, R | 0.33 | N/A | d |
| Weaving length (ft) | 2070 | 2500 | e |

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS2000: Freeway Weaving Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency/Co.: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Dir of Travel: | US 160 Westbound |
| Weaving Location: | CR 233 On US 550 Off |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

| | | |
|---|---|---|
| Freeway free-flow speed, SFF | 60 | mph |
| Weaving number of lanes, N | 3 | |
| Weaving segment length, L | 2070 | ft |
| Terrain type | Rolling | |
| Grade | | % |
| Length | | mi |
| Weaving type | A | Multilane or C-D |
| Volume ratio, VR | 0.51 | |
| Weaving ratio, R | 0.19 | |

## Conversion to pc/h Under Base Conditions

| | Non-Weaving V A-C | Non-Weaving V B-D | Weaving V A-D | Weaving V B-C | |
|---|---|---|---|---|---|
| Volume, V | 1673 | 38 | 337 | 1462 | veh/h |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | |
| Peak 15-min volume, v15 | 440 | 10 | 89 | 385 | v |
| Trucks and buses | 5 | 5 | 5 | 5 | % |
| Recreational vehicles | 0 | 0 | 0 | 0 | % |
| Trucks and buses PCE, ET | 2.5 | 2.5 | 2.5 | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | 2.0 | 2.0 | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | 0.930 | 0.930 | 0.930 | |
| Driver population adjustment, fP | 1.00 | 1.00 | 1.00 | 1.00 | |
| Flow rate, v | 1893 | 42 | 381 | 1654 | pc/h |

## Weaving and Non-Weaving Speeds

| | Weaving | Non-Weaving |
|---|---|---|
| a (Exhibit 24-6) | 0.15 | 0.00 |
| b (Exhibit 24-6) | 2.20 | 4.00 |
| c (Exhibit 24-6) | 0.97 | 1.30 |
| d (Exhibit 24-6) | 0.80 | 0.75 |
| Weaving intensity factor, Wi | 2.06 | 0.39 |
| Weaving and non-weaving speeds, Si | 31.32 | 50.97 |
| Number of lanes required for unconstrained operation, Nw (Exhibit 24-7) | | 1.77 |
| Maximum number of lanes, Nw (max) (Exhibit 24-7) | | 1.40 |
| Type of operation is | | Constrained |

## Weaving Segment Speed, Density, Level of Service and Capacity

| | | |
|---|---|---|
| Weaving segment speed, S | 38.57 | mph |
| Weaving segment density, D | 34.31 | pc/mi/ln |
| Level of service, LOS | D | |
| Capacity of base condition, cb | 4948 | pc/h |
| Capacity as a 15-minute flow rate, c | 4603 | pc/h |
| Capacity as a full-hour volume, ch | 4373 | pc/h |

## Limitations on Weaving Segments

| | Analyzed | If Max Exceeded Maximum | See Note Note |
|---|---|---|---|
| Weaving flow rate, Vw | 2035 | 2800 | a |
| Average flow rate (pcphpl) | 1323 | 2300 | b |
| Volume ratio, VR | 0.51 | 0.45 | c |
| Weaving ratio, R | 0.19 | N/A | d |
| Weaving length (ft) | 2070 | 2500 | e |

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | CR 233 to SH 172 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1605 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 422 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 908 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 908 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 15.1 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | CR 233 to SH 172 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2525 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 664 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1429 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1429 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 23.8 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | SH 172 to CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1685 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 443 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 953 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 953 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 15.9 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | SH 172 to CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2025 |

Description: US 160 FEIS Grandview Section - Year 2025 Analysis

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2290 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 603 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1296 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1296 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 21.6 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |
| Project Description | US 160 FEIS Grandview Section - Year 2025 Analysis | | |

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1605 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1816 |
| Ramp | 585 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 634 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 1816 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 1816 | 4600 | No |
| $V_{12}$ | 1816 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1182 | 4600 | No |
| $V_R$ | 634 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 17.2 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.420 (Exhibit 25-19)

$S_R$= 52.4 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 52.4 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |
| Project Description | US 160 FEIS Grandview Section - Year 2025 Analysis | | |

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2525 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2857 |
| Ramp | 1180 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1279 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

## Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

## Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 2857 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 2857 | 4600 | No |
| $V_{12}$ | 2857 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1578 | 4600 | No |
| $V_R$ | 1279 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 26.1 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.478 (Exhibit 25-19)

$S_R$= 51.4 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 51.4 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1020 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1154 |
| Ramp | 110 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 119 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1154 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 1273 | See Exhibit 25-7 | No |
| $V_{R12}$ | 1273 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 11.6 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.287 (Exibit 25-19)

$S_R$= 54.8 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 54.8 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1345 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1522 |
| Ramp | 240 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 260 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1522 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 1782 | See Exhibit 25-7 | No |
| $V_{R12}$ | 1782 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 15.5 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.296 (Exibit 25-19)

$S_R$= 54.7 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 54.7 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |
| Project Description | US 160 FEIS Grandview Section - Year 2025 Analysis | | |

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 935 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1058 |
| Ramp | 135 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 146 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 1058 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | 1058 | 4600 | No |
| $V_{12}$ | 1058 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 912 | 4600 | No |
| $V_R$ | 146 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 10.7 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.376 (Exhibit 25-19)

$S_R$= 53.2 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.2 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |
| Project Description | US 160 FEIS Grandview Section - Year 2025 Analysis | | |

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1450 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1641 |
| Ramp | 205 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 222 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 1641 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 1641 | 4600 | No |
| $V_{12}$ | 1641 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1419 | 4600 | No |
| $V_R$ | 222 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 15.7 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.383 (Exhibit 25-19)

$S_R$= 53.1 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.1 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 800 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 905 |
| Ramp | 885 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 960 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

### Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 905 pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 1865 | See Exhibit 25-7 | No |
| $V_{R12}$ | 1865 | 4600:All | No |

### Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 15.8 (pc/ m/ln)

LOS = B (Exhibit 25-4)

### Speed Estimation

$M_S$ = 0.298 (Exibit 25-19)

$S_R$= 54.6 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 54.6 mph (Exhibit 25-14)

Diverge Areas

### Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

### Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

### Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2025 |

Project Description US 160 FEIS Grandview Section - Year 2025 Analysis

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1245 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1409 |
| Ramp | 1045 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1133 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1409 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2542 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2542 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 21.0 (pc/ m/ln)

LOS = C (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.323 (Exibit 25-19)

$S_R$= 54.2 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 54.2 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# Appendix B

## Alternative G Modified

At-Grade Intersection Evaluation Worksheets

# Preferred Alternative (G Modified) Analysis

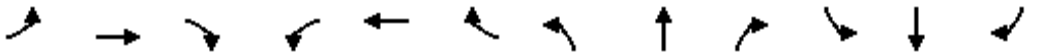
## (At-Grade, Signalized Intersections)

### Apendix B - US 160 Analysis - Peak Hour LOS Results (Signalized Intersections)

| Intersection and Approaches | 2025 Traffic Volumes with Current Laneage | | | | | Year 2025 Traffic Volumes with 3 Lanes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Lanes | AM Peak Hour | | PM Peak Hour | | Number of Lanes | AM Peak Hour | | PM Peak Hour | |
| | | Delay[(a)] | LOS | Delay[(a)] | LOS | | Delay[(a)] | LOS | Delay[(a)] | LOS |
| **SIGNAL CONTROL** | | | | | | | | | | |
| **US 550 & US 160** | - | **142.2** | **F** | **241.3** | **F** | - | **72.3** | **E** | **116.9** | **F** |
| Eastbound Left | 2 | *223.3* | *F* | *295.3* | *F* | *2* | *137.9* | *F* | *218.5* | *F* |
| Eastbound Through | 2 | *158.8* | *F* | *241.3* | *F* | *3* | *61.4* | *E* | *67.3* | *E* |
| Eastbound Right | 1 | *0.3* | *A* | *2.7* | *A* | *1* | *0.3* | *A* | *2.7* | *A* |
| Westbound Left | 2 | *164.4* | *F* | *110.5* | *F* | *2* | *127.2* | *F* | *123.2* | *F* |
| Westbound Through | 2 | *175.5* | *F* | *403.7* | *F* | *3* | *91.0* | *F* | *205.6* | *F* |
| Westbound Right | 1 | *28.5* | *C* | *39.7* | *D* | *1* | *34.3* | *C* | *55.3* | *E* |
| Northbound Left | 2 | *215.2* | *F* | *317.5* | *F* | *2* | *111.4* | *F* | *214.9* | *F* |
| Northbound Through | 1 | *46.0* | *D* | *62.4* | *E* | *1* | *40.3* | *D* | *65.2* | *E* |
| Northbound Right | 1 | *0.5* | *A* | *0.3* | *A* | *1* | *0.5* | *A* | *0.3* | *A* |
| Southbound Left | 1 | *72.6* | *E* | *88.7* | *F* | *1* | *72.0* | *E* | *69.2* | *E* |
| Southbound Through | 1 | *59.2* | *E* | *61.1* | *E* | *1* | *59.2* | *E* | *61.1* | *E* |
| Southbound Right | 1 | *0.4* | *A* | *0.7* | *A* | *1* | *0.4* | *A* | *0.7* | *A* |

Notes:

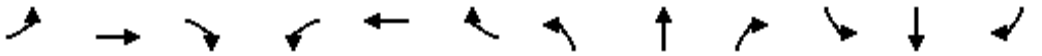
a) Delay measured as seconds per vehicle



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 480 | 1905 | 315 | 240 | 1750 | 140 | 945 | 70 | 485 | 110 | 55 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 3539 | 1583 | 3433 | 3539 | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 3539 | 1583 | 3433 | 3539 | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 505 | 2005 | 332 | 253 | 1842 | 147 | 995 | 74 | 511 | 116 | 58 | 405 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 62 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 505 | 2005 | 332 | 253 | 1842 | 85 | 995 | 74 | 511 | 116 | 58 | 405 |
| Turn Type | Prot | | Free | Prot | | Perm | Prot | | Free | Prot | | Free |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | Free | | | Free |
| Actuated Green, G (s) | 17.0 | 68.5 | 151.0 | 10.0 | 61.5 | 61.5 | 33.0 | 36.5 | 151.0 | 18.0 | 21.5 | 151.0 |
| Effective Green, g (s) | 17.0 | 68.5 | 151.0 | 10.0 | 61.5 | 61.5 | 33.0 | 36.5 | 151.0 | 18.0 | 21.5 | 151.0 |
| Actuated g/C Ratio | 0.11 | 0.45 | 1.00 | 0.07 | 0.41 | 0.41 | 0.22 | 0.24 | 1.00 | 0.12 | 0.14 | 1.00 |
| Clearance Time (s) | 4.0 | 5.0 | | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | | 4.0 | 5.0 | |
| Lane Grp Cap (vph) | 386 | 1605 | 1583 | 227 | 1441 | 645 | 750 | 450 | 1583 | 211 | 265 | 1583 |
| v/s Ratio Prot | c0.15 | c0.57 | | 0.07 | 0.52 | | c0.29 | 0.04 | | 0.07 | 0.03 | |
| v/s Ratio Perm | | | 0.21 | | | 0.05 | | | c0.32 | | | 0.26 |
| v/c Ratio | 1.31 | 1.25 | 0.21 | 1.11 | 1.28 | 0.13 | 1.33 | 0.16 | 0.32 | 0.55 | 0.22 | 0.26 |
| Uniform Delay, d1 | 67.0 | 41.2 | 0.0 | 70.5 | 44.8 | 28.0 | 59.0 | 45.2 | 0.0 | 62.7 | 57.3 | 0.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 156.3 | 117.5 | 0.3 | 93.9 | 130.7 | 0.4 | 156.2 | 0.8 | 0.5 | 9.9 | 1.9 | 0.4 |
| Delay (s) | 223.3 | 158.8 | 0.3 | 164.4 | 175.5 | 28.5 | 215.2 | 46.0 | 0.5 | 72.6 | 59.2 | 0.4 |
| Level of Service | F | F | A | F | F | C | F | D | A | E | E | A |
| Approach Delay (s) | | 151.7 | | | 164.6 | | | 137.8 | | | 20.8 | |
| Approach LOS | | F | | | F | | | F | | | C | |

| Intersection Summary | | | | | |
|---|---|---|---|---|---|
| HCM Average Control Delay | 142.2 | HCM Level of Service | | F | |
| HCM Volume to Capacity ratio | 1.08 | | | | |
| Actuated Cycle Length (s) | 151.0 | Sum of lost time (s) | | 8.0 | |
| Intersection Capacity Utilization | 107.4% | ICU Level of Service | | G | |
| Analysis Period (min) | 15 | | | | |

c Critical Lane Group



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 480 | 2725 | 1060 | 240 | 3135 | 135 | 565 | 70 | 295 | 170 | 85 | 590 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.95 | 1.00 | 0.97 | 0.95 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 3539 | 1583 | 3433 | 3539 | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 3539 | 1583 | 3433 | 3539 | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 505 | 2868 | 1116 | 253 | 3300 | 142 | 595 | 74 | 311 | 179 | 89 | 621 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 505 | 2868 | 1116 | 253 | 3300 | 109 | 595 | 74 | 311 | 179 | 89 | 621 |
| Turn Type | Prot | | Free | Prot | | Perm | Prot | | Free | Prot | | Free |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | Free | | | Free |
| Actuated Green, G (s) | 15.0 | 83.5 | 150.0 | 10.0 | 78.5 | 78.5 | 17.0 | 19.5 | 150.0 | 19.0 | 21.5 | 150.0 |
| Effective Green, g (s) | 15.0 | 83.5 | 150.0 | 10.0 | 78.5 | 78.5 | 17.0 | 19.5 | 150.0 | 19.0 | 21.5 | 150.0 |
| Actuated g/C Ratio | 0.10 | 0.56 | 1.00 | 0.07 | 0.52 | 0.52 | 0.11 | 0.13 | 1.00 | 0.13 | 0.14 | 1.00 |
| Clearance Time (s) | 4.0 | 5.0 | | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | | 4.0 | 5.0 | |
| Lane Grp Cap (vph) | 343 | 1970 | 1583 | 229 | 1852 | 828 | 389 | 242 | 1583 | 224 | 267 | 1583 |
| v/s Ratio Prot | c0.15 | 0.81 | | 0.07 | c0.93 | | c0.17 | 0.04 | | 0.10 | 0.05 | |
| v/s Ratio Perm | | | c0.70 | | | 0.07 | | | 0.20 | | | 0.39 |
| v/c Ratio | 1.47 | 1.46 | 0.70 | 1.10 | 1.78 | 0.13 | 1.53 | 0.31 | 0.20 | 0.80 | 0.33 | 0.39 |
| Uniform Delay, d1 | 67.5 | 33.2 | 0.0 | 70.0 | 35.8 | 18.3 | 66.5 | 59.1 | 0.0 | 63.6 | 57.8 | 0.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 0.81 | 1.45 | 2.17 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 227.8 | 208.0 | 2.7 | 53.7 | 352.0 | 0.0 | 251.0 | 3.2 | 0.3 | 25.0 | 3.3 | 0.7 |
| Delay (s) | 295.3 | 241.3 | 2.7 | 110.5 | 403.7 | 39.7 | 317.5 | 62.4 | 0.3 | 88.7 | 61.1 | 0.7 |
| Level of Service | F | F | A | F | F | D | F | E | A | F | E | A |
| Approach Delay (s) | | 188.0 | | | 369.7 | | | 197.6 | | | 24.5 | |
| Approach LOS | | F | | | F | | | F | | | C | |

| Intersection Summary | | | | | |
|---|---|---|---|---|---|
| HCM Average Control Delay | 241.3 | HCM Level of Service | F | | |
| HCM Volume to Capacity ratio | 1.51 | | | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 13.0 | | |
| Intersection Capacity Utilization | 134.8% | ICU Level of Service | H | | |
| Analysis Period (min) | 15 | | | | |

c Critical Lane Group

# SEH MEMORANDUM

# Year 2030 Traffic Operations Analysis for Alternatives of the US 160 FEIS

# September 17, 2010

MEMORANDUM

TO: Mike McVaugh, PE - CDOT Region 5

FROM: Phil Weisbach, PE
Jon E. Larson, PE

DATE: September 17, 2010

RE: Year 2030 Traffic Operations Analysis for Alternatives of the US 160 FEIS
SEH No. CODOT – 105181

## Executive Summary

Alternatives for the US 550 connection to the US 160 corridor were originally evaluated in the US Highway 160 from Durango to Bayfield Final Environmental Impact Statement (FEIS) dated May 2006. The US 160 Highway from Durango to Bayfield Record of Decision (US 160 ROD) documented selection of Grandview Alternative G Modified as the Preferred Alternative which included an interchange of US 160 with US 550 approximately 0.6 miles east of the current intersection.

This analysis updates the traffic operations analysis from the FEIS to the year 2030 for several alternatives listed below and for at-grade intersections. An additional memo will analyze options for the US 160 Section 4(f) which includes some of the alternatives from the US 160 FEIS. This analysis looks at projected traffic in the year 2030 to evaluate if the roadway will meet the capacity requirements for the purpose and need 20 years into the future. The technical documentation of this analysis is included in the appendices of this memo.

This analysis addresses several questions:

A. Does the US 160 Alternative G Modified continue to meet the capacity requirements of the purpose and need in the design year 2030?
B. Do the future connections at Alternative G Modified, Three Springs/CR 233, and SH 172/CR 234 in the design year 2030 need to be interchanges?
C. In the year 2030, does Alternative F Modified from the US 160 FEIS meet the capacity requirements of the purpose and need?

The purpose for improvements to the US 160 corridor include increasing travel efficiency and capacity to meet current and future needs, while improving safety for the traveling public by reducing the number and severity of accidents, and controlling access. The design year of the US 160 FEIS was 2025. The analysis performed in this memorandum will be the same as the FEIS except the design year is changed to 2030.

**Summary of Results:** The results of the analysis performed are summarized below:

| YEAR 2030 Analysis | Purpose and Need for Capacity | |
|---|---|---|
| | Met | Not Met |
| Alternative (G Modified) | ✓ | |
| Alternative (F Modified) | | ✓ |
| **At-Grade Signalized Intersections** | | |
| US 160 @ 172/CR 234 | | ✓ |
| US 160 @ CR 233 (Three Springs) | | ✓ |
| US 160 @ Grandview | | ✓ |

# Analysis Performed

## Evaluation Criteria

The interchange alternatives were evaluated to determine if each alternative met operational level of service requirements as described in the Executive Summary of the FEIS, based on guidance in the AASHTO Policy on Geometric Design of Highways and Streets 2004 (AASHTO Green Book) and capacity analysis performed according to the methods described in the Highway Capacity Manual[1] (HCS). This memorandum deals with the capacity analysis and not design. Traffic volumes used in the analysis are year 2030 peak hour volumes that were projected from the year 2025 volumes documented in Appendix A, Traffic Report, Figure 8 of the US 160 FEIS. The 2025 background traffic volumes were projected based on the background annual growth rates in the accepted methodology in the FEIS to calculate the year 2030 background scenario. For this scenario it is assumed the approved development of the 2004 Grandview Area Plan by the City of Durango and La Plata County is fully built out in the year 2030. The trips generated by the Grandview development were combined with the year 2030 background volumes to generate the year 2030 total peak hour volumes used in the analysis.

The capacity requirement for the purpose and need of the Grandview Section is as follows:

- A Level of Service (LOS) D or better for an urban signalized intersection, including signalized intersections at single point urban interchanges (SPUI), and its individual legs or movements during the peak hour in year 2030; and
- A LOS D or better for urban interchange merge, diverge, weaving area, auxiliary lanes, and/or freeway sections during the peak hour in year 2030.

Anything worse than LOS D for any intersection, leg, movement, ramp or freeway section is considered "failing," and not meeting the purpose and need. These criteria were applied to the alternatives analyzed in this memorandum.

---

[1] Highway Capacity Manual - Special Report 209. Transportation Research Board. National Research Council. 2000.

For the purposes of this analysis, US 160 is assumed to be east/west and US 550 is assumed to be north/south. Each analysis verifies the capacity requirements of each interchange that is a part of the Grandview Section as described in the FEIS.

**US 160 Continuous Through Lanes**

**US 160 FEIS**

Using year 2025 projected traffic volumes, the Alternative G Modified in the US 160 FEIS included a four-lane typical section, two continuous lanes in each direction, throughout the corridor with a westbound auxiliary lane and eastbound climbing lane from the Grandview Section limit at MP 88 to the future connection of US 160 and US 550. Auxiliary lanes were added to maintain an operational level of service of D by improving the merge, diverge and weave movements, thus helping to make safer lane transitions to and from the future location US 160/US 550 interchange.

**Year 2030 Traffic Operations Analysis**

In the analysis, the projected traffic volumes were extended to the year 2030. The background traffic on US 160 was increased from the year 2025 to 2030, and the trip generation from a fully developed Grandview Area Plan increased traffic on the US 160 mainline as well as the entering and exiting traffic volumes to US 160. Due to the increased entering/exiting volumes, auxiliary lanes will need to be extended, from those assumed in the US 160 FEIS. The auxiliary lanes in the year 2030 need to be extended to the future CR 233 (Three Springs) interchange to maintain a LOS D for the traffic operations of the merge, diverge and weaving movements along US 160.

Since the number of continuous through lanes remains constant throughout the US 160 corridor and auxiliary lanes are not carried through any of the interchanges, auxiliary lanes are not considered capacity-adding improvement measures. However, they can be utilized to improve the traffic operations between two successive interchanges and to assist in accommodating high entering/exiting traffic volumes. Without auxiliary lanes at high volume locations, bottleneck areas can result due to poor levels of service for the merging, diverging, and weaving movements. Areas of congestion such as bottleneck locations typically coincide with areas that exhibit poor accident ratings.

**Special Case: Alternative F Modified**

Though Alternative F modified does not include a Grandview interchange, the auxiliary lane assumptions for this alternative do not change. From the west project limit to the Alternative F Modified Interchange (Three Springs interchange) there would be two through lanes in each direction with an eastbound climbing lane and a westbound auxiliary lane. This is true for the US 160 FEIS as well in the year 2030 analysis.

**US 160 Interchanges and Signalized Intersections**

- **Highway Segments, Ramp Merge/Diverge, Weaving Sections.** The capacity of each of these features was evaluated based on HCS criteria with a minimum LOS D or better as the operational goal. The Year 2025 projected traffic volumes from the FEIS were adjusted to reflect projected Year 2030 volumes, and were used to evaluate LOS for each alternative.
- **Signalized Intersections.** The capacities of signalized intersections were evaluated using HCS criteria with a minimum LOS D or better for the intersection and the individual legs of the intersection. An individual leg having an LOS of E or F is also a failing criteria for the intersection.

## Alternative G Modified (FEIS) Analysis (Year 2030) – Figure 1

This evaluation was performed to determine whether the Alternative G Modified (FEIS) meets the capacity requirements of the purpose and need for the design year 2030. The analysis assumes two

through lanes in each direction through the Grandview Section with a westbound auxiliary lane and eastbound climbing lane from the Grandview Section limit at MP 88 to the future connection of US 160 and US 550, similar to the US 160 FEIS, but with additional eastbound and westbound auxiliary lanes between the US 160/US 550 interchange and CR 233 (Three Springs) interchange. A trumpet interchange is assumed at the US 550 Grandview Interchange and Single Point Urban Interchange (SPUI) is assumed at both the CR 233 (Three Springs) and SH 172 / CR 234 interchanges.

The results of the analysis (Figure 1) show that the freeway segments and ramp merge/diverge operations for all of the interchanges are expected to operate at LOS D or better during the morning and evening peak periods. The analysis worksheets are contained in Appendix A for reference.

**Conclusion**

Based on the analysis, the results show that this alternative satisfies the capacity requirements of the purpose and need in the year 2030. This alternative accommodates the projected year 2030 volumes at LOS D or better.

## At-Grade, Signalized Intersection Analysis – Figure 2

For this scenario, it is assumed that US 550 connects to US 160 at the existing connection or west of that location. The traffic volumes on US 550 were routed as through volumes on US 160 based on historic directional splits at the existing US 550 / US 160 intersection.

The connections evaluated in the US 160 FEIS Alternative G Modified were analyzed as at-grade, signalized intersections using year 2025 peak hour traffic volumes. This analysis is to determine if these connections could operate as at-grade intersections in the year 2030. Figure 2 illustrates the intersection laneage configurations, traffic volumes and the traffic operations analysis results. The analysis worksheets are contained in Appendix B for reference.

**SH 172 / CR 234 – Signalized Intersection**

The assumed lane configuration on US 160 includes two left turn lanes (eastbound), one left turn lane (westbound), two through lanes and one right turn lane in each direction. On CR 234 (southbound), the lane configuration includes one lane each for the left turn, through and right turn movements. On SH 172 (northbound), the lane configuration includes two left turn lanes, one through lane and one right turn lane.

The signalized intersection is expected to operate at LOS D in the morning peak period and LOS E in the evening peak period. Numerous individual movements are shown to exhibit LOS E during the morning peak period and LOS F during the evening peak period as well. A triple left turn lane on northbound SH 172 is a critical improvement in that this intersection could not meet the LOS D capacity requirements in the year 2030 without it. However, there is a local cemetery on the southwest corner of the intersection and on the east side of the intersection approximately 1500 feet south there is a local elementary school. These two features constrain the intersection and its ability to carry more lanes of traffic. To avoid impacts to the cemetery and the school, the FEIS selected a SPUI to address the traffic volumes at this intersection. The limits of the proposed interchange in the FEIS do not encroach on either of these properties. An at-grade signalized intersection would encroach on one or both properties if additional lanes were added to SH 172 to accommodate the traffic volumes at the intersection.

**CR 233 (Three Springs) – Signalized Intersection**

The assumed lane configuration on US 160 includes two left turn lanes (eastbound), one left turn lane (westbound), two through lanes and one right turn lane in each direction. On Three Springs Blvd., the lane configuration includes two left turn lanes, one through lane and one right turn lane southbound and one through lane, left turn lane, and right turn lane northbound.

The signalized intersection is expected to operate at LOS D in the morning peak period and LOS F in the evening peak period. Numerous individual movements are shown to exhibit LOS F during the morning and evening peak periods as well.

In an attempt to improve the LOS to acceptable levels, additional lanes were added to particularly heavy movements and signal timing was optimized. Even with providing three lanes in each direction through the intersection on US 160 and analyzing triple left turn lanes, the LOS D evaluation criteria for signalized intersections and individual movements could not be achieved.

**Grandview – Signalized Intersection**

The assumed lane configuration on US 160 includes two left turn lanes, two through lanes, and one right turn lane in each direction. On the Grandview approach, the lane configuration includes two left turn lanes, one through lane and one right turn lane in each direction.

The signalized intersection is expected to operate at LOS C in the morning peak period and LOS F during the evening peak period. Numerous individual movements are shown to exhibit LOS F during the morning and evening peak periods as well.

In an attempt to improve the LOS to acceptable levels, additional lanes were added to particularly heavy movements and signal timing was optimized. Even with providing three lanes in each direction through the intersection on US 160 and analyzing triple left turn lanes, the LOS D evaluation criteria for signalized intersections and individual movements could not be achieved.

**Conclusion**

Based on the analysis of the three intersections, the results show that interchanges are necessary for the three connections to satisfy the capacity requirements for the purpose and need.

## Alternative F Modified (FEIS) Analysis (Year 2030) - Figure 3

This evaluation was performed to determine whether Alternative F Modified (Figure 3) meets the capacity requirements of the purpose and need in the year 2030, while utilizing the same evaluation criteria as in the FEIS. Though Alternative F modified (Three Springs Interchange) does not include a Grandview interchange, the auxiliary lane assumptions for this alternative do not change. From the west project limit to the Three Springs interchange would be two through lanes in each direction with an eastbound climbing lane and a westbound auxiliary lane. This is true for the US 160 FEIS as well as the year 2030 analysis. Interchanges evaluated where the SPUI interchanges at SH 172/CR 234 and CR 233 (Three Springs) with US 550 connecting at CR 233 (Three Springs). The Three Springs development traffic was distributed equally (50/50) to the CR 233 (Three Springs) and SH 172/CR 234 interchanges. The analysis worksheets are contained in Appendix C for reference.

**SH 172 / CR 234 Interchange**

The interchange will have single lane ramps with merge and diverge movements that will continue to operate acceptably at LOS B during the morning peak period and LOS C or better during the evening peak period. The signalized intersection in the center of the interchange will continue to operate acceptably at LOS C during the morning and evening peak periods with individual movements operating at LOS D or better during both peak periods.

**CR 233 (Three Springs) Interchange**

The merge, diverge, and weave movements will continue to operate acceptably at LOS C or better during the morning and evening peak periods except for the westbound on-ramp which is expected to operate at LOS F. The signalized intersection in the center of the interchange will continue to operate acceptably at LOS C during the morning peak period and LOS D during the evening peak period. However, the

eastbound right turn, northbound left turn, northbound through and southbound through movements will degrade to an unacceptable LOS E during the evening peak period.

**Conclusion**

With the additional traffic at the CR 233 (Three Springs) interchange for the Alternative F Modified configuration, the operational capacity does not satisfy the capacity requirements for the purpose and need due to the failing LOS for the US 160 westbound on-ramp merge to southbound US 550 at the CR 233 (Three Springs) interchange and the failing LOS southbound from CR 233 (Three Springs) to US 160 westbound right turn movement. This alternative does not meet the capacity requirement for the purpose and need in the year 2030.

## Conclusions

The following conclusions answer three questions fundamental to the purpose of the traffic operations analysis in this memorandum:

*Does the US 160 Alternative G Modified continue to meet the capacity requirements of the purpose and need in the design year 2030?*

**Alternative G Modified (FEIS) Analysis (Year 2030).** With year 2030 traffic volumes, this alternative meets the LOS criteria for the purpose and need.

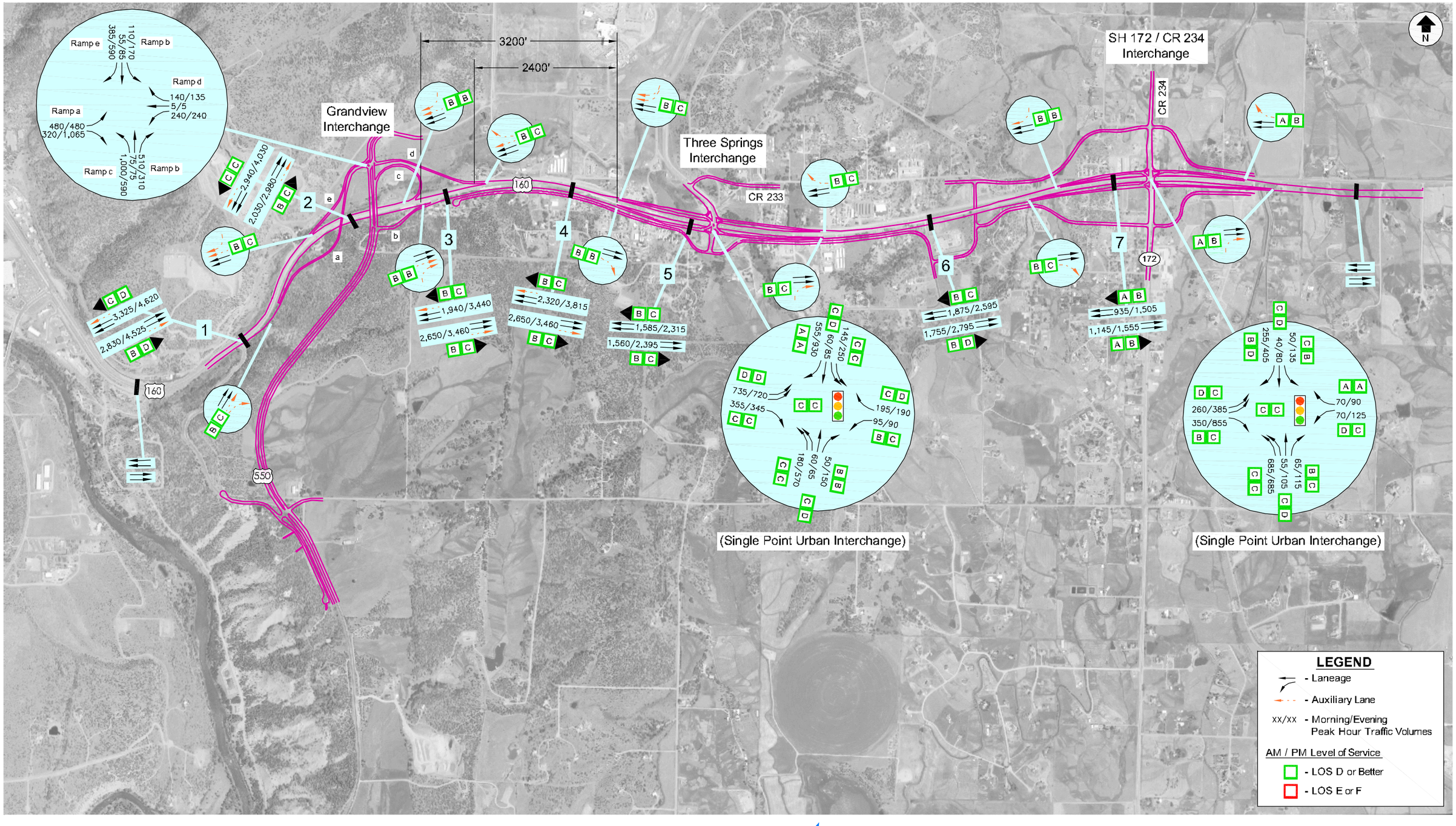
*Do the future connections at Alternative G Modified, Three Springs/CR 233, and SH 172/CR 234 in the design year 2030 need to be interchanges?*

**At-Grade, Signalized Intersections Analysis.** The signalized intersections are expected to operate at a failing LOS at the Grandview and CR 233 (Three Springs) intersections even with the absence of a northbound US 550 connection. The SH 172 / CR 234 intersection has environmental and other constraints that do not allow SH 172 to be widened to accommodate the 2030 traffic volumes. The results show that interchanges are necessary for the three connections to US 160 to satisfy the capacity requirements of the purpose and need.

*In the year 2030, does Alternative F Modified from the US 160 FEIS meet the capacity requirements of the purpose and need?*

**Alternative F Modified (FEIS) Analysis (Year 2030).** The CR 233 (Three Springs) interchange exceeds the LOS D threshold, therefore this alternative fails to meet the capacity requirements for the purpose and need.

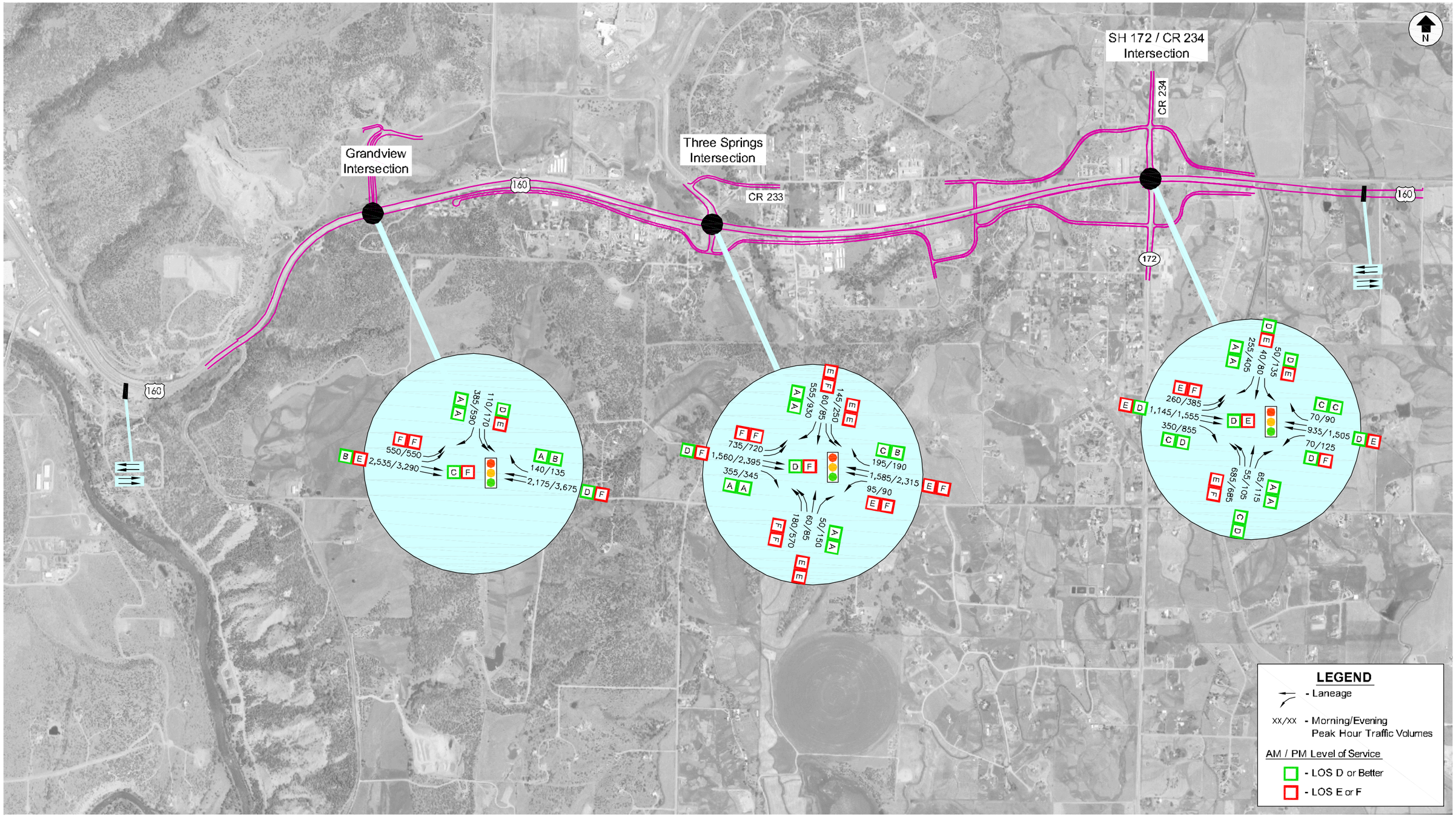
jel
Attachments
p:\ae\c\codot\105181\to #3 - us 160 interchange analysis\project___final memos_september 2010\2_2030 traffic ops analysis for alternatives from the us 160 feis_09-17-2010_final.docx




# Year 2030 Traffic Volumes

Year 2030 Traffic Operations Analysis for Alternatives of the US 160 FEIS
US 160 FEIS Alternative G (Modified) - Interchange Analysis

| Scale | 1"=1500' | Date | 4/28/10 | Drawn by | NWS | Job # | 105181 | Figure | 1 |
|---|---|---|---|---|---|---|---|---|---|

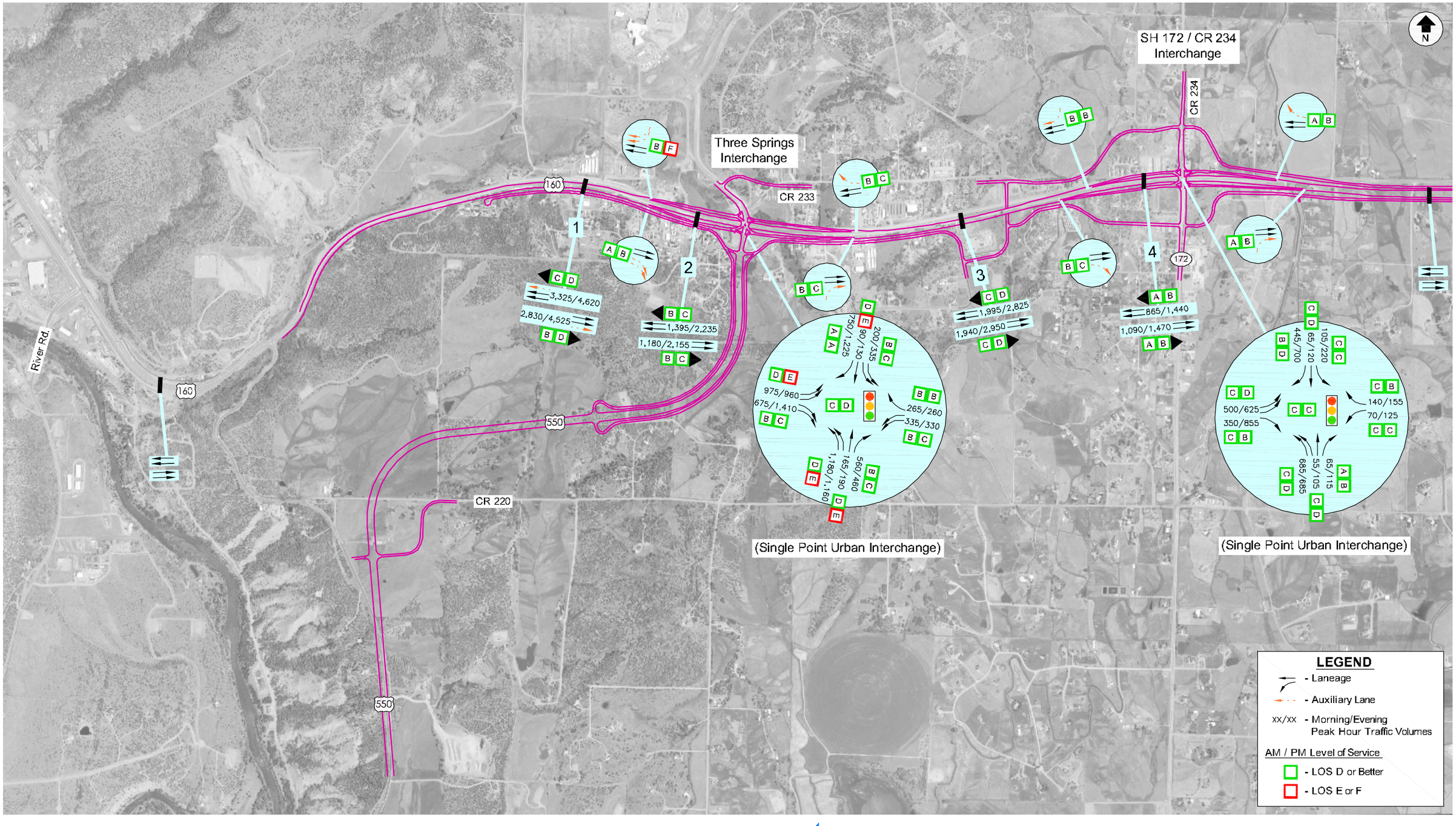



# Year 2030 Traffic Volumes

SEH

Year 2030 Traffic Operations Analysis for Alternatives of the US 160 FEIS
US 160 FEIS Alternative G (Modified) - At-Grade, Signalized Intersection Analysis

| Scale | 1"=1500' | Date | 4/28/10 | Drawn by | NWS | Job # | 105181 | Figure | 2 |
|---|---|---|---|---|---|---|---|---|---|




# Year 2030 Traffic Volumes

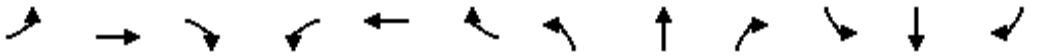
Year 2030 Traffic Operations Analysis for Alternatives of the US 160 FEIS
US 160 FEIS Alternative F (Modified) - Interchange Analysis

| Scale | 1"=1500' | Date | 4/28/10 | Drawn by | NWS | Job # | 105181 | Figure | 3 |
|---|---|---|---|---|---|---|---|---|---|

# Appendix A

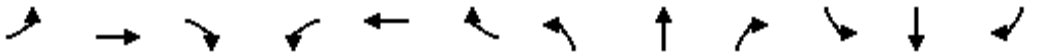
## Alternative G Modified

Interchange Evaluation Worksheets



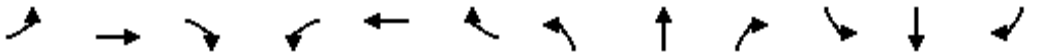
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 385 | 0 | 855 | 125 | 0 | 90 | 685 | 105 | 115 | 135 | 80 | 405 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 10.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 9.5 | 10.0 | 10.0 | 9.5 | 10.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 405 | 0 | 900 | 132 | 0 | 95 | 721 | 111 | 121 | 142 | 84 | 426 |
| RTOR Reduction (vph) | 0 | 0 | 211 | 0 | 0 | 39 | 0 | 0 | 82 | 0 | 0 | 63 |
| Lane Group Flow (vph) | 405 | 0 | 689 | 132 | 0 | 56 | 721 | 111 | 39 | 142 | 84 | 363 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 6 |
| Actuated Green, G (s) | 17.8 | | 52.7 | 17.8 | | 52.7 | 31.5 | 11.2 | 38.5 | 31.5 | 11.2 | 38.5 |
| Effective Green, g (s) | 17.8 | | 52.7 | 17.8 | | 52.7 | 31.5 | 11.2 | 29.0 | 31.5 | 11.2 | 29.0 |
| Actuated g/C Ratio | 0.20 | | 0.59 | 0.20 | | 0.59 | 0.35 | 0.12 | 0.32 | 0.35 | 0.12 | 0.32 |
| Clearance Time (s) | 10.0 | | | 10.0 | | | 10.0 | 9.5 | | 10.0 | 9.5 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 679 | | 927 | 350 | | 927 | 1202 | 232 | 510 | 620 | 232 | 510 |
| v/s Ratio Prot | 0.12 | | | 0.07 | | | 0.21 | 0.06 | | 0.08 | 0.05 | |
| v/s Ratio Perm | | | c0.44 | | | 0.04 | | | 0.02 | | | c0.23 |
| v/c Ratio | 0.60 | | 0.74 | 0.38 | | 0.06 | 0.60 | 0.48 | 0.08 | 0.23 | 0.36 | 0.71 |
| Uniform Delay, d1 | 32.8 | | 13.7 | 31.3 | | 8.0 | 24.1 | 36.7 | 21.2 | 20.7 | 36.1 | 26.8 |
| Progression Factor | 0.95 | | 1.27 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.4 | | 3.3 | 0.7 | | 0.0 | 0.8 | 6.9 | 0.1 | 0.2 | 4.3 | 4.7 |
| Delay (s) | 32.5 | | 20.7 | 32.0 | | 8.0 | 24.9 | 43.6 | 21.3 | 20.9 | 40.5 | 31.5 |
| Level of Service | C | | C | C | | A | C | D | C | C | D | C |
| Approach Delay (s) | | 24.3 | | | 22.0 | | | 26.6 | | | 30.3 | |
| Approach LOS | | C | | | C | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 26.1 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.74 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 87.8% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |



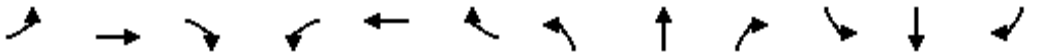
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 260 | 0 | 350 | 70 | 0 | 70 | 685 | 55 | 65 | 50 | 40 | 255 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | 9.0 | 9.0 | 8.5 | 9.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 274 | 0 | 368 | 74 | 0 | 74 | 721 | 58 | 68 | 53 | 42 | 268 |
| RTOR Reduction (vph) | 0 | 0 | 123 | 0 | 0 | 25 | 0 | 0 | 41 | 0 | 0 | 91 |
| Lane Group Flow (vph) | 274 | 0 | 245 | 74 | 0 | 49 | 721 | 58 | 27 | 53 | 42 | 178 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 6 |
| Actuated Green, G (s) | 12.5 | | 60.0 | 12.5 | | 60.0 | 27.8 | 23.2 | 44.2 | 27.8 | 23.2 | 44.2 |
| Effective Green, g (s) | 12.5 | | 60.0 | 12.5 | | 60.0 | 27.8 | 23.2 | 35.7 | 27.8 | 23.2 | 35.7 |
| Actuated g/C Ratio | 0.14 | | 0.67 | 0.14 | | 0.67 | 0.31 | 0.26 | 0.40 | 0.31 | 0.26 | 0.40 |
| Clearance Time (s) | 9.0 | | | 9.0 | | | 9.0 | 8.5 | | 9.0 | 8.5 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 477 | | 1055 | 246 | | 1055 | 1060 | 480 | 628 | 547 | 480 | 628 |
| v/s Ratio Prot | c0.08 | | | 0.04 | | | c0.21 | 0.03 | | 0.03 | 0.02 | |
| v/s Ratio Perm | | | 0.15 | | | 0.03 | | | 0.02 | | | c0.11 |
| v/c Ratio | 0.57 | | 0.23 | 0.30 | | 0.05 | 0.68 | 0.12 | 0.04 | 0.10 | 0.09 | 0.28 |
| Uniform Delay, d1 | 36.3 | | 5.9 | 34.8 | | 5.2 | 27.2 | 25.6 | 16.7 | 22.2 | 25.4 | 18.4 |
| Progression Factor | 1.25 | | 1.91 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.7 | | 0.1 | 0.7 | | 0.0 | 1.8 | 0.5 | 0.0 | 0.1 | 0.4 | 0.2 |
| Delay (s) | 46.9 | | 11.4 | 35.5 | | 5.2 | 29.0 | 26.1 | 16.7 | 22.2 | 25.7 | 18.7 |
| Level of Service | D | | B | D | | A | C | C | B | C | C | B |
| Approach Delay (s) | | 26.6 | | | 20.3 | | | 27.8 | | | 20.0 | |
| Approach LOS | | C | | | C | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 27.0 |
| Intersection Capacity Utilization | 51.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 385 | 0 | 855 | 125 | 0 | 90 | 685 | 105 | 115 | 135 | 80 | 405 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 10.0 | | 10.0 | 10.0 | | 10.0 | 10.0 | 9.5 | 10.0 | 10.0 | 9.5 | 10.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 405 | 0 | 900 | 132 | 0 | 95 | 721 | 111 | 121 | 142 | 84 | 426 |
| RTOR Reduction (vph) | 0 | 0 | 209 | 0 | 0 | 39 | 0 | 0 | 84 | 0 | 0 | 65 |
| Lane Group Flow (vph) | 405 | 0 | 691 | 132 | 0 | 56 | 721 | 111 | 37 | 142 | 84 | 361 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 6 |
| Actuated Green, G (s) | 17.5 | | 53.0 | 17.5 | | 53.0 | 33.3 | 9.7 | 36.7 | 33.3 | 9.7 | 36.7 |
| Effective Green, g (s) | 17.5 | | 53.0 | 17.5 | | 53.0 | 33.3 | 9.7 | 27.2 | 33.3 | 9.7 | 27.2 |
| Actuated g/C Ratio | 0.19 | | 0.59 | 0.19 | | 0.59 | 0.37 | 0.11 | 0.30 | 0.37 | 0.11 | 0.30 |
| Clearance Time (s) | 10.0 | | | 10.0 | | | 10.0 | 9.5 | | 10.0 | 9.5 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 668 | | 932 | 344 | | 932 | 1270 | 201 | 478 | 655 | 201 | 478 |
| v/s Ratio Prot | 0.12 | | | 0.07 | | | 0.21 | 0.06 | | 0.08 | 0.05 | |
| v/s Ratio Perm | | | c0.44 | | | 0.04 | | | 0.02 | | | c0.23 |
| v/c Ratio | 0.61 | | 0.74 | 0.38 | | 0.06 | 0.57 | 0.55 | 0.08 | 0.22 | 0.42 | 0.76 |
| Uniform Delay, d1 | 33.1 | | 13.5 | 31.6 | | 7.9 | 22.6 | 38.1 | 22.4 | 19.4 | 37.5 | 28.4 |
| Progression Factor | 0.96 | | 1.27 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.6 | | 3.2 | 0.7 | | 0.0 | 0.6 | 10.5 | 0.1 | 0.2 | 6.3 | 6.7 |
| Delay (s) | 33.3 | | 20.3 | 32.3 | | 7.9 | 23.2 | 48.6 | 22.5 | 19.6 | 43.8 | 35.1 |
| Level of Service | C | | C | C | | A | C | D | C | B | D | D |
| Approach Delay (s) | | 24.4 | | | 22.1 | | | 26.1 | | | 32.8 | |
| Approach LOS | | C | | | C | | | C | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 26.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.75 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 87.8% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 735 | 0 | 355 | 95 | 0 | 195 | 180 | 60 | 50 | 145 | 60 | 555 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | 9.0 | 9.0 | 8.5 | 9.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 774 | 0 | 374 | 100 | 0 | 205 | 189 | 63 | 53 | 153 | 63 | 584 |
| RTOR Reduction (vph) | 0 | 0 | 294 | 0 | 0 | 72 | 0 | 0 | 27 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 774 | 0 | 80 | 100 | 0 | 133 | 189 | 63 | 26 | 153 | 63 | 584 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 | | | 5 | | | 1 6 | | | 1 5 6 |
| Actuated Green, G (s) | 23.5 | | 19.3 | 23.5 | | 19.3 | 19.3 | 20.7 | 52.7 | 19.3 | 20.7 | 90.0 |
| Effective Green, g (s) | 23.5 | | 19.3 | 23.5 | | 19.3 | 19.3 | 20.7 | 44.2 | 19.3 | 20.7 | 81.5 |
| Actuated g/C Ratio | 0.26 | | 0.21 | 0.26 | | 0.21 | 0.21 | 0.23 | 0.49 | 0.21 | 0.23 | 0.91 |
| Clearance Time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | | 9.0 | 8.5 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 896 | | 339 | 462 | | 339 | 736 | 428 | 777 | 736 | 428 | 1433 |
| v/s Ratio Prot | c0.23 | | | 0.06 | | | 0.06 | 0.03 | | 0.04 | 0.03 | |
| v/s Ratio Perm | | | 0.05 | | | 0.08 | | | 0.02 | | | c0.37 |
| v/c Ratio | 0.86 | | 0.24 | 0.22 | | 0.39 | 0.26 | 0.15 | 0.03 | 0.21 | 0.15 | 0.41 |
| Uniform Delay, d1 | 31.7 | | 29.3 | 26.0 | | 30.3 | 29.4 | 27.6 | 11.8 | 29.1 | 27.6 | 0.6 |
| Progression Factor | 1.00 | | 1.00 | 0.57 | | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 8.7 | | 0.4 | 0.2 | | 0.7 | 0.2 | 0.7 | 0.0 | 0.1 | 0.7 | 0.2 |
| Delay (s) | 40.4 | | 29.6 | 15.0 | | 29.2 | 29.6 | 28.3 | 11.9 | 29.2 | 28.3 | 0.8 |
| Level of Service | D | | C | B | | C | C | C | B | C | C | A |
| Approach Delay (s) | | 36.9 | | | 24.5 | | | 26.2 | | | 8.4 | |
| Approach LOS | | D | | | C | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.2 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.51 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 59.3% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | CR 223 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1560 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1765 |
| Ramp | 195 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 211 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1765 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 1976 | See Exhibit 25-7 | No |
| $V_{R12}$ | 1976 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 11.6 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.232 (Exibit 25-19)

$S_R$= 55.8 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 55.8 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 3460 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3915 |
| Ramp | 1065 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1155 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =0.609 using Equation 5

$V_{12}$ = 2836 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 3915 | 6900 | No |
| $V_{12}$ | 2836 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 2760 | 6900 | No |
| $V_R$ | 1155 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = 19.6 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.467 (Exhibit 25-19)

$S_R$= 51.6 mph (Exhibit 25-19)

$S_0$= 65.5 mph (Exhibit 25-19)

S = 54.8 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2650 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2999 |
| Ramp | 1090 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1182 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =0.631 using Equation 5

$V_{12}$ = 2328 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 2999 | 6900 | No |
| $V_{12}$ | 2328 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1817 | 6900 | No |
| $V_R$ | 1182 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 15.3 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.469 (Exhibit 25-19)

$S_R$= 51.6 mph (Exhibit 25-19)

$S_0$= 65.8 mph (Exhibit 25-19)

S = 54.2 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{up}$ = ft
$V_u$ = veh/h

Terrain: Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$, $V_R$, $V_f$)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{down}$ = ft
$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1505 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1703 |
| Ramp | 1090 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1182 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas | Diverge Areas

## Estimation of $v_{12}$ — Merge Areas

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1703 pc/h

## Estimation of $v_{12}$ — Diverge Areas

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks — Merge Areas

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2885 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2885 | 4600:All | No |

## Capacity Checks — Diverge Areas

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F) — Merge Areas

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 18.2 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Level of Service Determination (if not F) — Diverge Areas

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation — Merge Areas

$M_S$ = 0.273 (Exibit 25-19)

$S_R$= 55.1 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 55.1 mph (Exhibit 25-14)

## Speed Estimation — Diverge Areas

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 935 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1058 |
| Ramp | 940 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1019 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1058 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2077 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2077 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 12.0 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.235 (Exibit 25-19)

$S_R$= 55.8 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 55.8 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1720 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1946 |
| Ramp | 215 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 233 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 1946 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | 1946 | 4600 | No |
| $V_{12}$ | 1946 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1713 | 4600 | No |
| $V_R$ | 233 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 12.0 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.384 (Exhibit 25-19)

$S_R$= 53.1 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.1 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1075 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1216 |
| Ramp | 140 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 152 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 1216 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 1216 | 4600 | No |
| $V_{12}$ | 1216 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1064 | 4600 | No |
| $V_R$ | 152 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 5.7 (pc/ mi /ln)

LOS= A (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.377 (Exhibit 25-19)

$S_R$= 53.2 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.2 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{up}$ = ft
$V_u$ = veh/h

Terrain: Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$, $V_R$, $V_f$)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{down}$ = ft
$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1555 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1760 |
| Ramp | 250 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 271 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas | Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1760 pc/h

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2031 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2031 | 4600:All | No |

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 12.0 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.233 (Exibit 25-19)

$S_R$= 55.8 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 55.8 mph (Exhibit 25-14)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1145 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1296 |
| Ramp | 115 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 125 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1296 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 1421 | See Exhibit 25-7 | No |
| $V_{R12}$ | 1421 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 7.3 (pc/ m/ln)

LOS = A (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.220 (Exibit 25-19)

$S_R$= 56.0 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 56.0 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2795 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3163 |
| Ramp | 1240 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1344 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = 1.000 using Equation 0

$V_{12}$ = 3163 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 3163 | 4600 | No |
| $V_{12}$ | 3163 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1819 | 4600 | No |
| $V_R$ | 1344 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = 22.5 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.484 (Exhibit 25-19)

$S_R$= 51.3 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 51.3 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1755 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1986 |
| Ramp | 610 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 661 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 1986 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | 1986 | 4600 | No |
| $V_{12}$ | 1986 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1325 | 4600 | No |
| $V_R$ | 661 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = 12.3 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.422 (Exhibit 25-19)

$S_R$= 52.4 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 52.4 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp E |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

$L_{up}$ = 1700 ft

$V_u$ = 565 veh/h

Terrain: Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$, $V_R$, $V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 4030 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 4560 |
| Ramp | 590 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 640 |
| UpStream | 565 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 613 |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.619 using Equation 1

$V_{12}$= 2821 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 5200 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3461 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 23.0 (pc/ m/ln)

LOS = C (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.328 (Exibit 25-19)

$S_R$= 54.1 mph (Exhibit 25-19)

$S_0$= 55.5 mph (Exhibit 25-19)

S= 54.6 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp e |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

$L_{up}$ = 1700 ft

$V_u$ = 945 veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2940 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3327 |
| Ramp | 385 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 417 |
| UpStream | 945 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1025 |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.619 using Equation 1

$V_{12}$= 2058 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3744 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2475 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 15.4 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.250 (Exibit 25-19)

$S_R$= 55.5 mph (Exhibit 25-19)

$S_0$= 57.2 mph (Exhibit 25-19)

S= 56.1 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp C |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{up}$ = ft
$V_u$ = veh/h

Terrain: Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$, $V_R$, $V_f$)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{down}$ = ft
$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 3440 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3893 |
| Ramp | 590 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 640 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas | Diverge Areas

## Estimation of $v_{12}$ — Merge Areas

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.631 using Equation 1

$V_{12}$= 2455 pc/h

## Estimation of $v_{12}$ — Diverge Areas

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks — Merge Areas

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 4533 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3095 | 4600:All | No |

## Capacity Checks — Diverge Areas

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F) — Merge Areas

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 17.4 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Level of Service Determination (if not F) — Diverge Areas

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation — Merge Areas

$M_S$ = 0.255 (Exibit 25-19)

$S_R$= 55.4 mph (Exhibit 25-19)

$S_0$= 56.6 mph (Exhibit 25-19)

S= 55.8 mph (Exhibit 25-14)

## Speed Estimation — Diverge Areas

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp C |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{up}$ = ft
$V_u$ = veh/h

Terrain: Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$, $V_R$, $V_f$)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{down}$ = ft
$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1940 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2195 |
| Ramp | 1000 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1084 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas | Diverge Areas

## Estimation of $v_{12}$ (Merge Areas)

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.631 using Equation 1

$V_{12}$= 1384 pc/h

## Estimation of $v_{12}$ (Diverge Areas)

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks (Merge Areas)

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3279 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2468 | 4600:All | No |

## Capacity Checks (Diverge Areas)

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F) (Merge Areas)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 12.3 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Level of Service Determination (if not F) (Diverge Areas)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation (Merge Areas)

$M_S$ = 0.215 (Exibit 25-19)

$S_R$= 56.1 mph (Exhibit 25-19)

$S_0$= 58.9 mph (Exhibit 25-19)

S= 56.8 mph (Exhibit 25-14)

## Speed Estimation (Diverge Areas)

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | Grandview Ramp B |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain: Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$, $V_R$, $V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2980 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3372 |
| Ramp | 480 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 520 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.619 using Equation 1

$V_{12}$= 2086 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3892 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2606 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 16.3 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.256 (Exibit 25-19)

$S_R$= 55.4 mph (Exhibit 25-19)

$S_0$= 57.2 mph (Exhibit 25-19)

S= 56.0 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | Grandview Ramp B |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain: Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$, $V_R$, $V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2030 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2297 |
| Ramp | 620 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 672 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.619 using Equation 1

$V_{12}$= 1421 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2969 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2093 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 12.3 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.235 (Exibit 25-19)

$S_R$= 55.8 mph (Exhibit 25-19)

$S_0$= 58.6 mph (Exhibit 25-19)

S= 56.6 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | Grandview Ramp A |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 4525 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 5120 |
| Ramp | 1545 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1675 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =0.555 using Equation 5

$V_{12}$ = 3587 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 5120 | 6900 | No |
| $V_{12}$ | 3587 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 3445 | 6900 | No |
| $V_R$ | 1675 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = 26.1 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.514 (Exhibit 25-19)

$S_R$= 50.8 mph (Exhibit 25-19)

$S_0$= 63.7 mph (Exhibit 25-19)

S = 54.1 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | Grandview Ramp A |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2830 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3202 |
| Ramp | 800 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 867 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =0.640 using Equation 5

$V_{12}$ = 2362 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 3202 | 6900 | No |
| $V_{12}$ | 2362 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 2335 | 6900 | No |
| $V_R$ | 867 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = 15.6 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.441 (Exhibit 25-19)

$S_R$= 52.1 mph (Exhibit 25-19)

$S_0$= 65.8 mph (Exhibit 25-19)

S = 55.1 mph (Exhibit 25-15)

HCS2000: Freeway Weaving Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency/Co.: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Dir of Travel: | US 160 Westbound |
| Weaving Location: | CR 233 On US 550 Off |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Inputs

| | | |
|---|---|---|
| Freeway free-flow speed, SFF | 60 | mph |
| Weaving number of lanes, N | 4 | |
| Weaving segment length, L | 2070 | ft |
| Terrain type | Rolling | |
| Grade | | % |
| Length | | mi |
| Weaving type | A | Multilane or C-D |
| Volume ratio, VR | 0.47 | |
| Weaving ratio, R | 0.19 | |

## Conversion to pc/h Under Base Conditions

| | Non-Weaving | | Weaving | | |
|---|---|---|---|---|---|
| | V A-C | V B-D | V A-D | V B-C | |
| Volume, V | 1975 | 40 | 340 | 1460 | veh/h |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | |
| Peak 15-min volume, v15 | 520 | 11 | 89 | 384 | v |
| Trucks and buses | 5 | 5 | 5 | 5 | % |
| Recreational vehicles | 0 | 0 | 0 | 0 | % |
| Trucks and buses PCE, ET | 2.5 | 2.5 | 2.5 | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | 2.0 | 2.0 | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | 0.930 | 0.930 | 0.930 | |
| Driver population adjustment, fP | 1.00 | 1.00 | 1.00 | 1.00 | |
| Flow rate, v | 2234 | 45 | 384 | 1652 | pc/h |

## Weaving and Non-Weaving Speeds

| | Weaving | Non-Weaving |
|---|---|---|
| a (Exhibit 24-6) | 0.15 | 0.00 |
| b (Exhibit 24-6) | 2.20 | 4.00 |
| c (Exhibit 24-6) | 0.97 | 1.30 |
| d (Exhibit 24-6) | 0.80 | 0.75 |
| Weaving intensity factor, Wi | 1.59 | 0.27 |
| Weaving and non-weaving speeds, Si | 34.27 | 54.43 |
| Number of lanes required for unconstrained operation, Nw (Exhibit 24-7) | | 2.18 |
| Maximum number of lanes, Nw (max) (Exhibit 24-7) | | 1.40 |
| Type of operation is | | Constrained |

## Weaving Segment Speed, Density, Level of Service and Capacity

| | | |
|---|---|---|
| Weaving segment speed, S | 42.61 | mph |
| Weaving segment density, D | 25.32 | pc/mi/ln |
| Level of service, LOS | C | |
| Capacity of base condition, cb | 7176 | pc/h |
| Capacity as a 15-minute flow rate, c | 6675 | pc/h |
| Capacity as a full-hour volume, ch | 6341 | pc/h |

## Limitations on Weaving Segments

| | Analyzed | If Max Exceeded Maximum | See Note Note |
|---|---|---|---|
| Weaving flow rate, Vw | 2036 | 2800 | a |
| Average flow rate (pcphpl) | 1078 | 2300 | b |
| Volume ratio, VR | 0.47 | 0.35 | c |
| Weaving ratio, R | 0.19 | N/A | d |
| Weaving length (ft) | 2070 | 2500 | e |

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

HCS2000: Freeway Weaving Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency/Co.: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Dir of Travel: | US 160 Westbound |
| Weaving Location: | CR 233 On US 550 Off |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Inputs

| | | |
|---|---|---|
| Freeway free-flow speed, SFF | 60 | mph |
| Weaving number of lanes, N | 4 | |
| Weaving segment length, L | 2070 | ft |
| Terrain type | Rolling | |
| Grade | | % |
| Length | | mi |
| Weaving type | A | Multilane or C-D |
| Volume ratio, VR | 0.45 | |
| Weaving ratio, R | 0.33 | |

## Conversion to pc/h Under Base Conditions

| | Non-Weaving | | Weaving | | |
|---|---|---|---|---|---|
| | V A-C | V B-D | V A-D | V B-C | |
| Volume, V | 1240 | 40 | 345 | 695 | veh/h |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | |
| Peak 15-min volume, v15 | 326 | 11 | 91 | 183 | v |
| Trucks and buses | 5 | 5 | 5 | 5 | % |
| Recreational vehicles | 0 | 0 | 0 | 0 | % |
| Trucks and buses PCE, ET | 2.5 | 2.5 | 2.5 | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | 2.0 | 2.0 | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | 0.930 | 0.930 | 0.930 | |
| Driver population adjustment, fP | 1.00 | 1.00 | 1.00 | 1.00 | |
| Flow rate, v | 1403 | 45 | 390 | 786 | pc/h |

## Weaving and Non-Weaving Speeds

| | Weaving | Non-Weaving |
|---|---|---|
| a (Exhibit 24-6) | 0.15 | 0.00 |
| b (Exhibit 24-6) | 2.20 | 4.00 |
| c (Exhibit 24-6) | 0.97 | 1.30 |
| d (Exhibit 24-6) | 0.80 | 0.75 |
| Weaving intensity factor, Wi | 0.95 | 0.13 |
| Weaving and non-weaving speeds, Si | 40.65 | 59.18 |
| Number of lanes required for unconstrained operation, Nw (Exhibit 24-7) | | 2.00 |
| Maximum number of lanes, Nw (max) (Exhibit 24-7) | | 1.40 |
| Type of operation is | | Constrained |

## Weaving Segment Speed, Density, Level of Service and Capacity

| | | |
|---|---|---|
| Weaving segment speed, S | 49.14 | mph |
| Weaving segment density, D | 13.35 | pc/mi/ln |
| Level of service, LOS | B | |
| Capacity of base condition, cb | 7176 | pc/h |
| Capacity as a 15-minute flow rate, c | 6675 | pc/h |
| Capacity as a full-hour volume, ch | 6341 | pc/h |

## Limitations on Weaving Segments

| | Analyzed | If Max Exceeded Maximum | See Note Note |
|---|---|---|---|
| Weaving flow rate, Vw | 1176 | 2800 | a |
| Average flow rate (pcphpl) | 656 | 2300 | b |
| Volume ratio, VR | 0.45 | 0.35 | c |
| Weaving ratio, R | 0.33 | N/A | d |
| Weaving length (ft) | 2070 | 2500 | e |

Notes:

a. Weaving segments longer than 2500 ft. are treated as isolated merge and diverge areas using the procedures of Chapter 25, "Ramps and Ramp Junctions".
b. Capacity constrained by basic freeway capacity.
c. Capacity occurs under constrained operating conditions.
d. Three-lane Type A segments do not operate well at volume ratios greater than 0.45. Poor operations and some local queuing are expected in such cases.
e. Four-lane Type A segments do not operate well at volume ratios greater than 0.35. Poor operations and some local queuing are expected in such cases.
f. Capacity constrained by maximum allowable weaving flow rate: 2,800 pc/h (Type A), 4,000 (Type B), 3,500 (Type C).
g. Five-lane Type A segments do not operate well at volume ratios greater than 0.20. Poor operations and some local queuing are expected in such cases.
h. Type B weaving segments do not operate well at volume ratios greater than 0.80. Poor operations and some local queuing are expected in such cases.
i. Type C weaving segments do not operate well at volume ratios greater than 0.50. Poor operations and some local queuing are expected in such cases.

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2595 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2936 |
| Ramp | 280 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 304 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 2936 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 2936 | 4600 | No |
| $V_{12}$ | 2936 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 2632 | 4600 | No |
| $V_R$ | 304 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 20.5 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.390 (Exhibit 25-19)

$S_R$= 53.0 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.0 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1875 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2122 |
| Ramp | 290 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 314 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 2122 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 2122 | 4600 | No |
| $V_{12}$ | 2122 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1808 | 4600 | No |
| $V_R$ | 314 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 13.5 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.391 (Exhibit 25-19)

$S_R$= 53.0 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.0 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | CR 223 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2395 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2710 |
| Ramp | 400 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 434 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 2710 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3144 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3144 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 20.6 (pc/ m/ln)

LOS = C (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.294 (Exibit 25-19)

$S_R$= 54.7 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 54.7 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | SH 172 to CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1875 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 493 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1061 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1061 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 17.7 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | US 550/CR 233 to SH 172 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2795 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 736 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1581 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1581 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 26.4 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | CR 233 to SH 172 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1755 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 462 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 993 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 993 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 16.5 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between CR 233 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2315 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 609 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1310 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1310 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 21.8 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between CR 233 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1585 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 417 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 897 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 897 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 14.9 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between CR 233 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2395 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 630 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1355 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1355 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 22.6 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between CR 233 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1560 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 411 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 883 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 883 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 14.7 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | CR 233 to Grandview |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 3815 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 1004 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1439 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1439 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 24.0 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | CR 233 to Grandview |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2320 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 611 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 875 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 875 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 14.6 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Grandview to CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 3460 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 911 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1305 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1305 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 21.8 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Grandview to CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2650 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 697 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1000 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1000 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 16.7 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between ramp C and D |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 3440 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 905 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1298 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1298 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 21.6 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between ramp C and D |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1940 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 511 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 732 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 732 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 12.2 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between Ramp A & B |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 3460 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 911 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1305 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1305 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 21.8 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between Ramp A & B |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2650 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 697 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1000 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1000 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 16.7 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between ramp C and E |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 4030 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 1061 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1520 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1520 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 25.3 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between ramp C and E |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2940 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 774 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1109 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1109 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 18.5 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between Ramp A & B |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2980 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 784 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1124 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1124 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 18.7 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between Ramp A & B |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2030 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 534 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 766 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 766 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 12.8 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | West of Grandview |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 4620 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 1216 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1743 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1743 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 59.9 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 29.1 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | West of Grandview |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 3325 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 875 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1254 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1254 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 20.9 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | West of Grandview |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 4525 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 1191 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1707 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1707 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 59.9 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 28.5 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | West of Grandview |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2830 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 745 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1067 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1067 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 17.8 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between SH 172 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1505 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 396 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 852 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 852 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 14.2 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between SH 172 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 935 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 246 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 529 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 529 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 8.8 | pc/mi/ln |
| Level of service, LOS | A | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between SH 172 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1555 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 409 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 880 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 880 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 14.7 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between SH 172 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1145 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 301 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 648 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 648 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 10.8 | pc/mi/ln |
| Level of service, LOS | A | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | SH 172 to CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2595 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 683 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1468 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

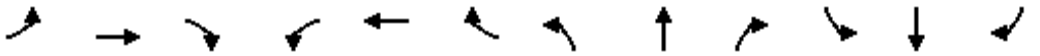
| | | |
|---|---|---|
| Flow rate, vp | 1468 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 24.5 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

# Appendix B

## Alternative G Modified

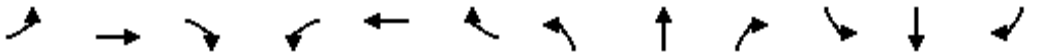
At-Grade Intersection Evaluation Worksheets



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 385 | 1555 | 855 | 125 | 1505 | 90 | 685 | 105 | 115 | 135 | 80 | 405 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 3539 | 1583 | 1770 | 3539 | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 3539 | 1583 | 1770 | 3539 | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 405 | 1637 | 900 | 132 | 1584 | 95 | 721 | 111 | 121 | 142 | 84 | 426 |
| RTOR Reduction (vph) | 0 | 0 | 352 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 405 | 1637 | 548 | 132 | 1584 | 55 | 721 | 111 | 121 | 142 | 84 | 426 |
| Turn Type | Prot | | Perm | Prot | | Perm | Prot | | Free | Prot | | Free |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | Free | | | Free |
| Actuated Green, G (s) | 17.0 | 70.0 | 70.0 | 11.0 | 64.0 | 64.0 | 30.0 | 26.0 | 145.0 | 20.0 | 16.0 | 145.0 |
| Effective Green, g (s) | 17.0 | 70.0 | 70.0 | 11.0 | 64.0 | 64.0 | 30.0 | 26.0 | 145.0 | 20.0 | 16.0 | 145.0 |
| Actuated g/C Ratio | 0.12 | 0.48 | 0.48 | 0.08 | 0.44 | 0.44 | 0.21 | 0.18 | 1.00 | 0.14 | 0.11 | 1.00 |
| Clearance Time (s) | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | | 4.0 | 5.0 | |
| Lane Grp Cap (vph) | 402 | 1708 | 764 | 134 | 1562 | 699 | 710 | 334 | 1583 | 244 | 206 | 1583 |
| v/s Ratio Prot | c0.12 | 0.46 | | 0.07 | c0.45 | | c0.21 | 0.06 | | 0.08 | c0.05 | |
| v/s Ratio Perm | | | 0.35 | | | 0.03 | | | 0.08 | | | 0.27 |
| v/c Ratio | 1.01 | 0.96 | 0.72 | 0.99 | 1.01 | 0.08 | 1.02 | 0.33 | 0.08 | 0.58 | 0.41 | 0.27 |
| Uniform Delay, d1 | 64.0 | 36.1 | 29.7 | 66.9 | 40.5 | 23.4 | 57.5 | 51.9 | 0.0 | 58.6 | 60.1 | 0.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 46.8 | 13.9 | 5.7 | 73.9 | 26.3 | 0.2 | 37.7 | 2.7 | 0.1 | 9.8 | 5.9 | 0.4 |
| Delay (s) | 110.8 | 50.0 | 35.4 | 140.8 | 66.8 | 23.7 | 95.2 | 54.6 | 0.1 | 68.3 | 66.0 | 0.4 |
| Level of Service | F | D | D | F | E | C | F | D | A | E | E | A |
| Approach Delay (s) | | 53.9 | | | 69.9 | | | 78.4 | | | 23.7 | |
| Approach LOS | | D | | | E | | | E | | | C | |

| Intersection Summary | | | | | |
|---|---|---|---|---|---|
| HCM Average Control Delay | 59.0 | HCM Level of Service | | E | |
| HCM Volume to Capacity ratio | 0.94 | | | | |
| Actuated Cycle Length (s) | 145.0 | Sum of lost time (s) | | 18.0 | |
| Intersection Capacity Utilization | 90.5% | ICU Level of Service | | E | |
| Analysis Period (min) | 15 | | | | |

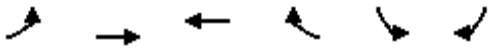
c Critical Lane Group



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 720 | 2395 | 345 | 90 | 2315 | 190 | 570 | 85 | 150 | 250 | 85 | 930 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 3539 | 1583 | 1770 | 3539 | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 3539 | 1583 | 1770 | 3539 | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 758 | 2521 | 363 | 95 | 2437 | 200 | 600 | 89 | 158 | 263 | 89 | 979 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 758 | 2521 | 363 | 95 | 2437 | 140 | 600 | 89 | 158 | 263 | 89 | 979 |
| Turn Type | Prot | | Free | Prot | | Perm | Prot | | Free | Prot | | Free |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | Free | | | Free |
| Actuated Green, G (s) | 23.0 | 88.0 | 150.0 | 12.0 | 77.0 | 77.0 | 20.0 | 14.0 | 150.0 | 18.0 | 12.0 | 150.0 |
| Effective Green, g (s) | 23.0 | 88.0 | 150.0 | 12.0 | 77.0 | 77.0 | 20.0 | 14.0 | 150.0 | 18.0 | 12.0 | 150.0 |
| Actuated g/C Ratio | 0.15 | 0.59 | 1.00 | 0.08 | 0.51 | 0.51 | 0.13 | 0.09 | 1.00 | 0.12 | 0.08 | 1.00 |
| Clearance Time (s) | 4.0 | 5.0 | | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | | 4.0 | 5.0 | |
| Lane Grp Cap (vph) | 526 | 2076 | 1583 | 142 | 1817 | 813 | 458 | 174 | 1583 | 412 | 149 | 1583 |
| v/s Ratio Prot | c0.22 | 0.71 | | 0.05 | c0.69 | | c0.17 | 0.05 | | 0.08 | 0.05 | |
| v/s Ratio Perm | | | 0.23 | | | 0.09 | | | 0.10 | | | c0.62 |
| v/c Ratio | 1.44 | 1.21 | 0.23 | 0.67 | 1.34 | 0.17 | 1.31 | 0.51 | 0.10 | 0.64 | 0.60 | 0.62 |
| Uniform Delay, d1 | 63.5 | 31.0 | 0.0 | 67.1 | 36.5 | 19.5 | 65.0 | 64.7 | 0.0 | 62.9 | 66.7 | 0.0 |
| Progression Factor | 0.94 | 1.11 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 199.5 | 96.9 | 0.0 | 22.3 | 157.3 | 0.5 | 154.5 | 10.3 | 0.1 | 7.4 | 16.4 | 1.8 |
| Delay (s) | 259.1 | 131.3 | 0.0 | 89.4 | 193.8 | 19.9 | 219.5 | 75.1 | 0.1 | 70.3 | 83.1 | 1.8 |
| Level of Service | F | F | A | F | F | B | F | E | A | E | F | A |
| Approach Delay (s) | | 144.8 | | | 177.5 | | | 163.4 | | | 20.8 | |
| Approach LOS | | F | | | F | | | F | | | C | |

| Intersection Summary | | | | | |
|---|---|---|---|---|---|
| HCM Average Control Delay | 137.8 | HCM Level of Service | | F | |
| HCM Volume to Capacity ratio | 1.27 | | | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | | 13.0 | |
| Intersection Capacity Utilization | 119.1% | ICU Level of Service | | H | |
| Analysis Period (min) | 15 | | | | |

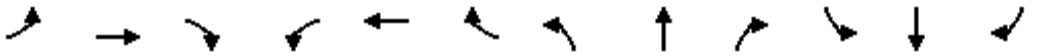
c Critical Lane Group



| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 550 | 3290 | 3675 | 135 | 170 | 590 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 5.0 | 5.0 | 5.0 | 4.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 1.00 | 0.97 | 1.00 |
| Frt | 1.00 | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 3433 | 3539 | 3539 | 1583 | 3433 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 3433 | 3539 | 3539 | 1583 | 3433 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 579 | 3463 | 3868 | 142 | 179 | 621 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 28 | 0 | 0 |
| Lane Group Flow (vph) | 579 | 3463 | 3868 | 114 | 179 | 621 |
| Turn Type | Prot | | | Perm | | Free |
| Protected Phases | 7 | 4 | 8 | | 1 | |
| Permitted Phases | | | | 8 | | Free |
| Actuated Green, G (s) | 18.0 | 129.0 | 107.0 | 107.0 | 12.0 | 150.0 |
| Effective Green, g (s) | 18.0 | 129.0 | 107.0 | 107.0 | 12.0 | 150.0 |
| Actuated g/C Ratio | 0.12 | 0.86 | 0.71 | 0.71 | 0.08 | 1.00 |
| Clearance Time (s) | 4.0 | 5.0 | 5.0 | 5.0 | 4.0 | |
| Lane Grp Cap (vph) | 412 | 3044 | 2524 | 1129 | 275 | 1583 |
| v/s Ratio Prot | c0.17 | 0.98 | c1.09 | | c0.05 | |
| v/s Ratio Perm | | | | 0.07 | | 0.39 |
| v/c Ratio | 1.41 | 1.14 | 1.53 | 0.10 | 0.65 | 0.39 |
| Uniform Delay, d1 | 66.0 | 10.5 | 21.5 | 6.6 | 67.0 | 0.0 |
| Progression Factor | 1.00 | 1.00 | 1.15 | 2.08 | 1.00 | 1.00 |
| Incremental Delay, d2 | 196.5 | 66.5 | 239.8 | 0.0 | 11.4 | 0.7 |
| Delay (s) | 262.5 | 77.0 | 264.5 | 13.8 | 78.3 | 0.7 |
| Level of Service | F | E | F | B | E | A |
| Approach Delay (s) | | 103.6 | 255.6 | | 18.1 | |
| Approach LOS | | F | F | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 164.7 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.44 | | |
| Actuated Cycle Length (s) | 150.0 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 136.4% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |

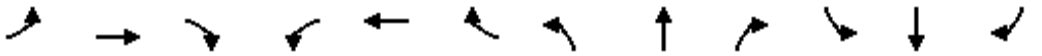
c Critical Lane Group



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 260 | 1145 | 350 | 70 | 935 | 70 | 685 | 55 | 65 | 50 | 40 | 255 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 3539 | 1583 | 1770 | 3539 | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 3539 | 1583 | 1770 | 3539 | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 274 | 1205 | 368 | 74 | 984 | 74 | 721 | 58 | 68 | 53 | 42 | 268 |
| RTOR Reduction (vph) | 0 | 0 | 245 | 0 | 0 | 49 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 274 | 1205 | 123 | 74 | 984 | 25 | 721 | 58 | 68 | 53 | 42 | 268 |
| Turn Type | Prot | | Perm | Prot | | Perm | Prot | | Free | Prot | | Free |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | 4 | | | 8 | | | Free | | | Free |
| Actuated Green, G (s) | 10.0 | 33.5 | 33.5 | 10.0 | 33.5 | 33.5 | 22.5 | 28.5 | 100.0 | 10.0 | 16.0 | 100.0 |
| Effective Green, g (s) | 10.0 | 33.5 | 33.5 | 10.0 | 33.5 | 33.5 | 22.5 | 28.5 | 100.0 | 10.0 | 16.0 | 100.0 |
| Actuated g/C Ratio | 0.10 | 0.34 | 0.34 | 0.10 | 0.34 | 0.34 | 0.22 | 0.28 | 1.00 | 0.10 | 0.16 | 1.00 |
| Clearance Time (s) | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | | 4.0 | 5.0 | |
| Lane Grp Cap (vph) | 343 | 1186 | 530 | 177 | 1186 | 530 | 772 | 531 | 1583 | 177 | 298 | 1583 |
| v/s Ratio Prot | c0.08 | c0.34 | | 0.04 | 0.28 | | c0.21 | 0.03 | | 0.03 | 0.02 | |
| v/s Ratio Perm | | | 0.08 | | | 0.02 | | | 0.04 | | | c0.17 |
| v/c Ratio | 0.80 | 1.02 | 0.23 | 0.42 | 0.83 | 0.05 | 0.93 | 0.11 | 0.04 | 0.30 | 0.14 | 0.17 |
| Uniform Delay, d1 | 44.0 | 33.2 | 24.0 | 42.3 | 30.6 | 22.5 | 38.0 | 26.4 | 0.0 | 41.8 | 36.1 | 0.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 17.5 | 30.2 | 1.0 | 7.1 | 6.8 | 0.2 | 19.8 | 0.4 | 0.1 | 4.3 | 1.0 | 0.2 |
| Delay (s) | 61.5 | 63.4 | 25.0 | 49.4 | 37.4 | 22.6 | 57.8 | 26.8 | 0.1 | 46.0 | 37.1 | 0.2 |
| Level of Service | E | E | C | D | D | C | E | C | A | D | D | A |
| Approach Delay (s) | | 55.5 | | | 37.2 | | | 51.0 | | | 11.2 | |
| Approach LOS | | E | | | D | | | D | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 45.8 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.77 | | |
| Actuated Cycle Length (s) | 100.0 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 77.9% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

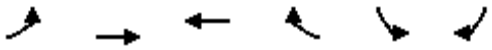
c Critical Lane Group



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 735 | 1560 | 355 | 95 | 1585 | 195 | 180 | 60 | 50 | 145 | 60 | 555 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | 4.0 | 4.0 | 5.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | 3539 | 1583 | 1770 | 3539 | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | 3539 | 1583 | 1770 | 3539 | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 774 | 1642 | 374 | 100 | 1668 | 205 | 189 | 63 | 53 | 153 | 63 | 584 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 96 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 774 | 1642 | 374 | 100 | 1668 | 109 | 189 | 63 | 53 | 153 | 63 | 584 |
| Turn Type | Prot | | Free | Prot | | Perm | Prot | | Free | Prot | | Free |
| Protected Phases | 7 | 4 | | 3 | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | | | Free | | | 8 | | | Free | | | Free |
| Actuated Green, G (s) | 31.0 | 74.0 | 140.0 | 22.0 | 65.0 | 65.0 | 10.0 | 16.0 | 140.0 | 10.0 | 16.0 | 140.0 |
| Effective Green, g (s) | 31.0 | 74.0 | 140.0 | 22.0 | 65.0 | 65.0 | 10.0 | 16.0 | 140.0 | 10.0 | 16.0 | 140.0 |
| Actuated g/C Ratio | 0.22 | 0.53 | 1.00 | 0.16 | 0.46 | 0.46 | 0.07 | 0.11 | 1.00 | 0.07 | 0.11 | 1.00 |
| Clearance Time (s) | 4.0 | 5.0 | | 4.0 | 5.0 | 5.0 | 4.0 | 5.0 | | 4.0 | 5.0 | |
| Lane Grp Cap (vph) | 760 | 1871 | 1583 | 278 | 1643 | 735 | 245 | 213 | 1583 | 245 | 213 | 1583 |
| v/s Ratio Prot | c0.23 | 0.46 | | 0.06 | c0.47 | | c0.06 | 0.03 | | 0.04 | 0.03 | |
| v/s Ratio Perm | | | 0.24 | | | 0.07 | | | 0.03 | | | c0.37 |
| v/c Ratio | 1.02 | 0.88 | 0.24 | 0.36 | 1.02 | 0.15 | 0.77 | 0.30 | 0.03 | 0.62 | 0.30 | 0.37 |
| Uniform Delay, d1 | 54.5 | 29.0 | 0.0 | 52.7 | 37.5 | 21.6 | 63.9 | 56.8 | 0.0 | 63.2 | 56.8 | 0.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 37.4 | 6.2 | 0.4 | 3.6 | 26.1 | 0.4 | 20.7 | 3.5 | 0.0 | 11.4 | 3.5 | 0.7 |
| Delay (s) | 91.9 | 35.2 | 0.4 | 56.3 | 63.6 | 22.0 | 84.5 | 60.3 | 0.0 | 74.6 | 60.3 | 0.7 |
| Level of Service | F | D | A | E | E | C | F | E | A | E | E | A |
| Approach Delay (s) | | 46.3 | | | 58.9 | | | 64.9 | | | 19.5 | |
| Approach LOS | | D | | | E | | | E | | | B | |

| Intersection Summary | | | | | |
|---|---|---|---|---|---|
| HCM Average Control Delay | 47.8 | HCM Level of Service | | D | |
| HCM Volume to Capacity ratio | 0.89 | | | | |
| Actuated Cycle Length (s) | 140.0 | Sum of lost time (s) | | 13.0 | |
| Intersection Capacity Utilization | 88.3% | ICU Level of Service | | E | |
| Analysis Period (min) | 15 | | | | |

c Critical Lane Group



| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 550 | 2535 | 2175 | 140 | 110 | 385 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 5.0 | 5.0 | 5.0 | 4.0 | 4.0 |
| Lane Util. Factor | 0.97 | 0.95 | 0.95 | 1.00 | 0.97 | 1.00 |
| Frt | 1.00 | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 3433 | 3539 | 3539 | 1583 | 3433 | 1583 |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 3433 | 3539 | 3539 | 1583 | 3433 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 579 | 2668 | 2289 | 147 | 116 | 405 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 55 | 0 | 0 |
| Lane Group Flow (vph) | 579 | 2668 | 2289 | 92 | 116 | 405 |
| Turn Type | Prot | | | Perm | | Free |
| Protected Phases | 7 | 4 | 8 | | 1 | |
| Permitted Phases | | | | 8 | | Free |
| Actuated Green, G (s) | 18.0 | 91.0 | 69.0 | 69.0 | 10.0 | 110.0 |
| Effective Green, g (s) | 18.0 | 91.0 | 69.0 | 69.0 | 10.0 | 110.0 |
| Actuated g/C Ratio | 0.16 | 0.83 | 0.63 | 0.63 | 0.09 | 1.00 |
| Clearance Time (s) | 4.0 | 5.0 | 5.0 | 5.0 | 4.0 | |
| Lane Grp Cap (vph) | 562 | 2928 | 2220 | 993 | 312 | 1583 |
| v/s Ratio Prot | c0.17 | 0.75 | c0.65 | | c0.03 | |
| v/s Ratio Perm | | | | 0.06 | | 0.26 |
| v/c Ratio | 1.03 | 0.91 | 1.03 | 0.09 | 0.37 | 0.26 |
| Uniform Delay, d1 | 46.0 | 6.7 | 20.5 | 8.1 | 47.0 | 0.0 |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 45.9 | 5.5 | 27.6 | 0.2 | 3.4 | 0.4 |
| Delay (s) | 91.9 | 12.2 | 48.1 | 8.3 | 50.4 | 0.4 |
| Level of Service | F | B | D | A | D | A |
| Approach Delay (s) | | 26.4 | 45.7 | | 11.5 | |
| Approach LOS | | C | D | | B | |

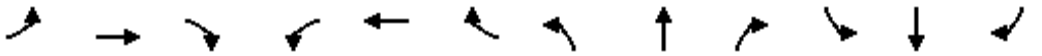
| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 32.7 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.96 | | |
| Actuated Cycle Length (s) | 110.0 | Sum of lost time (s) | 13.0 |
| Intersection Capacity Utilization | 95.0% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Appendix C

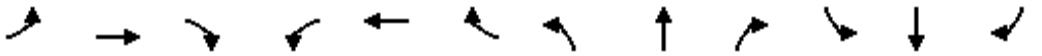
## Alternative F Modified

Interchange Evaluation Worksheets



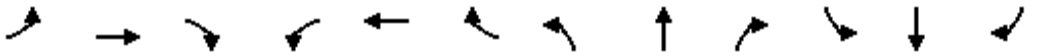
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 625 | 0 | 855 | 125 | 0 | 155 | 685 | 105 | 115 | 220 | 120 | 700 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | 9.0 | 9.0 | 8.5 | 9.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 658 | 0 | 900 | 132 | 0 | 163 | 721 | 111 | 121 | 232 | 126 | 737 |
| RTOR Reduction (vph) | 0 | 0 | 267 | 0 | 0 | 23 | 0 | 0 | 65 | 0 | 0 | 37 |
| Lane Group Flow (vph) | 658 | 0 | 633 | 132 | 0 | 140 | 721 | 111 | 56 | 232 | 126 | 700 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 6 |
| Actuated Green, G (s) | 35.0 | | 67.5 | 35.0 | | 67.5 | 37.7 | 20.8 | 64.3 | 37.7 | 20.8 | 64.3 |
| Effective Green, g (s) | 35.0 | | 67.5 | 35.0 | | 67.5 | 37.7 | 20.8 | 55.8 | 37.7 | 20.8 | 55.8 |
| Actuated g/C Ratio | 0.29 | | 0.56 | 0.29 | | 0.56 | 0.31 | 0.17 | 0.46 | 0.31 | 0.17 | 0.46 |
| Clearance Time (s) | 9.0 | | | 9.0 | | | 9.0 | 8.5 | | 9.0 | 8.5 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 1001 | | 890 | 516 | | 890 | 1079 | 323 | 736 | 556 | 323 | 736 |
| v/s Ratio Prot | 0.19 | | | 0.07 | | | 0.21 | 0.06 | | 0.13 | 0.07 | |
| v/s Ratio Perm | | | c0.40 | | | 0.09 | | | 0.04 | | | c0.44 |
| v/c Ratio | 0.66 | | 0.71 | 0.26 | | 0.16 | 0.67 | 0.34 | 0.08 | 0.42 | 0.39 | 0.95 |
| Uniform Delay, d1 | 37.2 | | 19.1 | 32.5 | | 12.6 | 35.7 | 43.6 | 17.8 | 32.5 | 44.0 | 30.8 |
| Progression Factor | 0.94 | | 0.87 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.5 | | 2.7 | 0.3 | | 0.1 | 1.6 | 2.9 | 0.0 | 0.5 | 3.5 | 21.8 |
| Delay (s) | 36.6 | | 19.3 | 32.8 | | 12.7 | 37.3 | 46.5 | 17.9 | 33.0 | 47.5 | 52.6 |
| Level of Service | D | | B | C | | B | D | D | B | C | D | D |
| Approach Delay (s) | | 26.6 | | | 21.7 | | | 35.9 | | | 47.9 | |
| Approach LOS | | C | | | C | | | D | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 34.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.91 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 27.0 |
| Intersection Capacity Utilization | 86.1% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |



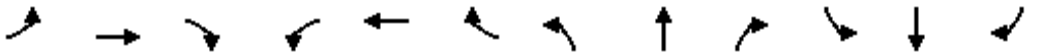
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 500 | 0 | 350 | 70 | 0 | 140 | 685 | 55 | 65 | 105 | 65 | 445 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 0.97 | | 1.00 | 1.00 | | 1.00 | 0.97 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 1583 | 1770 | | 1583 | 3433 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 526 | 0 | 368 | 74 | 0 | 147 | 721 | 58 | 68 | 111 | 68 | 468 |
| RTOR Reduction (vph) | 0 | 0 | 254 | 0 | 0 | 102 | 0 | 0 | 29 | 0 | 0 | 39 |
| Lane Group Flow (vph) | 526 | 0 | 114 | 74 | 0 | 45 | 721 | 58 | 39 | 111 | 68 | 429 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 | | | 5 | | | 1 6 | | | 1 6 |
| Actuated Green, G (s) | 22.3 | | 27.8 | 22.3 | | 27.8 | 27.8 | 24.9 | 52.2 | 27.8 | 24.9 | 52.2 |
| Effective Green, g (s) | 22.3 | | 27.8 | 22.3 | | 27.8 | 27.8 | 24.9 | 52.2 | 27.8 | 24.9 | 52.2 |
| Actuated g/C Ratio | 0.25 | | 0.31 | 0.25 | | 0.31 | 0.31 | 0.28 | 0.58 | 0.31 | 0.28 | 0.58 |
| Clearance Time (s) | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | 3.0 | | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 851 | | 489 | 439 | | 489 | 1060 | 515 | 918 | 547 | 515 | 918 |
| v/s Ratio Prot | c0.15 | | | 0.04 | | | c0.21 | 0.03 | | 0.06 | 0.04 | |
| v/s Ratio Perm | | | 0.07 | | | 0.03 | | | 0.02 | | | c0.27 |
| v/c Ratio | 0.62 | | 0.23 | 0.17 | | 0.09 | 0.68 | 0.11 | 0.04 | 0.20 | 0.13 | 0.47 |
| Uniform Delay, d1 | 30.1 | | 23.2 | 26.6 | | 22.1 | 27.2 | 24.3 | 8.1 | 22.9 | 24.4 | 10.9 |
| Progression Factor | 1.02 | | 0.88 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 1.3 | | 0.2 | 0.2 | | 0.1 | 1.8 | 0.4 | 0.0 | 0.2 | 0.5 | 0.4 |
| Delay (s) | 32.0 | | 20.6 | 26.8 | | 22.2 | 29.0 | 24.7 | 8.2 | 23.1 | 25.0 | 11.3 |
| Level of Service | C | | C | C | | C | C | C | A | C | C | B |
| Approach Delay (s) | | 27.3 | | | 23.7 | | | 27.1 | | | 14.7 | |
| Approach LOS | | C | | | C | | | C | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 23.8 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.61 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 15.0 |
| Intersection Capacity Utilization | 55.4% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 960 | 0 | 1410 | 330 | 0 | 260 | 1160 | 190 | 460 | 335 | 130 | 1225 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | 9.0 | 9.0 | 8.5 | 9.0 |
| Lane Util. Factor | 0.97 | | 0.88 | 0.97 | | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 1011 | 0 | 1484 | 347 | 0 | 274 | 1221 | 200 | 484 | 353 | 137 | 1289 |
| RTOR Reduction (vph) | 0 | 0 | 189 | 0 | 0 | 5 | 0 | 0 | 168 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 1011 | 0 | 1295 | 347 | 0 | 269 | 1221 | 200 | 316 | 353 | 137 | 1289 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 5 6 |
| Actuated Green, G (s) | 36.0 | | 66.5 | 36.0 | | 66.5 | 42.0 | 15.5 | 60.0 | 42.0 | 15.5 | 120.0 |
| Effective Green, g (s) | 36.0 | | 66.5 | 36.0 | | 66.5 | 42.0 | 15.5 | 51.5 | 42.0 | 15.5 | 111.5 |
| Actuated g/C Ratio | 0.30 | | 0.55 | 0.30 | | 0.55 | 0.35 | 0.13 | 0.43 | 0.35 | 0.13 | 0.93 |
| Clearance Time (s) | 9.0 | | | 9.0 | | | 9.0 | 8.5 | | 9.0 | 8.5 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 1030 | | 1544 | 1030 | | 877 | 1202 | 241 | 679 | 1202 | 241 | 1471 |
| v/s Ratio Prot | 0.29 | | | 0.10 | | | 0.36 | 0.11 | | 0.10 | 0.07 | |
| v/s Ratio Perm | | | 0.46 | | | 0.17 | | | 0.20 | | | c0.81 |
| v/c Ratio | 0.98 | | 0.84 | 0.34 | | 0.31 | 1.02 | 0.83 | 0.46 | 0.29 | 0.57 | 0.88 |
| Uniform Delay, d1 | 41.7 | | 22.3 | 32.7 | | 14.4 | 39.0 | 51.0 | 24.4 | 28.3 | 49.1 | 1.6 |
| Progression Factor | 1.00 | | 1.00 | 0.90 | | 0.75 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 23.5 | | 4.2 | 0.2 | | 0.2 | 30.0 | 26.9 | 0.5 | 0.1 | 9.4 | 6.2 |
| Delay (s) | 65.2 | | 26.4 | 29.6 | | 10.9 | 69.0 | 77.9 | 24.9 | 28.4 | 58.5 | 7.8 |
| Level of Service | E | | C | C | | B | E | E | C | C | E | A |
| Approach Delay (s) | | 42.1 | | | 21.4 | | | 58.7 | | | 15.8 | |
| Approach LOS | | D | | | C | | | E | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 38.0 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.88 | | |
| Actuated Cycle Length (s) | 120.0 | Sum of lost time (s) | 9.0 |
| Intersection Capacity Utilization | 123.5% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 976 | 0 | 675 | 335 | 0 | 265 | 1180 | 165 | 560 | 200 | 90 | 750 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 5.0 | 5.0 | | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lane Util. Factor | 0.97 | | 0.88 | 0.97 | | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 1027 | 0 | 711 | 353 | 0 | 279 | 1242 | 174 | 589 | 211 | 95 | 789 |
| RTOR Reduction (vph) | 0 | 0 | 200 | 0 | 0 | 6 | 0 | 0 | 261 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 1027 | 0 | 511 | 353 | 0 | 273 | 1242 | 174 | 328 | 211 | 95 | 789 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 5 6 |
| Actuated Green, G (s) | 29.0 | | 51.0 | 29.0 | | 51.0 | 34.0 | 12.0 | 46.0 | 34.0 | 12.0 | 90.0 |
| Effective Green, g (s) | 29.0 | | 51.0 | 29.0 | | 51.0 | 34.0 | 12.0 | 46.0 | 34.0 | 12.0 | 90.0 |
| Actuated g/C Ratio | 0.32 | | 0.57 | 0.32 | | 0.57 | 0.38 | 0.13 | 0.51 | 0.38 | 0.13 | 1.00 |
| Clearance Time (s) | 5.0 | | | 5.0 | | | 5.0 | 5.0 | | 5.0 | 5.0 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 1106 | | 1579 | 1106 | | 897 | 1297 | 248 | 809 | 1297 | 248 | 1583 |
| v/s Ratio Prot | c0.30 | | | 0.10 | | | c0.36 | 0.09 | | 0.06 | 0.05 | |
| v/s Ratio Perm | | | 0.18 | | | 0.17 | | | 0.21 | | | c0.50 |
| v/c Ratio | 0.93 | | 0.32 | 0.32 | | 0.30 | 0.96 | 0.70 | 0.41 | 0.16 | 0.38 | 0.50 |
| Uniform Delay, d1 | 29.5 | | 10.3 | 23.0 | | 10.2 | 27.3 | 37.3 | 13.6 | 18.6 | 35.6 | 0.0 |
| Progression Factor | 1.00 | | 1.00 | 0.74 | | 1.38 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 13.1 | | 0.1 | 0.1 | | 0.2 | 15.8 | 15.3 | 0.3 | 0.1 | 4.4 | 0.2 |
| Delay (s) | 42.6 | | 10.5 | 17.2 | | 14.3 | 43.1 | 52.6 | 13.9 | 18.6 | 40.1 | 0.2 |
| Level of Service | D | | B | B | | B | D | D | B | B | D | A |
| Approach Delay (s) | | 29.5 | | | 15.9 | | | 35.3 | | | 7.2 | |
| Approach LOS | | C | | | B | | | D | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.6 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.85 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 88.4% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1470 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1663 |
| Ramp | 335 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 363 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1663 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2026 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2026 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 11.9 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.233 (Exibit 25-19)

$S_R$= 55.8 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 55.8 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1090 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1233 |
| Ramp | 170 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 184 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1233 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 1417 | See Exhibit 25-7 | No |
| $V_{R12}$ | 1417 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 7.2 (pc/ m/ln)

LOS = A (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.219 (Exibit 25-19)

$S_R$= 56.0 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 56.0 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2950 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3338 |
| Ramp | 1480 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1605 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 3338 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 3338 | 4600 | No |
| $V_{12}$ | 3338 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1733 | 4600 | No |
| $V_R$ | 1605 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 24.0 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.507 (Exhibit 25-19)

$S_R$= 50.9 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 50.9 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1940 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2195 |
| Ramp | 850 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 922 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 2195 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 2195 | 4600 | No |
| $V_{12}$ | 2195 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1273 | 4600 | No |
| $V_R$ | 922 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 14.1 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.446 (Exhibit 25-19)

$S_R$= 52.0 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 52.0 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | US 550/CR 233 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2235 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2529 |
| Ramp | 2385 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 2586 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 2529 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 5115 | See Exhibit 25-7 | Yes |
| $V_{R12}$ | 5115 | 4600:All | Yes |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 21.4 (pc/ m/ln)

LOS = F (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.679 (Exibit 25-19)

$S_R$= 47.8 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 47.8 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | US 550/CR 233 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1395 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1579 |
| Ramp | 1930 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 2093 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1579 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3672 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3672 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 10.3 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.183 (Exibit 25-19)

$S_R$= 56.7 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 56.7 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | US 550/CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2825 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3197 |
| Ramp | 590 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 640 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 3197 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | 3197 | 4600 | No |
| $V_{12}$ | 3197 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 2557 | 4600 | No |
| $V_R$ | 640 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 22.7 (pc/ mi /ln)

LOS= C (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.421 (Exhibit 25-19)

$S_R$= 52.4 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 52.4 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | US 500/CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1995 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2257 |
| Ramp | 600 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 651 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 2257 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | 2257 | 4600 | No |
| $V_{12}$ | 2257 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1606 | 4600 | No |
| $V_R$ | 651 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 14.7 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.422 (Exhibit 25-19)

$S_R$= 52.4 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 52.4 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | US 550/CR 223 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{up}$ = ft
$V_u$ = veh/h

Terrain: Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$, $V_R$, $V_f$)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{down}$ = ft
$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2155 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2439 |
| Ramp | 795 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 862 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas | Diverge Areas

## Estimation of $v_{12}$ — Merge Areas

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 2439 pc/h

## Estimation of $v_{12}$ — Diverge Areas

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks — Merge Areas

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3301 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3301 | 4600:All | No |

## Capacity Checks — Diverge Areas

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F) — Merge Areas

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 21.6 (pc/ m/ln)

LOS = C (Exhibit 25-4)

## Level of Service Determination (if not F) — Diverge Areas

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation — Merge Areas

$M_S$ = 0.309 (Exibit 25-19)

$S_R$= 54.4 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 54.4 mph (Exhibit 25-14)

## Speed Estimation — Diverge Areas

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | US 550/CR 223 On Ramp |
| Date Performed | 11/18/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1180 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1335 |
| Ramp | 760 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 824 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1335 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2159 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2159 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 12.7 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.237 (Exibit 25-19)

$S_R$= 55.7 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 55.7 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | US 550/CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 4525 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 5120 |
| Ramp | 2370 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 2570 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =0.450 using Equation 0

$V_{12}$ = 3717 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 5120 | 6900 | No |
| $V_{12}$ | 3717 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 2550 | 6900 | No |
| $V_R$ | 2570 | 4100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 13.7 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.594 (Exhibit 25-19)

$S_R$= 49.3 mph (Exhibit 25-19)

$S_0$= 64.2 mph (Exhibit 25-19)

S = 52.7 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Eastbound |
| Agency or Company | | Junction | US 550/CR 233 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph | $L_{down}$ = ft |
| Vu = veh/h | Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 2830 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3202 |
| Ramp | 1650 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1789 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =0.450 using Equation 0

$V_{12}$ = 2425 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 3202 | 6900 | No |
| $V_{12}$ | 2425 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1413 | 6900 | No |
| $V_R$ | 1789 | 4100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 2.6 (pc/ mi /ln)

LOS= A (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.524 (Exhibit 25-19)

$S_R$= 50.6 mph (Exhibit 25-19)

$S_0$= 65.8 mph (Exhibit 25-19)

S = 53.6 mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |

Project Description Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{up}$ = ft

$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp

☐ Yes ☐ On

☐ No ☐ Off

$L_{down}$ = ft

$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1440 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1629 |
| Ramp | 1385 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1502 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 1629 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 3131 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3131 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 20.0 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.293 (Exibit 25-19)

$S_R$= 54.7 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 54.7 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 On Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |

Project Description: Year 2030 Traffic Operations Analysis of the US 160 FEIS

## Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{up}$ = ft
$V_u$ = veh/h

Terrain: Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$, $V_R$, $V_f$)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{down}$ = ft
$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 865 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 979 |
| Ramp | 1130 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 1225 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas | Diverge Areas

## Estimation of $v_{12}$ (Merge Areas)

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 1.000 using Equation 0

$V_{12}$= 979 pc/h

## Estimation of $v_{12}$ (Diverge Areas)

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks (Merge Areas)

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 2204 | See Exhibit 25-7 | No |
| $V_{R12}$ | 2204 | 4600:All | No |

## Capacity Checks (Diverge Areas)

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F) (Merge Areas)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 12.9 (pc/ m/ln)

LOS = B (Exhibit 25-4)

## Level of Service Determination (if not F) (Diverge Areas)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation (Merge Areas)

$M_S$ = 0.239 (Exibit 25-19)

$S_R$= 55.7 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S= 55.7 mph (Exhibit 25-14)

## Speed Estimation (Diverge Areas)

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/12/2009 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

**Inputs**

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

**Conversion to pc/h Under Base Conditions**

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1720 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1946 |
| Ramp | 280 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 304 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 1946 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 1946 | 4600 | No |
| $V_{12}$ | 1946 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 1642 | 4600 | No |
| $V_R$ | 304 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 12.0 (pc/ mi /ln)

LOS= B (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.390 (Exhibit 25-19)

$S_R$= 53.0 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.0 mph (Exhibit 25-15)

## RAMPS AND RAMP JUNCTIONS WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | SH 172 Off Ramp |
| Date Performed | 11/13/2009 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 |
| Project Description | Year 2030 Traffic Operations Analysis of the US 160 FEIS | | |

### Inputs

| Upstream Adj Ramp | Terrain | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| Vu = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | VD = veh/h |

### Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1075 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 1216 |
| Ramp | 210 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 228 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

### Merge Areas

**Estimation of $v_{12}$**

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= using Equation

$V_{12}$= pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | | See Exhibit 25-7 | |
| $V_{R12}$ | | 4600:All | |

**Level of Service Determination (if not F)**

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = (pc/ mi /ln)

LOS = (Exhibit 25-4)

**Speed Estimation**

$M_S$ = (Exibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S= mph (Exhibit 25-14)

### Diverge Areas

**Estimation of $v_{12}$**

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ =1.000 using Equation 0

$V_{12}$ = 1216 pc/h

**Capacity Checks**

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{Fl}=V_F$ | 1216 | 4600 | No |
| $V_{12}$ | 1216 | 4400:All | No |
| $V_{FO} = V_F - V_R$ | 988 | 4600 | No |
| $V_R$ | 228 | 2100 | No |

**Level of Service Determination (if not F)**

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = 5.7 (pc/ mi /ln)

LOS= A (Exhibit 25-4)

**Speed Estimation**

$D_s$ = 0.384 (Exhibit 25-19)

$S_R$= 53.1 mph (Exhibit 25-19)

$S_0$= N/A mph (Exhibit 25-19)

S = 53.1 mph (Exhibit 25-15)

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | West of US 550/CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 4525 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 1191 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1707 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1707 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 59.9 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 28.5 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | West of US 550/CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2830 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 745 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1067 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1067 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 17.8 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between SH 172 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1440 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 379 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 815 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 815 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 13.6 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between SH 172 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 865 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 228 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 489 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 489 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 8.1 | pc/mi/ln |
| Level of service, LOS | A | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between SH 172 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1470 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 387 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 832 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 832 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 13.9 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between SH 172 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1090 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 287 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 617 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 617 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 10.3 | pc/mi/ln |
| Level of service, LOS | A | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | SH 172 to US 550/CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2825 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 743 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1598 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1598 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 26.6 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | SH 172 to US 550/CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1995 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 525 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1129 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1129 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 18.8 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | US 550/CR 233 to SH 172 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2950 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 776 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1669 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1669 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 27.8 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | US 550/CR 233 to SH 172 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1940 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 511 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1098 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1098 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 18.3 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between CR 233/US 550 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2235 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 588 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1265 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1265 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 21.1 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | Between CR 233/US 550 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1395 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 367 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 789 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 789 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 13.1 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between CR 233/US 550 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 2155 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 567 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1219 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1219 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 20.3 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Eastbound |
| From/To: | Between CR 233/US 550 Ramps |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 1180 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 311 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 668 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 2 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 4.5 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 668 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 2 | |
| Density, D | 11.1 | pc/mi/ln |
| Level of service, LOS | B | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | PM Peak |
| Freeway/Direction: | Westbound |
| From/To: | West of US 550/CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 4620 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 1216 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1743 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1743 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 59.9 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 29.1 | pc/mi/ln |
| Level of service, LOS | D | |

Overall results are not computed when free-flow speed is less than 55 mph.

HCS2000: Basic Freeway Segments Release 4.1f

## Operational Analysis

| | |
|---|---|
| Analyst: | SEH Inc. |
| Agency or Company: | |
| Date Performed: | 11/13/2009 |
| Analysis Time Period: | AM Peak |
| Freeway/Direction: | Westbound |
| From/To: | West of US 550/CR 233 |
| Jurisdiction: | |
| Analysis Year: | Year 2030 |
| Description: | Year 2030 Traffic Operations Analysis of the US 160 FEIS |

## Flow Inputs and Adjustments

| | | |
|---|---|---|
| Volume, V | 3325 | veh/h |
| Peak-hour factor, PHF | 0.95 | |
| Peak 15-min volume, v15 | 875 | v |
| Trucks and buses | 5 | % |
| Recreational vehicles | 0 | % |
| Terrain type: | Rolling | |
| Grade | 0.00 | % |
| Segment length | 0.00 | mi |
| Trucks and buses PCE, ET | 2.5 | |
| Recreational vehicle PCE, ER | 2.0 | |
| Heavy vehicle adjustment, fHV | 0.930 | |
| Driver population factor, fp | 1.00 | |
| Flow rate, vp | 1254 | pc/h/ln |

## Speed Inputs and Adjustments

| | | |
|---|---|---|
| Lane width | 12.0 | ft |
| Right-shoulder lateral clearance | 6.0 | ft |
| Interchange density | 0.50 | interchange/mi |
| Number of lanes, N | 3 | |
| Free-flow speed: | Measured | |
| FFS or BFFS | 60.0 | mi/h |
| Lane width adjustment, fLW | 0.0 | mi/h |
| Lateral clearance adjustment, fLC | 0.0 | mi/h |
| Interchange density adjustment, fID | 0.0 | mi/h |
| Number of lanes adjustment, fN | 3.0 | mi/h |
| Free-flow speed, FFS | 60.0 | mi/h |
| | Urban Freeway | |

## LOS and Performance Measures

| | | |
|---|---|---|
| Flow rate, vp | 1254 | pc/h/ln |
| Free-flow speed, FFS | 60.0 | mi/h |
| Average passenger-car speed, S | 60.0 | mi/h |
| Number of lanes, N | 3 | |
| Density, D | 20.9 | pc/mi/ln |
| Level of service, LOS | C | |

Overall results are not computed when free-flow speed is less than 55 mph.

# SEH MEMORANDUM

# Year 2030 Traffic Operations Analysis for the US 550 at US 160 Section 4(f) Alternatives

# December 23, 2010

MEMORANDUM

TO: Mike McVaugh, PE - CDOT Region 5

FROM: Phil Weisbach, PE
Jon E. Larson, PE

DATE: December 23, 2010

RE: Year 2030 Traffic Operations Analysis for the US 550 at US 160 Section 4(f) Alternatives
SEH No. CODOT - 105181

## Executive Summary

Alternatives for the US 550 connection to the US 160 corridor were originally evaluated in the US Highway 160 from Durango to Bayfield Final Environmental Impact Statement (FEIS) dated May 2006. The US 160 Highway from Durango to Bayfield Record of Decision (US 160 ROD) documented selection of Grandview Alternative G Modified as the Preferred Alternative which included an interchange of US 160 with US 550 approximately 0.6 miles east of the current intersection. In the Preferred Alternative, the US 550 connection crossed a large ranch property owned by the Webb family. CDOT is currently re-evaluating the connection of US 550 to US 160 due to late discoveries including the designation of a portion of the Webb Ranch as an eligible historic property.

This memo analyzes whether the alternatives being considered in the 4(f) analysis meet the capacity requirements of the purpose and need in the year 2030. This analysis looks at projected traffic in the year 2030 to evaluate if the roadway will meet the capacity requirements for the purpose and need 20 years into the future. The Section 4(f) alternatives focus on the connection of US 550 to US 160 in the Grandview Section. All of the alternatives assume that there is an existing Grandview trumpet interchange and single point urban interchanges (SPUIs) at CR 233 (Three Springs) and SH 172/CR 234. The need for these three interchanges in the Grandview Section is explained in a separate technical memorandum: *Year 2030 Traffic Operations Analysis for Alternatives of the US 160 FEIS* dated December 4, 2009. The traffic volumes have been adjusted to the year 2030 requiring the auxiliary lanes in each direction to extend from the west limit of the Grandview Section to the CR 233 (Three Springs) Interchange. The modified auxiliary lanes are included in each of the alternatives. For example; G Modified is the same as in the FEIS except it includes auxiliary lanes in each direction from the west limit of the Grandview Section to the CR 233 (Three Springs) Interchange. F Modified is the same as in the FEIS except it includes the Grandview Interchange and auxiliary lanes in each direction from the west limit of the Grandview Section to the CR 233 (Three Springs) Interchange. Preliminary Alternative A is the same as in the FEIS except it includes the Grandview Interchange and auxiliary lanes in each direction from west limit of the Grandview Section to the CR 233 (Three Springs). For these reasons, "Revised" has been added to the titles of these alternatives.

The technical results and supporting data of these analyses are included in the appendices of this memo.

The following describes the alternatives being considered for the Section 4(f) analysis:

A. **US 550 at US 160 At-Grade Intersection Alternative.** This alternative includes a revised US 550 at US 160 signalized intersection at its current location in the year 2030 (Feasibility Alternative 1B in the FEIS). The analysis for this alternative also addresses design variations T.1.4, T.1.6, and T.4.4 (These design variations are similar except for

minor differences in vertical grade and horizontal alignment which do not affect the traffic operational analysis at the intersection). This alternative assumes there is a Grandview trumpet interchange east of the intersection and SPUIs at CR 233 (Three Springs) and SH 172/CR 234.

B. **Partial Interchange at the Existing US 550 / US 160 Intersection.** This alternative includes a partial interchange at the existing US 550/US 160 location. The analysis for this alternative also addresses design variations T.2.4, T.2.6, T.3.4, and T.3.6 (These design variations are similar except for minor differences in vertical grade and horizontal alignment which do not affect the traffic operational analysis). This alternative assumes there is a Grandview trumpet interchange east of the partial interchange and SPUIs at CR 233 (Three Springs) and SH 172/CR 234.

C. **Revised Preliminary Alternative A.** This alternative includes grade-separated trumpet interchanges at the existing US 550/US 160 connection and at the Grandview Interchange with SPUIs at SH 172/CR 234 and CR 233 (Three Springs).

D. **Revised G Modified.** This alternative connects US 550 to US 160 via the Grandview trumpet interchange, and CR 233 (Three Springs) and SH 172/ CR 234 would be SPUI interchanges.

E. **Revised F Modified and Eastern Realignment Alternative.** These two alternatives will both connect to the CR 233 (Three Springs) interchange. The Revised F Modified includes an additional trumpet interchange at the Grandview Interchange, and SPUI interchanges at CR 233 (Three Springs) and SH 172/CR 234. US 550 would connect to US 160 at the CR 233 (Three Springs) interchange. The Eastern Realignment Alternative has a different US 550 alignment when compared to the Revised F Modified US 550 alignment, but both alignments connect to US 160 at the Three Springs/ CR 233 interchange. The traffic operational analysis for both alternatives is the same.

F. **Western Realignment Alternative.** This alternative would relocate the existing US 550/US 160 intersection to the west where it would intersect US 160 with a directional interchange. This alternative assumes there is a Grandview trumpet interchange and SPUIs at CR 233 (Three Springs) and SH 172/CR 234.

The purpose for improvements to the US 160 corridor include increasing travel efficiency and capacity to meet current and future needs, while improving safety for the traveling public by reducing the number and severity of accidents, and controlling access. The design year of the US 160 FEIS was 2025. The analysis performed in this memorandum will use the same methodology as the FEIS except the design year is adjusted to 2030.

**Summary of Results:** The results of the analysis performed are summarized below:

| Year 2030 Analysis | | Purpose and Need for Capacity | |
|---|---|---|---|
| | | Met | Not Met |
| A | US 550 @ US 160 At-Grade Intersection Alternatives | | ✓ |
| B | Partial Interchange @ Existing US 550 / US 160 | ✓ | |
| C | Revised Preliminary Alternative A | ✓ | |
| D | Revised G Modified | ✓ | |
| E | Revised F Modified & Eastern Realignment Alternative | ✓ | |
| F | Western Realignment Alternative | | ✓ |

## Evaluation Criteria

The interchange alternatives were evaluated to determine if each alternative met operational level of service requirements as described in the Executive Summary of the FEIS, based on guidance in the AASHTO Policy on Geometric Design of Highways and Streets 2004 (AASHTO Green Book) and capacity analysis performed according to the methods described in the Highway Capacity Manual[1] (HCS). This memorandum deals with the capacity analysis and not design. Traffic volumes used in the analysis are year 2030 peak hour volumes that were projected from the year 2025 volumes documented in Appendix A, Traffic Report, Figure 8 of the US 160 FEIS. The 2025 background traffic volumes were projected based on the background annual growth rates in the accepted methodology in the FEIS to calculate the year 2030 background scenario. The trips generated by the Grandview development were combined with the year 2030 background volumes to generate the year 2030 total peak hour volumes used in the analysis.

For the purposes of this analysis, US 160 is assumed to be east/west and US 550 is assumed to be north/south.

**US 160 Interchanges and Signalized Intersections**

The capacity requirement for the purpose and need of the Grandview Section is as follows:

- A Level of Service (LOS) D or better for an urban signalized intersection, including signalized intersections at single point urban interchanges (SPUI), and its individual legs or movements during the peak hour in year 2030; and
- A LOS D or better for urban interchange merge, diverge, weaving area, auxiliary lanes. and/or freeway sections during the peak hour in year 2030.

[1] Highway Capacity Manual - Special Report 209. Transportation Research Board. National Research Council. 2000.

Anything worse than LOS D for any intersection, leg, movement, ramp, auxiliary lane, or freeway section is considered "failing," and not meeting the purpose and need. These criteria were applied to the alternatives analyzed in this memorandum.

**US 160 Continuous Through Lanes**

**Preferred Alternative**

The Preferred Alternative in the US 160 FEIS included a four-lane typical section, two continuous lanes in each direction, throughout the corridor with a westbound auxiliary lane and eastbound climbing lane from the west limit of the Grandview Section to the future connection of US 160 and US 550. Auxiliary lanes were added to maintain an operational level of service of D by improving the merge, diverge and weave movements, by helping to make safer lane transitions to and from the future US 160/US 550 interchange.

**Year 2030 Traffic Operations Analysis**

In the analysis, the projected traffic volumes were extended to the year 2030. The background traffic on US 160 was increased from the year 2025 to 2030, and the trip generation from a fully developed Grandview Area Plan increased traffic on the US 160 mainline as well as the entering and exiting traffic volumes to US 160. Due to the increased entering/exiting volumes, auxiliary lanes will need to be extended, from those assumed in the US 160 FEIS. The auxiliary lanes in the year 2030 need to be extended to the future CR 233 (Three Springs) interchange to maintain a LOS D for the traffic operations of the merge, diverge and weaving movements along US 160.

Since the number of continuous through lanes remains constant throughout the US 160 corridor and auxiliary lanes are not carried through any of the interchanges, auxiliary lanes are not considered capacity-adding improvement measures. However, they can be utilized to improve the traffic operations between two successive interchanges and to assist in accommodating high entering/exiting traffic volumes. Without auxiliary lanes at high volume locations, bottleneck areas can result due to poor levels of service for the merging, diverging, and weaving movements. Areas of congestion such as bottleneck locations typically coincide with areas that exhibit poor accident ratings. Auxiliary lanes help to solve merge, diverge and weave issues as well as improve the safety complications associated with poor traffic operations.

## Section 4(f) Alternatives Under Consideration

Utilizing the year 2030 volumes developed along the US 160 corridor five alternatives were analyzed. The alternatives were evaluated to determine if each met capacity requirements as described in the purpose and need of the FEIS but in the design year 2030. The analysis considers two through lanes in each direction and one auxiliary lane in each direction extending from the CR 233 (Three Springs) interchange to the west end of the Grandview Section. The auxiliary lanes are not continuous over the entire distance from CR 233 to the west end of the Grandview Section. The auxiliary lanes drop off at the off ramps for the Grandview Interchange and begin again where the Grandview Interchange on ramps merge with US 160.

### A. US 550 at US 160 At-Grade Intersection Alternative – Figure 1

The EIS considered a signalized intersection at the existing US 550/US 160 intersection (Feasibility Alternative 1B) and determined that this option did not meet the purpose and need. This alternative is being re-evaluated in light of new information, including traffic information provided by Krager and Associates in a letter sent by attorney Thomas McNeill on behalf of the owners of the Webb Ranch to the FHWA. This analysis also addresses the capacity requirements for the design variations T.1.4, T.1.6, and T.4.4.

Each design variation illustrates US 550 intersecting US 160 as an at-grade intersection at the existing US 550/US 160 intersection location. The intersection geometry is also the same for T.1.4, T.1.6 and T.4.4 as illustrated in Figure 1. The differences occur approximately 500 feet away from the US 550/US 160 intersection where the horizontal curvature and grade varies. The design variations are contained in Appendix A for reference.

- **Design Variation T.1.4** shows a 1050-foot radius and a 4% grade;
- **Design Variation T.1.6** shows a 925-foot radius and a 6% grade; and
- **Design Variation T.4.4** shows a 1250-foot radius and a 4% grade.

Since these design variations occur away from US 550 / US 160, they do not influence the traffic operations at the intersection and do not affect the results of the analysis.

**Connection of US 550 to US 160**

The Krager and Associates analysis states that an at-grade signalized intersection will operate at LOS C with three through lanes in each direction on US 160. While the volumes used in the analysis were derived from the year 2025 volumes found in Figure 8 of the US 160 FEIS (refer to Appendix A of this memo), this analysis only accounts for the volumes on three legs of the Grandview interchange and does not include the traffic accessing US 160 from the north leg of the Grandview interchange. The Krager and Associates conclusions were erroneously based on traffic volumes that are lower than what was documented in the US 160 FEIS. Using volumes that account for all of the traffic that would be expected at the intersection in the year 2030, the intersection is expected to operate at LOS D during the morning peak period (80 second cycle length) and LOS E during the evening peak period (90 second cycle length) with the number of lanes proposed by Krager and Associates. In addition, the volume to capacity ratios (v/c) for the individual lanes are approaching a v/c ratio of 1.0 and traffic queues expected during the evening peak period will be in excess of 1,750 feet (Approximately 88 vehicles). Modifying/increasing the traffic signal cycle lengths will further degrade the intersection level of service and no additional capacity can be achieved for this alternative.

**Adjacent interchanges in the Grandview Section**

This analysis also evaluated the LOS conditions for the other interchanges identified in the Grandview Section. The analysis verified that the other interchanges in the section all meet the capacity requirements for the purpose and need in the year 2030. The analysis worksheets are contained in Appendix A for reference.

**Conclusion**

This alternative does not meet capacity requirements for the purpose and need because an intersection is not adequate to maintain LOS D in the evening peak hour.

## B. Partial Interchange at the Existing US 550 at US 160 Intersection – Figure 2

This alternative proposes to modify the signalized intersection at US 160/US 550 by eliminating the left turn movement from northbound US 550 to westbound US 160 and replacing it with a loop ramp to service the left turn volumes at the intersection. To accommodate the through volumes, US 160 would have two through lanes and one auxiliary lane westbound from the CR 233 (Three Springs) interchange through the US 550 intersection. US 160 eastbound would have two through lanes and one climbing lane from west of the US 550 intersection to the CR 233 / Three Springs interchange. This analysis will also address the capacity requirements for the design variations T.2.4, T.2.6, T.3.4, and T.3.6.

Each design variation illustrates US 550 intersecting US 160 as an at-grade intersection at the existing US 550/US 160 intersection location but with a flyover to accommodate the northbound left turn movement. The intersection geometry and flyover ramp movement are the same for T.2.4, T.2.6, T.3.4

and T.3.6 as illustrated in Figure 2. The differences occur approximately 500 feet away from the US 550/US 160 intersection where the horizontal curvature and grade varies, and the location and radius of the flyover. The design alternatives are contained in Appendix B for reference.

- **Design Variation T.2.4** shows a 1050-foot radius and a 4% grade. The location of the flyover has half of the loop on each the north and south side of US 160;
- **Design Variation T.2.6** shows a 925-foot radius and 6% grade. The location of the flyover has half of the loop on each the north and south side of US 160;
- **Design Variation T.3.4** shows a 1050-foot radius and a 4% grade. The location of the flyover loop is entirely on the north side of US 160; and
- **Design Variation T.3.6** shows a 925-foot radius and a 6% grade. The location of the flyover loop is entirely on the north side of US 160.

Since these design variations occur away from US 550 / US 160, they do not influence the traffic operations at the intersection and do not affect the results of the analysis.

**Connection of US 550 to US 160**

The signalized intersection is expected to operate at LOS A in the morning (60 second cycle length) and LOS A in the evening (90 second cycle length). The loop ramp has an approximate design speed of 30 MPH and the merge for the loop ramp is expected to operate at LOS B in the morning peak hour and LOS C in the evening peak hour. The westbound to southbound double-left turn movement is expected to operate at LOS C in the morning and LOS D in the evening. During the evening peak period the eastbound through movement is expected to operate at LOS C and traffic queues are expected to be in excess of 900 feet. All other movements are expected to operate at LOS A during the both peak periods. In addition, the volume to capacity ratios (v/c) for the individual lanes are approaching a v/c ratio of 1.0 during the evening peak period.

**Adjacent interchanges in the Grandview Section**

This analysis also evaluated the LOS conditions for the other interchanges identified in the Grandview Section. The analysis verified that the other interchanges in the section all meet the capacity requirements for the purpose and need in the year 2030. The analysis worksheets are contained in Appendix B for reference.

**Conclusion**

The alternative does satisfy the capacity requirements for the purpose and need in the year 2030.

## C. Revised Preliminary Alternative A – Figure 3

The FEIS considered an interchange at US 550/US 160 (Preliminary Alternative A). However, the Preliminary Alternative A was not considered to be a reasonable alternative because it has poor geometry which combines 6 percent grades, sharp curves and maximum super-elevation on a north-facing slope that will create icing conditions and hazards in the winter. In part, because of these reasons, Preliminary Alternative A from the EIS was not considered to be reasonable or practicable and was dismissed without the traffic operations being analyzed. This alternative is being re-evaluated despite the geometric problems to determine whether the traffic operations will meet the purpose and need for capacity.

The Revised Preliminary Alternative A proposes a Single Point Urban Interchange (SPUI) at SH 172/CR 234 and CR 233 (Three Springs) with a grade separated trumpet interchange at the existing US 550/US 160 connection. This alternative has been revised from the FEIS to include a grade separated trumpet interchange (Grandview Interchange) east of the existing US 550/US 160 Intersection. To accommodate the through volumes, US 160 would have two through lanes and one auxiliary lane westbound from the

CR 233 (Three Springs) interchange through the US 550 interchange. US 160 eastbound would have two through lanes and one climbing lane from west of the US 550 interchange to the CR 233 (Three Springs) interchange. The analysis worksheets are contained in Appendix C for reference.

**Connection of US 550 to US 160**
The weaving segment for eastbound US 160 between US 550 interchange and Grandview interchange is expected to operate at LOS B during the morning peak period and LOS C during the evening peak period. All merge and diverge sections between US 550 and US 160 are expected to operate at LOS B during the morning peak period and LOS C during the evening peak period.

**Adjacent interchanges in the Grandview Section**
This analysis also evaluated the LOS conditions for the other interchanges identified in the Grandview Section. The analysis verified that the other interchanges in the section all meet the capacity requirements for the purpose and need in the year 2030.

**Conclusion**
This alternative satisfies the capacity requirements of the purpose and need. The planned interchange and auxiliary lane configurations are adequate to accommodate the projected volumes at LOS D or better with US 550 connecting to this location.

## D. Revised G Modified – Figure 4

This alternative includes two through lanes in each direction through the Grandview Section with eastbound and westbound auxiliary lanes from the CR 233 (Three Springs) interchange to the west end of the section. A trumpet interchange is assumed at the Grandview location and a SPUI is assumed at the CR 233 (Three Springs) and SH 172 / CR 234 interchanges.

**Connection of US 550 to US 160**
The merge and diverge movements at the Grandview Interchange are expected to operate at LOS B or better during the morning peak period and LOS C or better during the evening peak period. The weaving segment for westbound US 160 between Three Springs interchange and Grandview interchange is expected to operate at LOS B during the morning peak period and LOS C during the evening peak period.

The roundabout at the intersection between US 550 and the US 160 ramps is expected to operate at LOS A during the morning and evening peak periods. Each approach to the roundabout is expected to operate at LOS A during the morning and evening peak periods as well. The analysis worksheets are contained in Appendix D for reference.

**Adjacent interchanges in the Grandview Section**
This analysis also evaluated the LOS conditions for the other interchanges identified in the Grandview Section. The analysis verified that the other interchanges in the section all meet the capacity requirements for the purpose and need in the year 2030.

**Conclusion**
The analysis shows that this alternative satisfies the capacity requirements of the purpose and need in the year 2030. This alternative accommodates the projected year 2030 volumes at LOS D or better.

## E. Revised F Modified and Eastern Realignment Alternative – Figure 5

These two alternatives will both connect to the CR 233 (Three Springs) interchange. The Revised F Modified includes an additional trumpet interchange at the Grandview Interchange, and SPUI interchanges at CR 233 (Three Springs) and SH 172/CR 234. US 550 would connect to US 160 at CR

233 (Three Springs) interchange. The Eastern Realignment Alternative has a different US 550 alignment when compared to the Revised F Modified US 550 alignment, but both alignments connect to US 160 at the CR 233 (Three Springs) interchange. The traffic operational analysis is the same for both alternatives where they connect to US 160. Frontage roads will parallel both alignments from US 160 to CR 220. These roads will provide local access to the properties south of US 160. US 160 will have two through lanes and one auxiliary lane in each direction from the west ramps of the Grandview Interchange to the west ramps of the CR 233 (Three Springs) interchange. The analysis assumes two through lanes in each direction through the Grandview Section with eastbound and westbound auxiliary lanes from the CR 233 (Three Springs) interchange to the west end of the section. The analysis worksheets are contained in Appendix E for reference.

**Connection of US 550 to US 160**

The merge and diverge movements at the CR 233 (Three Springs) Interchange are expected to operate at LOS B or better during the morning peak period and LOS C or better during evening peak period. The weaving segment for westbound US 160 between Three Springs interchange and Grandview interchange is expected to operate at LOS B during the morning peak period and LOS C during the evening peak period.

The signalized intersection in the center of the interchange is expected to operate at LOS C during the morning and evening peak periods (90 second cycle AM, 110 second cycle PM), and all of individual movements are expected to operate at LOS D or better during both peak periods. During the evening peak period, the individual movements operating at-capacity are the eastbound left turn and right turn movements as well as the northbound left turn movement which are expected to operate at volume to capacity ratios (v/c) near 1.0. Traffic queues are expected to be in excess of 600 feet.

**Adjacent interchanges in the Grandview Section**

This analysis also evaluated the LOS conditions for the other interchanges identified in the Grandview Section. The analysis verified that the other interchanges in the section all meet the capacity requirements for the purpose and need in the year 2030.

**Conclusion**

This alternative satisfies the capacity requirements of the purpose and need. The interchange is adequate to accommodate the projected volumes at LOS D or better with US 550 connecting to this location.

## F. Western Realignment Alternative - Figure 6 & 7

This alternative proposes to relocate US 550 to the west where it would intersect US 160 with a directional interchange thus eliminating the signalized intersection of US 160/US 550. The alignment would include two river crossings requiring bridges. Two of the ramps from the interchange would terminate approximately 700 feet from the existing River Road signalized intersection on US 160. The traffic operational results for the interchange do not include the impacts of the traffic signal operation at River Road. Impacts due to the proximity of River Road are described below. The analysis worksheets are contained in Appendix F for reference.

**Connection of US 550 to US 160**

The Western Realignment Interchange is expected to operate at LOS C or better during the morning and evening peak periods in the analysis. However, when the interaction of the River Road signalized intersection with the interchange is analyzed, there is a queuing of traffic in the evening peak period of approximately 1,700 feet (85 vehicles) on US 160 (Figure 7). The queues on US 160 will force queues to form on the ramp itself, congesting the merge area such that a free flow merge could not occur.

Ramp merge calculations in the HCS software assume free flow operations and cannot analyze the queue impacts from a closely spaced signalized intersection downstream from the ramp merge point. The results of the HCS analysis determines the ramp merge has acceptable operations even though the proximity of the traffic signal would cause congestion on the ramp. Our operations analysis evaluated this relationship and determined that the expected vehicle stoppages at the interchange merge area is a capacity failure.

Unlike the other alternatives, this interchange will experience congestion and capacity problems due to the close proximity of the River Road signalized intersection to the westbound on ramp to US 160. Intersection queues, westbound at River Road, during the evening peak period will extend beyond the merge for the US 550 to US 160 on ramp. This will cause vehicles to stop on the ramp during the evening peak period. Approaching vehicles on US 550 would not be able to see the stopped vehicles due to the interchange ramp design and curvature. The speed differential between approaching vehicles and stopped vehicles on the ramp will create an unsafe condition that could result in a high probability of sideswipe and rear-end accidents. This alternative does not meet the purpose and need for capacity, resulting in an unsafe roadway condition between the interchange and the adjacent signalized intersection. This is considered a failing condition as it is not consistent with the purpose and need to have a known design that contributes to congestion and safety issues. The analysis worksheets are contained in Appendix G for reference.

**Adjacent interchanges in the Grandview Section**

This analysis also evaluated the LOS conditions for the other interchanges identified in the Grandview Section. The analysis verified that the other interchanges in the section all meet the capacity requirements for the purpose and need in the year 2030.

**Conclusion**

The proximity of River Road to the US 550 westbound on-ramp to US 160 will create queue conflicts, congestion, and backups at the westbound interchange on-ramp. The Western Realignment does not meet the purpose and need for capacity resulting in an unsafe roadway condition between the interchange and the adjacent signalized intersection.

## Conclusions

**US 550 at US 160 At-Grade Intersection Alternative.** This includes design variations T.1.4, T.1.6, T.4.4. This alternative does not meet the capacity requirements of the purpose and need because the geometry of the US 160/US550 intersection is not adequate to maintain LOS D in the evening peak hour.

**Partial Interchange at the Existing US 550 at US 160 Intersection.** This analysis also addresses the capacity requirements for the design variations T.2.4, T.2.6, T.3.4, and T.3.6. The alternative does satisfy the capacity requirements for the purpose and need.

**Revised Preliminary Alternative A.** This alternative satisfies the capacity requirements of the purpose and need. The planned interchange and auxiliary lane configurations are adequate to accommodate the projected volumes at LOS D or better with US 550 connecting to this location.

**Revised G Modified.** With year 2030 traffic volumes, this alternative meets the capacity requirements in the purpose and need.

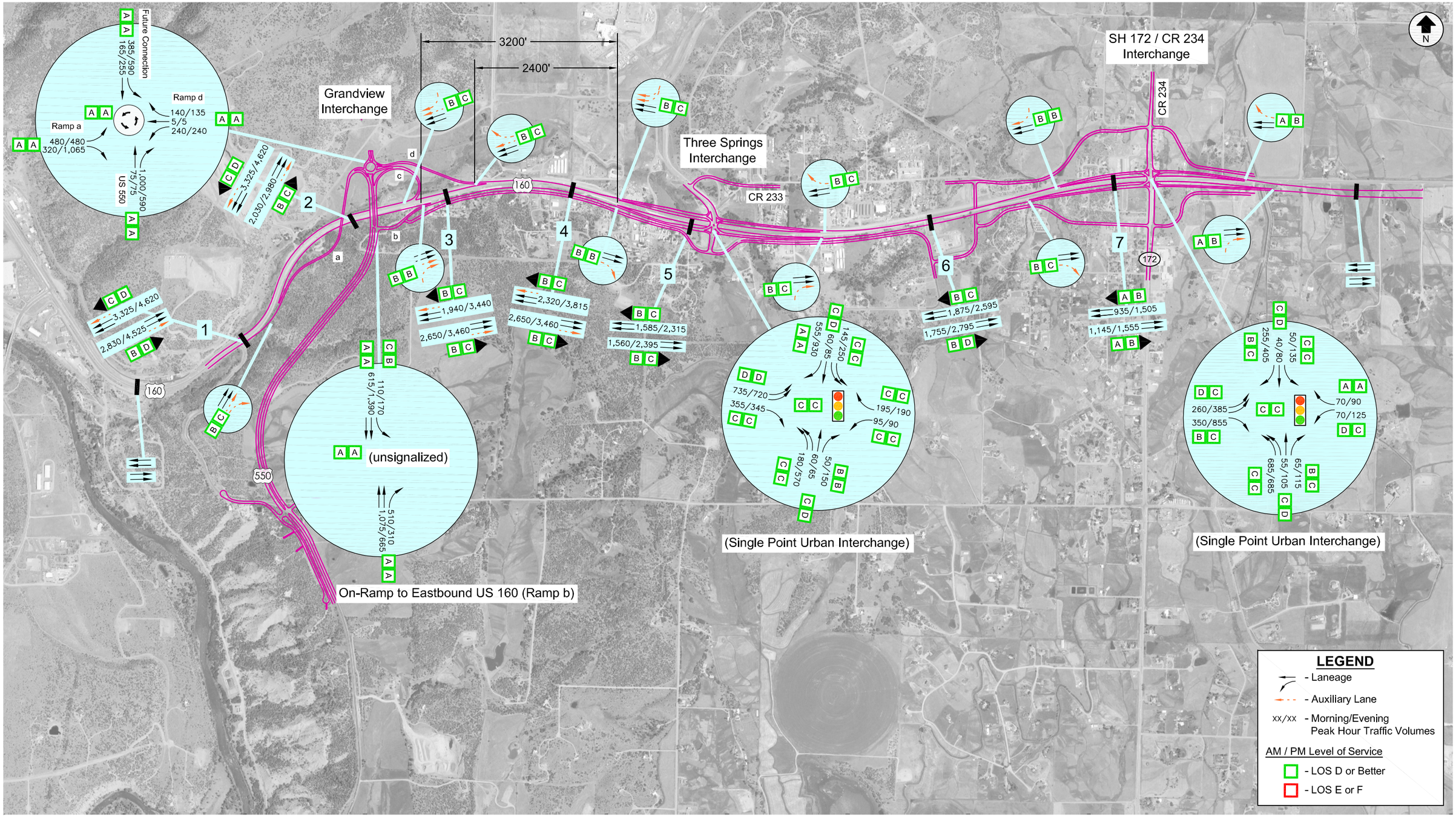
**Revised F Modified and Eastern Realignment Alternative.** Both of these alternatives meet the capacity requirements of the purpose and need due to the additional Grandview Interchange which reduces the traffic impacts of the fully developed residential and commercial area in Grandview to the north of the CR 233 (Three Springs) interchange.

**Western Realignment Alternative.** Capacity is a criteria of the purpose and need, this alternative does not satisfy the capacity requirement of the purpose and need. The proximity of River Road to US 550 northbound to westbound US 160 on-ramp causes capacity queuing conflicts with the on-ramp and potential safety issues, this alternative does not satisfy the purpose and need.

## Capacity Analysis and Comparison of Alternatives beyond the Horizon Year of 2030

In a separate report (*US 160 Section 4(f) Alternatives Considered in the Least Harm Analysis – The Degree to Which Each Alternative Meets the Purpose and Need for the Project*, dated December 23, 2010) an analysis was performed to determine which of alternatives that met the criteria of LOS D or better for the 2030 traffic capacity analysis performed best if traffic were increased beyond the volumes used for the 2030 analysis. In this analysis, traffic was increased at the intersections of US 160/US 550 in 2% increments until a movement failed (i.e., resulted in LOS E or worse) that could not be corrected by simply optimizing the traffic operations at the intersections and without adding additional lanes at the intersection. The results of this analysis showed that the signalized US 160/US 550 (Three Springs Interchange) intersection for Revised F Modified and the Eastern Realignment alternative failed with the first 2% increase of traffic at the intersection, while the roundabout intersection in Revised G Modified remained at LOS A for the overall intersection and all movements with the same 2% increase in traffic. This analysis showed that the US 160/US 550 intersection in Revised F Modified and the Eastern Realignment was approaching capacity with the 2030 traffic volumes, and exceeded the capacity of the intersection with only a slight increase in traffic beyond the 2030 volumes while the roundabout intersection in Revised G Modified had substantial reserve capacity beyond the 2030 volumes. As a result of this analysis, ***it was concluded that the roundabout at the Grandview Interchange (Revised G Modified) has more reserve capacity than a signalized intersection at the Three Springs Interchange (Revised F Modified) and thus Revised G Modified better meets the project purpose and need.***

jel
Attachments
p:\ae\c\codot\105181\to #3 - us 160 interchange analysis\project____final memos_december 2010\3\3_2030 traffic ops analysis for the us 550 at us 160 section 4f_12-23-2010_final.docx




# Year 2030 Traffic Volumes

Year 2030 Traffic Operation Analysis for the US 550 at US 160 Section 4(f) Alternatives
Revised Alternative G Modified

| Scale | 1"=1500' | Date | 4/28/10 | Drawn by | NWS | Job # | 105181 | Figure | 4 |
|---|---|---|---|---|---|---|---|---|---|

# SEH MEMORANDUM

# US 160 Section 4(f) Alternatives Considered in the Least Harm Analysis—The Degree to Which Each Alternative Meets the Purpose and Need for the Project

# January 5, 2011

# MEMORANDUM

TO: Mike McVaugh, PE - CDOT Region 5

FROM: Phil Weisbach, PE
Jon E. Larson, PE

DATE: January 5, 2011

RE: US 160 Section 4(f) Alternatives Considered in the Least Harm Analysis – The Degree to Which Each Alternative Meets the Purpose and Need for the Project
SEH No. CODOT - 105181

## Executive Summary

Alternatives for the US 550 connection to the US 160 corridor were originally evaluated in the US Highway 160 from Durango to Bayfield Final Environmental Impact Statement (FEIS) dated May 2006. The US 160 Highway from Durango to Bayfield Record of Decision (US 160 ROD) documented selection of Grandview Alternative G Modified as the Preferred Alternative which included an interchange of US 160 with US 550 approximately 0.6 miles east of the current intersection.

A separate memo entitled *Year 2030 Traffic Operations Analysis for the US 550 at US 160 Section 4(f)* (December 23, 2010) analyzes whether the alternatives being considered in the 4(f) analysis meet the capacity requirements of the purpose and need in the year 2030. The analysis looks at projected traffic in the year 2030 to evaluate if the roadway will meet the capacity requirements for the purpose and need 20 years into the future. The Section 4(f) alternatives focus on the connection of US 550 to US 160 in the Grandview Section. All of the alternatives assume that there is an existing Grandview trumpet interchange and single point urban interchanges (SPUIs) at CR 233 (Three Springs) and SH 172/CR 234. The need for these three interchanges in the Grandview Section is explained in a separate technical memorandum: *Year 2030 Traffic Operations Analysis for Alternatives of the US 160 FEIS* dated September 17, 2010.

Of the alternatives considered in the Section 4(f) analysis, three alternatives are being considered under the least harm analysis. These alternatives include Revised G Modified, Revised F Modified, and the Eastern Realignment. One of the balancing factors when considering the least overall harm is the degree to which each alternative meets the purpose and need for the project This analysis evaluates the degree to which these alternatives meet the purpose and need and focuses specifically on the connection of US 550 to US 160. The alternative that exhibits the highest degree of meeting the purpose and need provides the most overall benefit to the access, safety and capacity of US 160 throughout its 20-year design.

The technical traffic analysis data for this memo is included in the attached appendices at the end of this document.

This analysis addresses several fundamental questions:

A. Which alternative exhibits more desirable access control along US 160?

B. Which alternative is ‘more safe’ and exhibits the least overall potential for harm to the motorists?

C. Which alternative exhibits the most reserve capacity at the intersection where US 550 connects with US 160?

D. Which alternative has the highest degree of meeting the purpose and need for access, safety and capacity?

The purpose for improvements to the US 160 corridor include increasing travel efficiency and capacity to meet current and future needs, while improving safety for the traveling public by reducing the number and severity of accidents, and controlling access. The design year of the US 160 FEIS was 2025. The analysis performed in this memorandum will be the same as the FEIS except the design year is changed to 2030.

**Summary of Results:** The results of the analysis performed are summarized below:

**Fundamental Questions**

| US 160 Section 4(f) Alternatives Considered in the Least Harm Analysis | Revised G Modified | Revised F Modified[1] | Eastern Realignment[1] |
|---|---|---|---|
| Which alternative exhibits more desirable access control along US 160? | ✓ | ✓ | ✓ |
| Which alternative is 'more safe' and exhibits the least overall potential for harm to the motorists? | ✓ | | |
| Which alternative exhibits the most reserve capacity at the intersection where US 550 connects with US 160? | ✓ | | |
| Which alternative has the highest degree of meeting the purpose and need for access, safety and capacity? | ✓ | | |

Note:

1. The Revised F Modified and Eastern Realignment alternatives have different alignments, but both alternatives connect to US 160 at Three Springs. The traffic capacity, access, and safety analysis are the same for Revised F Modified and Eastern Realignment alternatives.

## Section 4(f) Alternatives Evaluated

The following describes the alternatives being considered in the least harm analysis for the Section 4(f) Evaluation:

A. **Revised G Modified – Figure 1.** This alternative connects US 550 to US 160 via the Grandview trumpet interchange which intersects with US 550 via a roundabout, and CR 233 (Three Springs) and SH 172/ CR 234 would be SPUI interchanges.

B. **Revised F Modified and Eastern Realignment Alternative – Figure 2.** These two alternatives will both connect to the CR 233 (Three Springs) interchange. The Revised F Modified includes an additional trumpet interchange at the Grandview Interchange, and SPUI interchanges at CR 233 (Three Springs) and SH 172/CR 234. US 550 would connect to US 160 at the CR 233 (Three Springs) interchange. The Eastern Realignment Alternative has a different US 550 alignment when compared to the Revised F Modified US 550 alignment, but both alignments connect to US 160 at the Three Springs/ CR 233 interchange. The traffic operational analysis for both alternatives is the same.

Figures 1 and 2 illustrate the alignments for these alternatives as well as the year 2030 traffic operations analysis from the Section 4(f) alternatives evaluation. The traffic volumes, interchange traffic control/laneage and interchange spacing will be used as the basis for the analysis to determine which alternative is more beneficial to the purpose and need.

# Evaluation of the Degree with which Alternatives Meet Purpose and Need

## A. Access

Access control was evaluated to determine which alternative better promotes an access management system that meets the expectations of a high-speed, high volume highway through appropriate control of access frequency and spacing.

**Revised G Modified – Figure 1**

This alternative includes two through lanes in each direction through the Grandview Section with interchanges at the Grandview location, CR 233 (Three Springs) and SH 172 / CR 234. Local access within this corridor will be managed with a local frontage road system to limit direct access to the highway only at the interchanges. Additionally, this alternative includes establishing an access line along the corridor to preclude future additional accesses. Within the Grandview Section, there are no other accesses proposed other than the three interchanges. The approximate distances between the interchanges are tabulated below:

- Between Grandview Interchange & Three Springs Interchange = 5,600 feet
- Between Three Springs Interchange & SH 172 / CR 234 = 7,150 feet

**Revised F Modified and Eastern Realignment Alternative – Figure 2**

This alternative includes two through lanes in each direction through the Grandview Section with interchanges at the Grandview location, CR 233 (Three Springs) and SH 172 / CR 234. Local access within this corridor will be managed with a local frontage road system to limit direct access to the highway only at the interchanges. Additionally, this alternative includes an access line along the corridor to preclude future additional accesses. Within the Grandview Section, there are no other accesses proposed other than the three interchanges. The approximate distances between the interchanges are tabulated below:

- Between Grandview Interchange & Three Springs Interchange = 5,600 feet
- Between Three Springs Interchange & SH 172 / CR 234 = 7,150 feet

**Conclusion**

The analysis shows that access for the three alternatives exhibit the same frequency and spacing. Regardless of where US 550 connects to US 160, local access to US 160 is managed by a frontage road system to minimize access to US 160 only at the planned interchanges. ***Therefore, the degree with which the alternatives meet purpose and need for access is the same for all three alternatives.***

## B. Safety

Safety was evaluated to determine which alternative more safely accommodates the traffic volumes associated with the connection of US 550 to US 160.

**Revised G Modified – Figure 1**

This alternative connects US 550 to US 160 via the Grandview trumpet interchange. However, traffic on US 550 is accommodated at its intersection with US 160 by a roundabout that is expected to operate at an acceptable level of service in the year 2030.

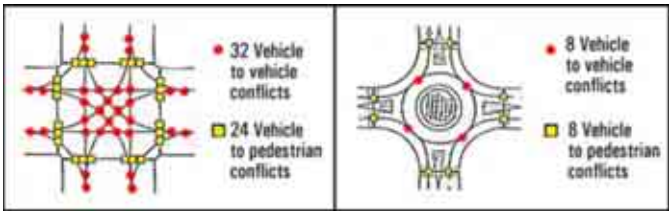
**Revised F Modified and Eastern Realignment Alternative – Figure 2**

This alternative connects US 550 to US 160 via the Three Springs SPUI interchange. Traffic on US 550 is accommodated at its intersection with US 160 by a SPUI and controlled by a traffic signal that is expected to operate at an acceptable level of service in the year 2030.

**Roundabouts Versus Traffic Signals**

One of the benefits of roundabout installations is the improvement in overall safety performance to other traffic control installations. Though the frequency of crashes is not always lower for roundabouts, there is a pronounced reduction in injury rates. The typical reasons for the increased safety level at roundabouts are[1]:

- **Roundabouts have fewer conflict points.** The frequency of crashes at an intersection is related to the number of conflict points. At a four-legged conventional signalized intersection, there are 32 vehicle-to-vehicle conflicts and 24 vehicle-to-pedestrian conflicts. At a four-legged roundabout, this number is reduced to 8 as shown in the figure below. The four dots in the roundabout illustrations represent two conflict points each for the merge conflict and the diverge conflict.




- **Lower speeds and lower speed differential.** Lower speeds associated with roundabouts allow drivers more time to react to potential conflicts.
- **Fewer number of driver decisions.** Drivers only need to be aware of vehicles to their left at entry of roundabouts. Drivers at traffic signals need to be aware of traffic coming from as many as three directions at any time. In addition the driver must remain aware of the signal indication while monitoring the vehicle movements through the intersection.
- **Less severe crashes.** Severity of crashes is based on the relative speed and angle of the conflicting streams. Most vehicles travel at similar speeds through roundabouts with a small angle between the vehicle paths. The potential for hazardous conflicts, such as right angle and left turn head-on crashes is eliminated in roundabout use.

Research shows that roundabouts can be an effective way to improve safety at intersections. In a review of 55 sites that were converted from four-way intersections to roundabouts, before and after crash data shows a reduction in crashes 35% (1,122 to 726). More importantly, the severe injury crashes were reduced 76% (from 296 to 72).[2]

**Conclusion**

The analysis shows that a roundabout controlled intersection is more likely to provide safer operations than a conventional traffic signal due to the lower speeds, fewer conflicting movements and the elimination of head-on and broad-side crashes that are typically associated with injury crashes. Regarding safety, to accommodate the significant volume of traffic from US 550, use of a roundabout at the Grandview Interchange would be safer than sending US 550 to a traffic signal at the Three Springs Interchange. ***Therefore, the Revised G Modified has a higher degree of safety benefit compared to Revised F Modified and the Eastern Realignment Alternative.***

---

[1] Roundabouts: An Information Guide. Federal Highway Administration (Report No. FHWA-RD-00-067). June 2000

[2] Roundabouts in the United States. National Cooperative Highway Research Program (Report 572). Transportation Research Board. 2007.

## C. Capacity

The capacity analysis evaluates the connection of US 550 to US 160 to determine which alternative can accommodate more future traffic volume growth beyond the year 2030 forecasted volumes. The year 2030 volumes and traffic represent the basis for which the reserve capacity is measured in the additional analysis. The procedure involved in evaluating the alternatives consists of:

- Begin with the Year 2030 traffic volumes and report results;
- Inflate the traffic volumes at the intersection of US 550 / US 160 in 2% increments until an intersection or individual movement for an alternative fails;
- For the traffic signal operations, the signal phasing and cycle length is then optimized to see if a timing solution could extend the capability of the traffic operations to have capacity for more volume;
- After optimization of the signal phasing and cycle length, the volumes are increased to the point where a movement cannot meet LOS D or better, the alternative is considered to fail; then
- The last alternative that continues to meet the purpose and need for capacity is considered to have the most reserve capacity.

Table 1 illustrates the level of service analysis results. Level of service worksheets are contained in Appendix A for reference.

**Revised G Modified**

This alternative connects US 550 to US 160 via the Grandview trumpet interchange. Traffic on US 550 is accommodated at its intersection with US 160 by a roundabout. The roundabout configuration has 220-foot inscribed circle diameter and includes two circulation lanes with right turn bypass lanes for the eastbound and northbound directions. The US 550 northbound connection to US 160 westbound (Ramp C) is accomplished by a right-turn bypass at the roundabout. The roundabout also connects to Ramp C for any vehicles that need to go westbound on US 160.

The roundabout was analyzed using RODEL. To be consistent with the US 160 Section 4(f) analysis, the roundabout was analyzed with a capacity factor of 0.9 for the two-lane approaches. Additionally, it was evaluated at an 85% confidence level, which simulates the worst few minutes of the peak period instead of the average delay spread across the peak period. The results in RODEL with these assumptions are considered conservative, which provides an increased level of confidence that the results are dependable.

**Year 2030 Traffic Volumes.** The roundabout overall and each approach are expected to operate well at LOS A during the morning and evening peak periods. The merge from Ramp C is expected to operate at LOS B during the morning peak period and LOS C during the evening peak period.

**Year 2030 Traffic Volumes + 2% Inflation.** This scenario evaluates the roundabout approaches and Ramp C, but inflates the year 2030 traffic volumes on each approach by 2% to determine if the roundabout is able to absorb this level of volume increase beyond the year 2030. The roundabout as well as each approach is expected to operate well at LOS A during the morning and evening peak periods. The merge from Ramp C is expected to operate at LOS B during the morning peak period and LOS C during the evening peak period. The roundabout would have to exhibit an 84% increase in traffic volume beyond the year 2030 traffic volumes before it experiences a failing LOS E at one of its movements. Consequently, Ramp C would have to exhibit a 67% increase in traffic volume beyond the year 2030 traffic volumes before the merge operations diminish from an acceptable LOS D to a failing LOS F.

**Revised F Modified and Eastern Realignment Alternative**

This alternative connects US 550 to US 160 via the Three Springs interchange. Traffic on US 550 is accommodated at its intersection with US 160 by a SPUI. The intersection configuration includes the following:

- Eastbound approach – Two left turn lanes and two right turn lanes.
- Westbound approach – Two left turn lanes and one right turn lane.
- Northbound approach – Two left turn lanes, one through lane and one right turn lane.
- Southbound approach – Two left turn lanes, one through lane and one right turn lane.

The traffic signal was modeled in Synchro to emulate SPUI operations which are more efficient than a conventional intersection.

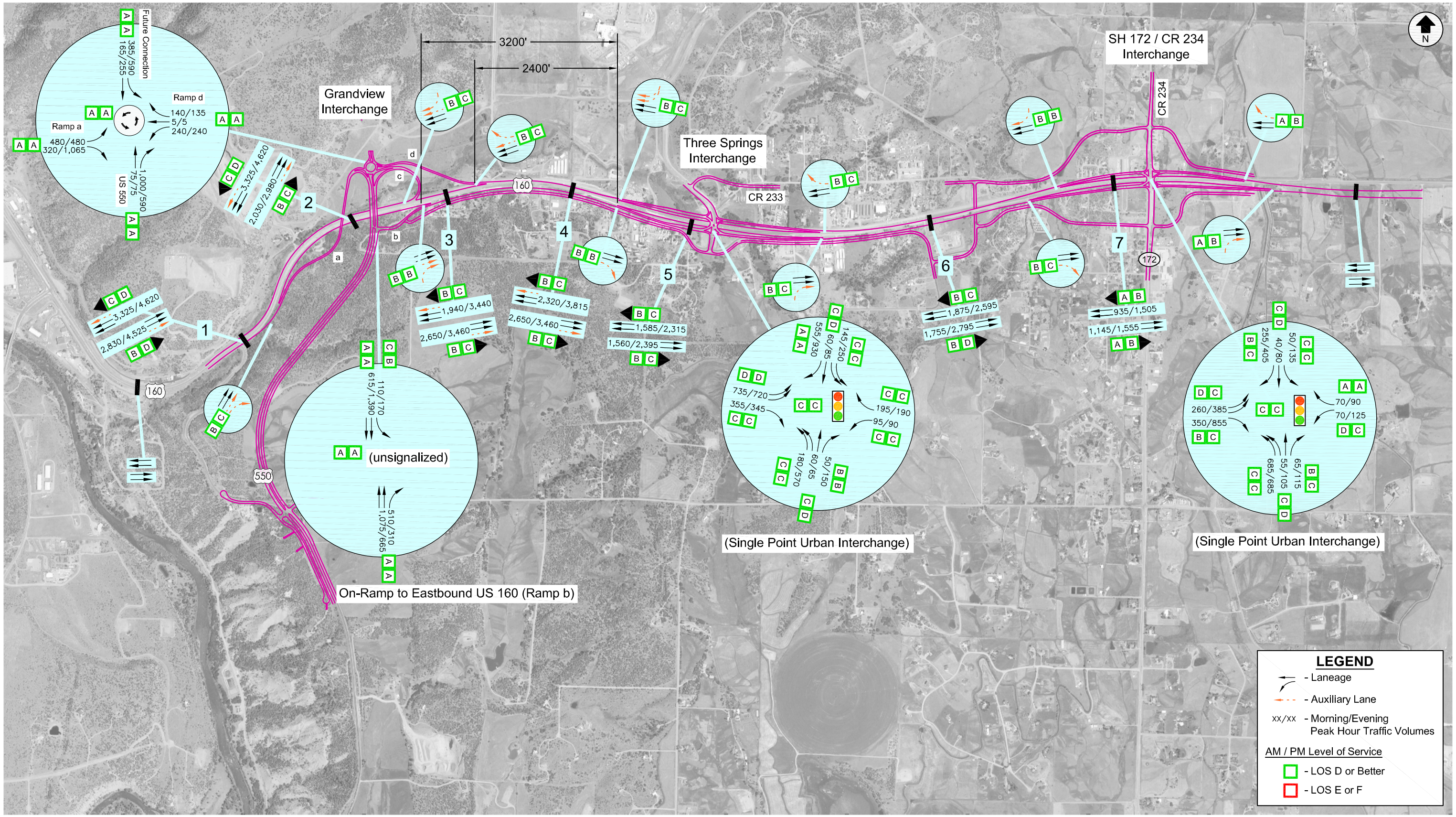
**Year 2030 Traffic Volumes.** The signalized intersection at the Three Springs SPUI is expected to operate at LOS C during the morning and evening peak periods and all of individual movements are expected to operate at LOS D or better during both peak periods.

**Year 2030 Traffic Volumes + 2% Inflation.** This scenario evaluates the SPUI, but inflates the year 2030 traffic peak hour turning movements by 2% to determine if the intersection is able to absorb this level of volume increase beyond the year 2030. The signalized intersection at the Three Springs SPUI is expected to operate at acceptable LOS C during the morning and evening peak periods. However, the northbound left turn is expected to operate at LOS E during evening peak period. Numerous signal phasing and cycle length combinations were attempted, but the signal operations could not be improved to acceptable levels. A 2% increase for the northbound left turn equates to approximately 25-30 vehicles in the morning and evening peak periods. This minor increase creates a failing northbound left turn movement.

**Conclusion**

The analysis shows that the traffic signal fails if traffic volumes were increased by 2% beyond the year 2030 projected traffic volumes. The analysis shows that the roundabout can be expected to accommodate an increase in traffic by 84% and Ramp C can be expected to accommodate an increase in traffic by 67% beyond the year 2030 projected traffic volumes. Therefore, it is clear that there is more reserve capacity with the roundabout than the traffic signal. ***Therefore, the roundabout at the Grandview Interchange (Revised G Modified) has more reserve capacity than a signalized intersection at the Three Springs Interchange (Revised F Modified).***

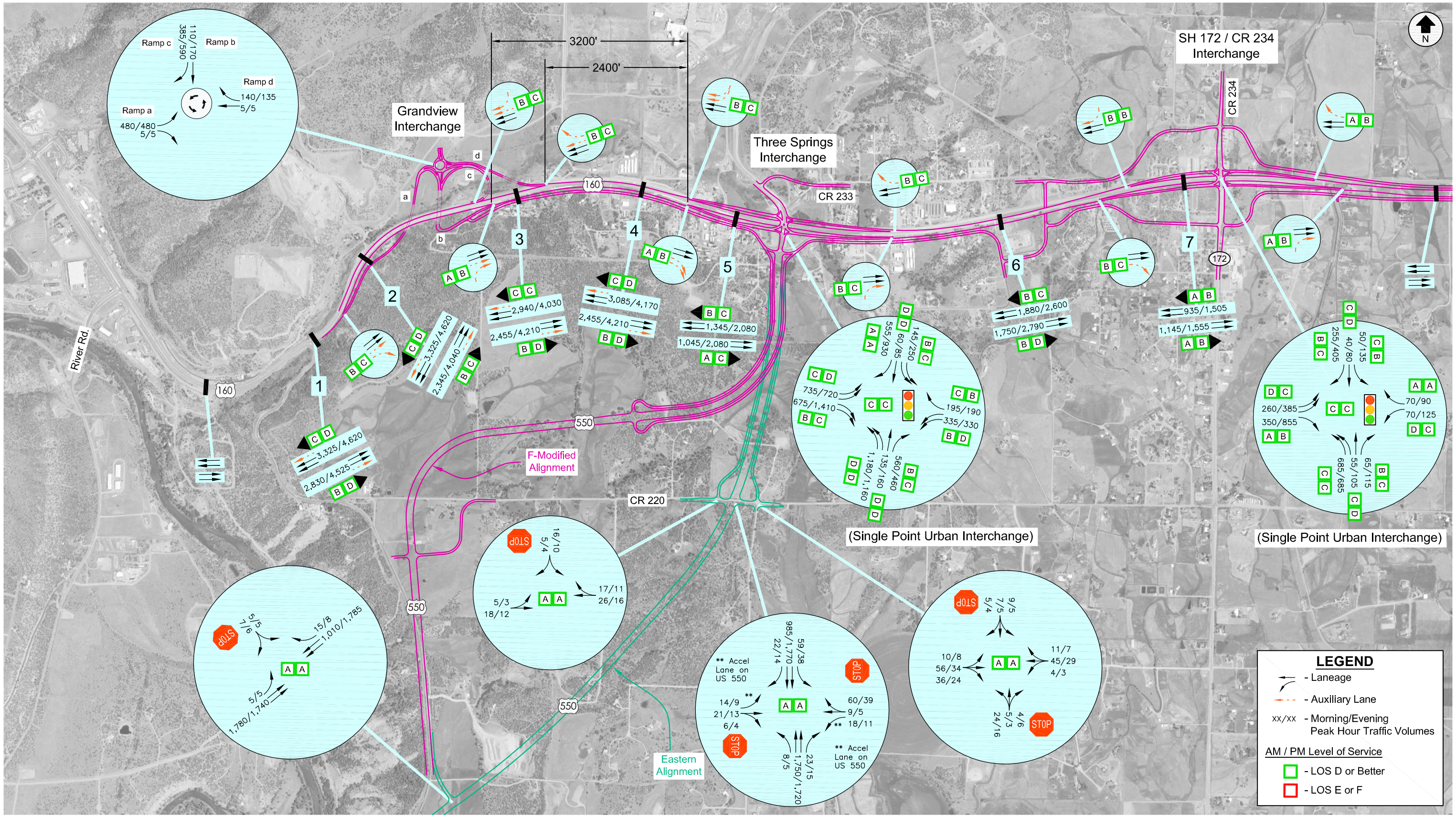
jel
Attachments
p:\ae\c\codot\105181\to #3 - us 160 interchange analysis\project____final memos_december 2010\4\4_degree of purpose-need_us 160 section 4f_1-05-2011_jel.docx




# Year 2030 Traffic Volumes

US 160 Section 4(f) Alternatives Considered in the Least Harm Analysis
Revised Alternative G Modified

| Scale | 1"=1500' | Date | 12/23/10 | Drawn by | JEL | Job # | 105181 | Figure | 1 |
|---|---|---|---|---|---|---|---|---|---|




# Year 2030 Traffic Volumes

US 160 Section 4(f) Alternatives Considered in the Least Harm Analysis
Revised Alternative F Modified and Eastern Realignment Alternative

| Scale | 1"=1500' | Date | 12/23/10 | Drawn by | JEL | Job # | 105181 | Figure | 2 |
|---|---|---|---|---|---|---|---|---|---|

**Table 1. Reserve Capacity Comparison - Roundabout (Alt G) vs. Traffic Signal (Alt F)**

| Intersection and Critical Movements | Year 2030 Traffic Volumes[1] | | | | Year 2030 Traffic Volumes + 2% Inflation | | | |
|---|---|---|---|---|---|---|---|---|
| | AM Peak Hour | | PM Peak Hour | | AM Peak Hour | | PM Peak Hour | |
| | Delay[2] | LOS | Delay[2] | LOS | Delay[2] | LOS | Delay[2] | LOS |
| **Revised G Modified** | | | | | | | | |
| **US 550 @ Grandview (Roundabout)** | **2.6** | **A** | **3.1** | **A** | **2.3** | **A** | **2.7** | **A** |
| Eastbound Approach | *3.0* | A | *3.6* | A | *2.4* | A | *3.0* | A |
| Northbound Approach | *4.2* | A | *4.8* | A | *4.2* | A | *5.4* | A |
| Westbound Approach | *2.4* | A | *2.4* | A | *2.4* | A | *2.4* | A |
| Southbound Approach | *2.4* | A | *3.0* | A | *1.8* | A | *2.4* | A |
| **Revised F Modified & Eastern Realignment Alternative** | | | | | | | | |
| **US 550 @ Three Springs (Traffic Signal)** | **25.8** | **C** | **30.9** | **C** | **26.6** | **C** | **32.5** | **C** |
| Eastbound Left | *31.6* | C | *52.5* | D | *33.4* | C | *54.9* | D |
| Eastbound Right | *10.1* | B | *21.0* | C | *10.1* | B | *22.1* | C |
| Westbound Left | *10.2* | B | *35.2* | D | *25.9* | C | *35.3* | D |
| Westbound Right | *21.9* | C | *10.4* | B | *9.2* | A | *10.4* | B |
| Northbound Left | *50.2* | D | *54.8* | D | *50.0* | D | *59.7* | E |
| Northbound Through | *42.9* | D | *53.0* | D | *42.7* | D | *53.6* | D |
| Northbound Right | *17.0* | B | *23.8* | C | *17.3* | B | *24.1* | C |
| Southbound Left | *18.9* | B | *24.2* | C | *19.2* | B | *24.2* | C |
| Southbound Through | *36.1* | D | *44.7* | D | *36.6* | D | *44.9* | D |
| Southbound Right | *1.5* | A | *2.1* | A | *1.2* | A | *2.2* | A |

Notes:

**1.** Traffic volumes referenced from Year 2030 Traffic Operations Analysis for the US 550 at US 160 Section 4(f) Alternatives Technical Memo (12-23-2010)

**2.** Delay is measured as seconds/vehicle.

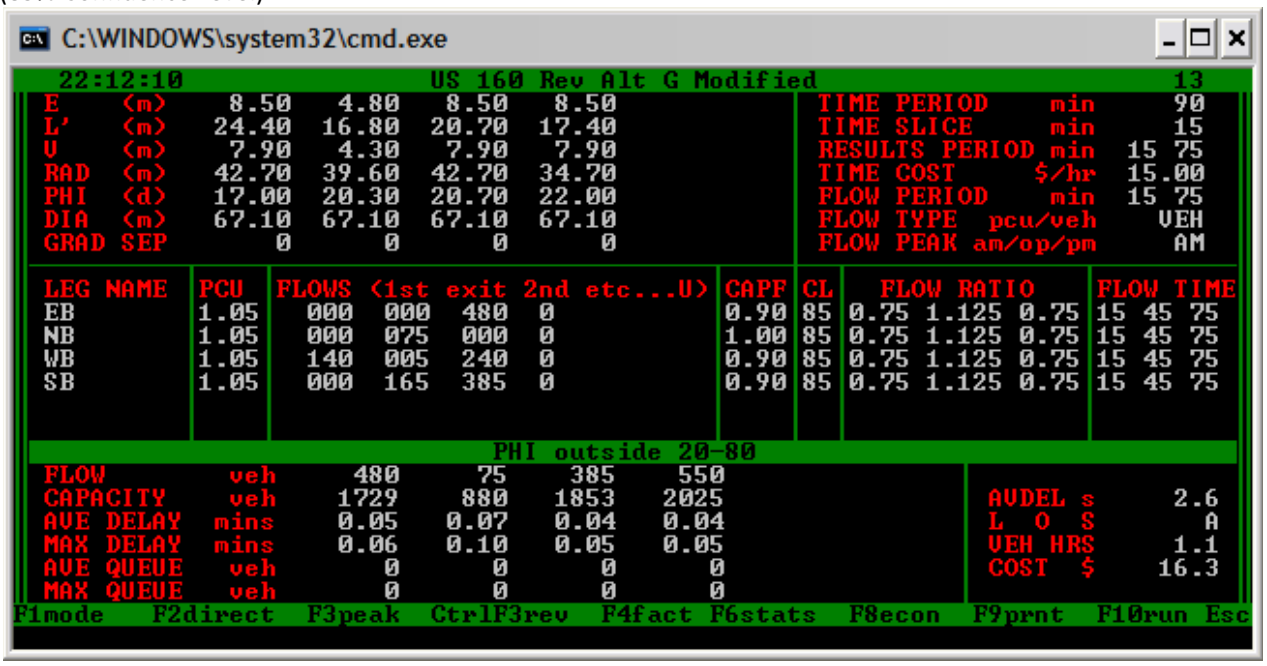
US 160 Section 4(f) Alternatives Considered in the Least Harm Analysis – The Degree to Which Each Alternative Meets the Purpose and Need for the Project

# Appendix A

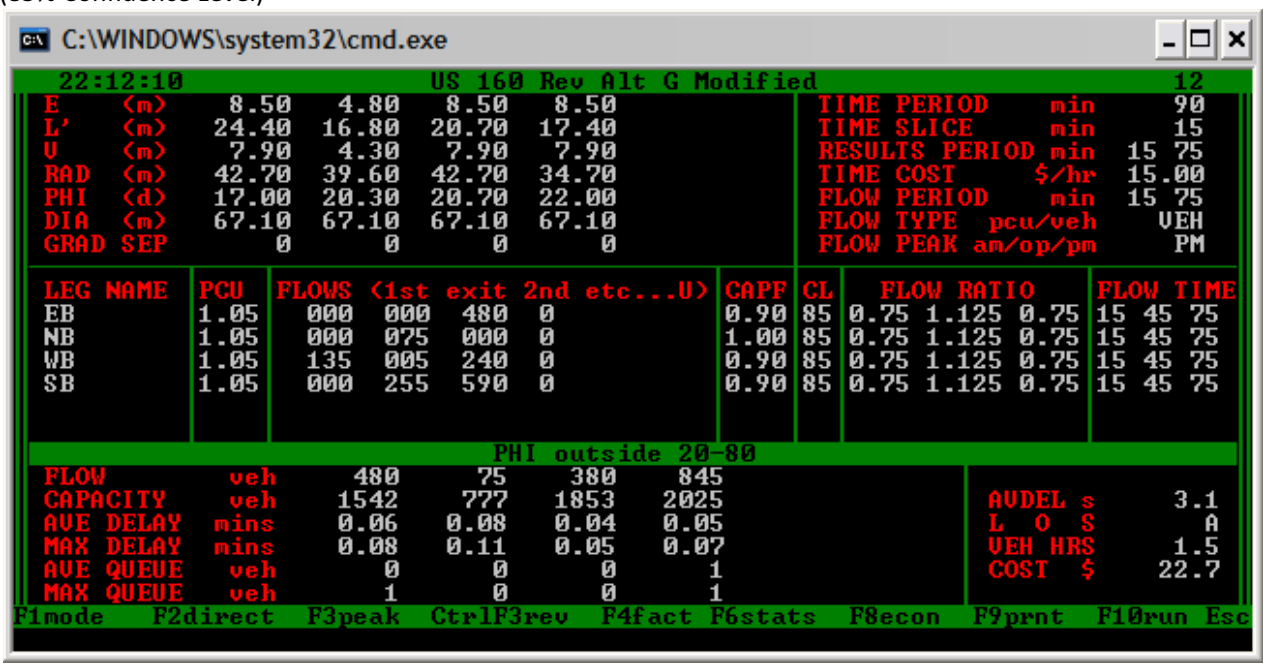
Level of Service Worksheets

**Grandview Interchange Roundabout Analysis (Revised Alternative G Mod)**

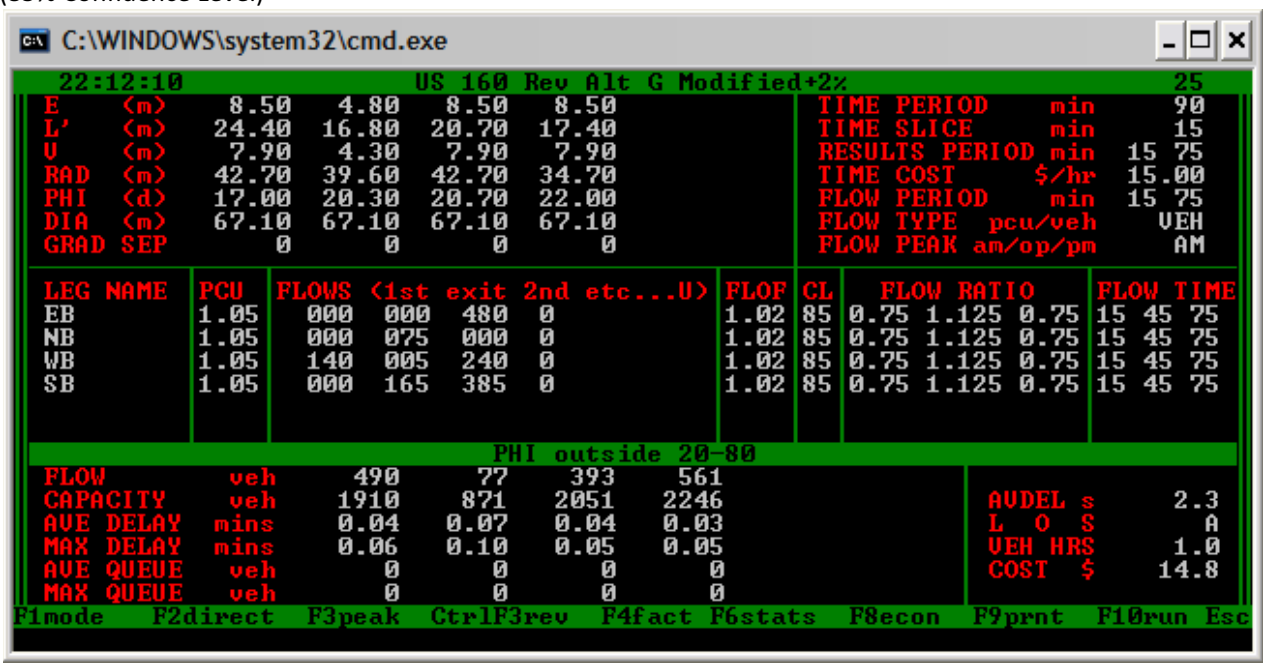
**Year 2030 Traffic Volumes:** 2-Lane Roundabout (ICD 220') with right turn bypass lanes for EB&NB (AM) (85% Confidence Level)



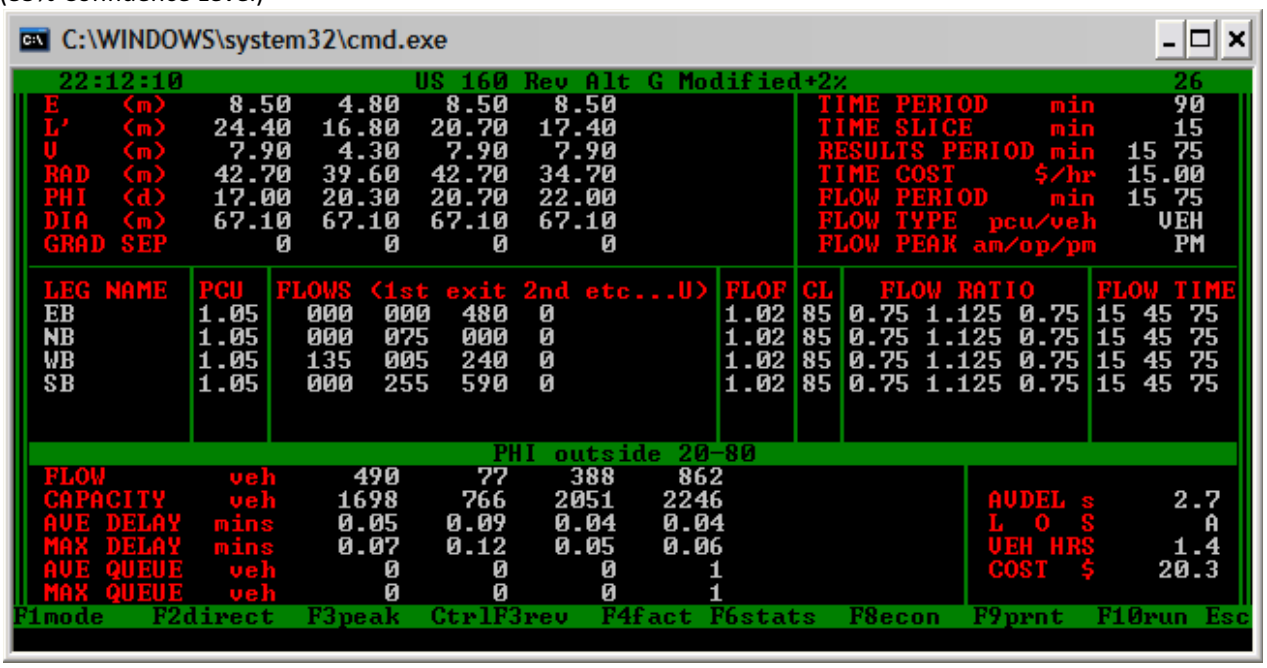

**Year 2030 Traffic Volumes:** 2-Lane Roundabout (ICD 220') with right turn bypass lanes for EB&NB (PM) (85% Confidence Level)



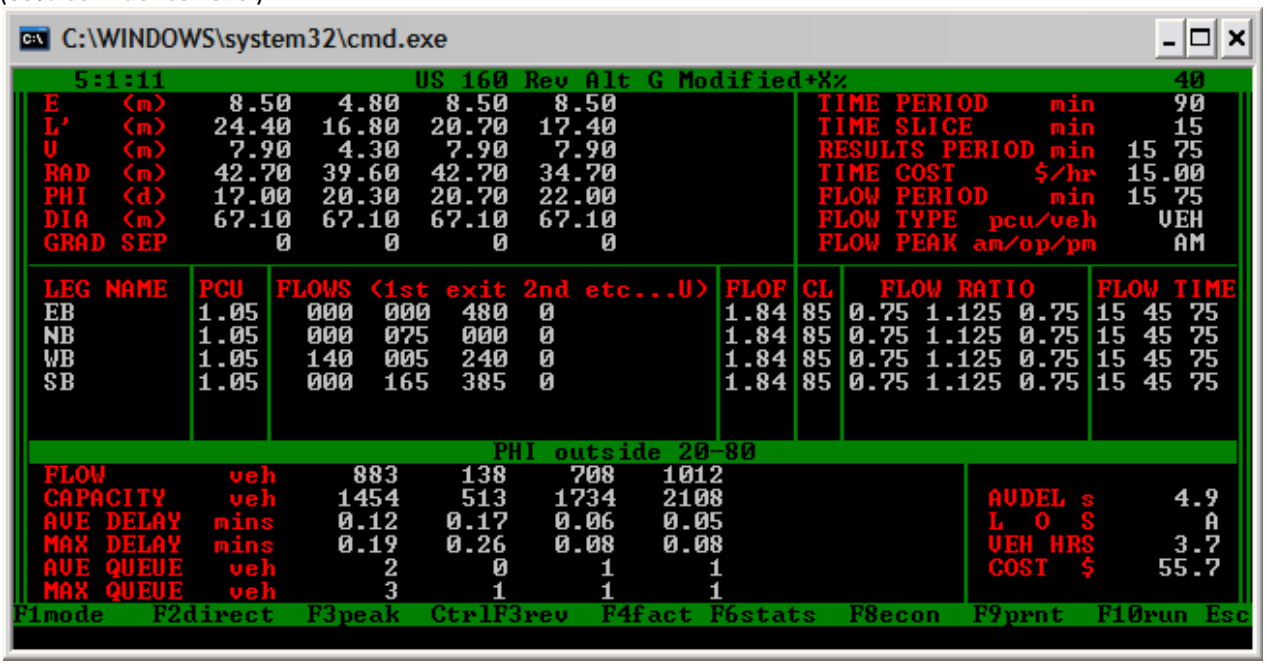
**Year 2030 Traffic Volumes + 2%:** 2-Lane Roundabout (ICD 220') with right turn bypass lanes for EB&NB (AM) (85% Confidence Level)



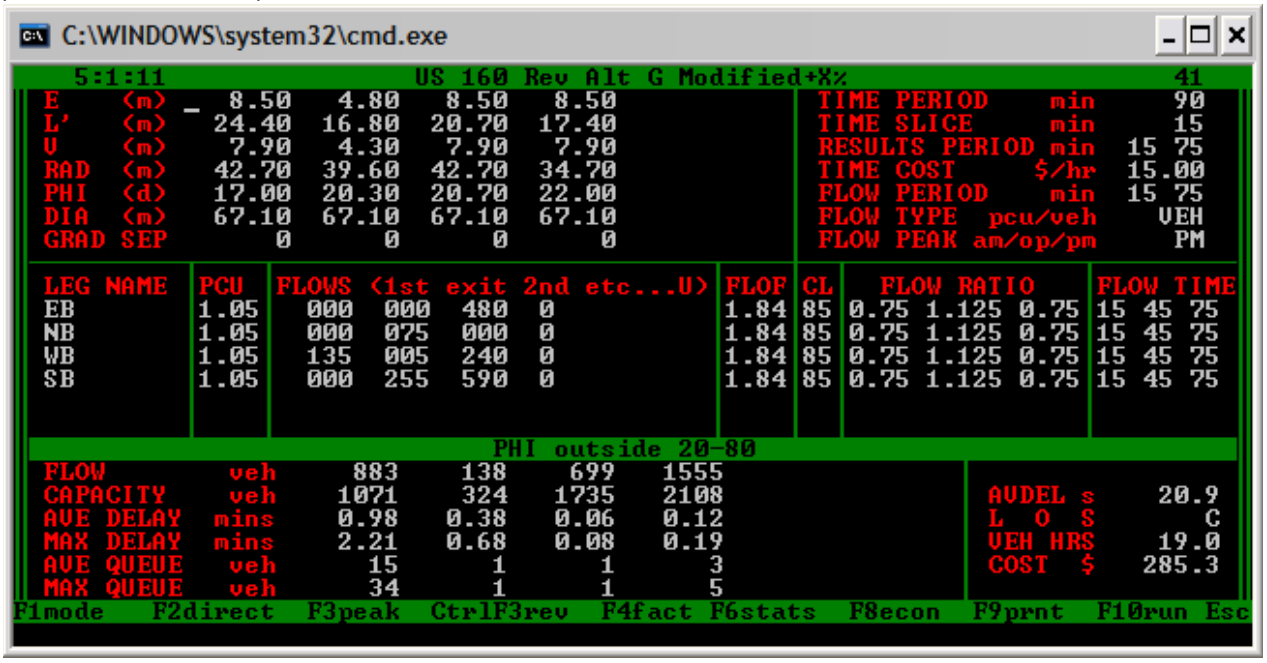

**Year 2030 Traffic Volumes + 2%:** 2-Lane Roundabout (ICD 220') with right turn bypass lanes for EB&NB (PM) (85% Confidence Level)



**Year 2030 Traffic Volumes + 84%:** 2-Lane Roundabout (ICD 220') with right turn bypass lanes for EB&NB (AM) (85% Confidence Level)




**Year 2030 Traffic Volumes + 84%:** 2-Lane Roundabout (ICD 220') with right turn bypass lanes for EB&NB (PM) (85% Confidence Level)



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 720 | 0 | 1410 | 330 | 0 | 190 | 1160 | 160 | 460 | 250 | 85 | 930 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | 9.0 | 9.0 | 8.5 | 9.0 |
| Lane Util. Factor | 0.97 | | 0.88 | 0.97 | | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 758 | 0 | 1484 | 347 | 0 | 200 | 1221 | 168 | 484 | 263 | 89 | 979 |
| RTOR Reduction (vph) | 0 | 0 | 121 | 0 | 0 | 6 | 0 | 0 | 260 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 758 | 0 | 1363 | 347 | 0 | 194 | 1221 | 168 | 224 | 263 | 89 | 979 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 5 6 |
| Actuated Green, G (s) | 27.0 | | 65.5 | 27.0 | | 65.5 | 40.0 | 16.5 | 52.0 | 40.0 | 16.5 | 110.0 |
| Effective Green, g (s) | 27.0 | | 65.5 | 27.0 | | 65.5 | 40.0 | 16.5 | 43.5 | 40.0 | 16.5 | 101.5 |
| Actuated g/C Ratio | 0.25 | | 0.60 | 0.25 | | 0.60 | 0.36 | 0.15 | 0.40 | 0.36 | 0.15 | 0.92 |
| Clearance Time (s) | 9.0 | | | 9.0 | | | 9.0 | 8.5 | | 9.0 | 8.5 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 843 | | 1660 | 843 | | 943 | 1248 | 279 | 626 | 1248 | 279 | 1461 |
| v/s Ratio Prot | c0.22 | | | 0.10 | | | c0.36 | 0.09 | | 0.08 | 0.05 | |
| v/s Ratio Perm | | | c0.49 | | | 0.12 | | | 0.14 | | | 0.62 |
| v/c Ratio | 0.90 | | 0.82 | 0.41 | | 0.21 | 0.98 | 0.60 | 0.36 | 0.21 | 0.32 | 0.67 |
| Uniform Delay, d1 | 40.2 | | 17.6 | 34.8 | | 10.3 | 34.6 | 43.7 | 23.4 | 24.1 | 41.7 | 0.9 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 12.3 | | 3.4 | 0.3 | | 0.1 | 20.2 | 9.3 | 0.4 | 0.1 | 3.0 | 1.2 |
| Delay (s) | 52.5 | | 21.0 | 35.2 | | 10.4 | 54.8 | 53.0 | 23.8 | 24.2 | 44.7 | 2.1 |
| Level of Service | D | | C | D | | B | D | D | C | C | D | A |
| Approach Delay (s) | | 31.7 | | | 26.1 | | | 46.6 | | | 9.3 | |
| Approach LOS | | C | | | C | | | D | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 30.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.86 | | |
| Actuated Cycle Length (s) | 110.0 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 105.3% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 735 | 0 | 677 | 337 | 0 | 195 | 1180 | 135 | 560 | 145 | 60 | 555 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 6.0 | 5.0 | | 6.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 0.97 | | 0.88 | 0.97 | | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 774 | 0 | 713 | 355 | 0 | 205 | 1242 | 142 | 589 | 153 | 63 | 584 |
| RTOR Reduction (vph) | 0 | 0 | 183 | 0 | 0 | 16 | 0 | 0 | 327 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 774 | 0 | 530 | 355 | 0 | 189 | 1242 | 142 | 262 | 153 | 63 | 584 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 5 6 |
| Actuated Green, G (s) | 27.0 | | 52.0 | 27.0 | | 52.0 | 33.0 | 13.0 | 46.0 | 33.0 | 13.0 | 90.0 |
| Effective Green, g (s) | 27.0 | | 52.0 | 27.0 | | 52.0 | 33.0 | 13.0 | 40.0 | 33.0 | 13.0 | 78.0 |
| Actuated g/C Ratio | 0.30 | | 0.58 | 0.30 | | 0.58 | 0.37 | 0.14 | 0.44 | 0.37 | 0.14 | 0.87 |
| Clearance Time (s) | 5.0 | | | 5.0 | | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 1030 | | 1610 | 1030 | | 915 | 1259 | 269 | 704 | 1259 | 269 | 1372 |
| v/s Ratio Prot | c0.23 | | | 0.10 | | | c0.36 | c0.08 | | 0.04 | 0.03 | |
| v/s Ratio Perm | | | 0.19 | | | 0.12 | | | 0.17 | | | 0.37 |
| v/c Ratio | 0.75 | | 0.33 | 0.34 | | 0.21 | 0.99 | 0.53 | 0.37 | 0.12 | 0.23 | 0.43 |
| Uniform Delay, d1 | 28.5 | | 9.9 | 24.6 | | 9.1 | 28.3 | 35.7 | 16.6 | 18.9 | 34.1 | 1.3 |
| Progression Factor | 1.00 | | 1.00 | 0.41 | | 2.40 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 3.1 | | 0.1 | 0.2 | | 0.1 | 21.9 | 7.2 | 0.3 | 0.0 | 2.0 | 0.2 |
| Delay (s) | 31.6 | | 10.0 | 10.2 | | 21.9 | 50.2 | 42.9 | 17.0 | 18.9 | 36.1 | 1.5 |
| Level of Service | C | | B | B | | C | D | D | B | B | D | A |
| Approach Delay (s) | | 21.3 | | | 14.5 | | | 39.8 | | | 7.5 | |
| Approach LOS | | C | | | B | | | D | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.8 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.82 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 77.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 720 | 0 | 1410 | 330 | 0 | 190 | 1160 | 160 | 460 | 250 | 85 | 930 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 9.0 | | 9.0 | 9.0 | | 9.0 | 9.0 | 8.5 | 9.0 | 9.0 | 8.5 | 9.0 |
| Lane Util. Factor | 0.97 | | 0.88 | 0.97 | | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 758 | 0 | 1484 | 347 | 0 | 200 | 1221 | 168 | 484 | 263 | 89 | 979 |
| RTOR Reduction (vph) | 0 | 0 | 121 | 0 | 0 | 6 | 0 | 0 | 260 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 758 | 0 | 1363 | 347 | 0 | 194 | 1221 | 168 | 224 | 263 | 89 | 979 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 5 6 |
| Actuated Green, G (s) | 27.0 | | 65.5 | 27.0 | | 65.5 | 40.0 | 16.5 | 52.0 | 40.0 | 16.5 | 110.0 |
| Effective Green, g (s) | 27.0 | | 65.5 | 27.0 | | 65.5 | 40.0 | 16.5 | 43.5 | 40.0 | 16.5 | 101.5 |
| Actuated g/C Ratio | 0.25 | | 0.60 | 0.25 | | 0.60 | 0.36 | 0.15 | 0.40 | 0.36 | 0.15 | 0.92 |
| Clearance Time (s) | 9.0 | | | 9.0 | | | 9.0 | 8.5 | | 9.0 | 8.5 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 843 | | 1660 | 843 | | 943 | 1248 | 279 | 626 | 1248 | 279 | 1461 |
| v/s Ratio Prot | c0.22 | | | 0.10 | | | c0.36 | 0.09 | | 0.08 | 0.05 | |
| v/s Ratio Perm | | | c0.49 | | | 0.12 | | | 0.14 | | | 0.62 |
| v/c Ratio | 0.90 | | 0.82 | 0.41 | | 0.21 | 0.98 | 0.60 | 0.36 | 0.21 | 0.32 | 0.67 |
| Uniform Delay, d1 | 40.2 | | 17.6 | 34.8 | | 10.3 | 34.6 | 43.7 | 23.4 | 24.1 | 41.7 | 0.9 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 12.3 | | 3.4 | 0.3 | | 0.1 | 20.2 | 9.3 | 0.4 | 0.1 | 3.0 | 1.2 |
| Delay (s) | 52.5 | | 21.0 | 35.2 | | 10.4 | 54.8 | 53.0 | 23.8 | 24.2 | 44.7 | 2.1 |
| Level of Service | D | | C | D | | B | D | D | C | C | D | A |
| Approach Delay (s) | | 31.7 | | | 26.1 | | | 46.6 | | | 9.3 | |
| Approach LOS | | C | | | C | | | D | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 30.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.86 | | |
| Actuated Cycle Length (s) | 110.0 | Sum of lost time (s) | 18.0 |
| Intersection Capacity Utilization | 105.3% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 735 | 0 | 677 | 337 | 0 | 195 | 1180 | 135 | 560 | 145 | 60 | 555 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 5.0 | | 6.0 | 5.0 | | 6.0 | 6.0 | 6.0 | 5.0 | 6.0 | 6.0 | 5.0 |
| Lane Util. Factor | 0.97 | | 0.88 | 0.97 | | 1.00 | 0.97 | 1.00 | 1.00 | 0.97 | 1.00 | 1.00 |
| Frt | 1.00 | | 0.85 | 1.00 | | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Flt Permitted | 0.95 | | 1.00 | 0.95 | | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | 3433 | | 2787 | 3433 | | 1583 | 3433 | 1863 | 1583 | 3433 | 1863 | 1583 |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Adj. Flow (vph) | 774 | 0 | 713 | 355 | 0 | 205 | 1242 | 142 | 589 | 153 | 63 | 584 |
| RTOR Reduction (vph) | 0 | 0 | 183 | 0 | 0 | 16 | 0 | 0 | 327 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 774 | 0 | 530 | 355 | 0 | 189 | 1242 | 142 | 262 | 153 | 63 | 584 |
| Turn Type | Prot | | custom | Prot | | custom | Prot | | custom | Prot | | custom |
| Protected Phases | 1 | | | 1 | | | 5 | 6 | | 5 | 6 | |
| Permitted Phases | | | 5 6 | | | 5 6 | | | 1 6 | | | 1 5 6 |
| Actuated Green, G (s) | 27.0 | | 52.0 | 27.0 | | 52.0 | 33.0 | 13.0 | 46.0 | 33.0 | 13.0 | 90.0 |
| Effective Green, g (s) | 27.0 | | 52.0 | 27.0 | | 52.0 | 33.0 | 13.0 | 40.0 | 33.0 | 13.0 | 78.0 |
| Actuated g/C Ratio | 0.30 | | 0.58 | 0.30 | | 0.58 | 0.37 | 0.14 | 0.44 | 0.37 | 0.14 | 0.87 |
| Clearance Time (s) | 5.0 | | | 5.0 | | | 6.0 | 6.0 | | 6.0 | 6.0 | |
| Vehicle Extension (s) | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | 1030 | | 1610 | 1030 | | 915 | 1259 | 269 | 704 | 1259 | 269 | 1372 |
| v/s Ratio Prot | c0.23 | | | 0.10 | | | c0.36 | c0.08 | | 0.04 | 0.03 | |
| v/s Ratio Perm | | | 0.19 | | | 0.12 | | | 0.17 | | | 0.37 |
| v/c Ratio | 0.75 | | 0.33 | 0.34 | | 0.21 | 0.99 | 0.53 | 0.37 | 0.12 | 0.23 | 0.43 |
| Uniform Delay, d1 | 28.5 | | 9.9 | 24.6 | | 9.1 | 28.3 | 35.7 | 16.6 | 18.9 | 34.1 | 1.3 |
| Progression Factor | 1.00 | | 1.00 | 0.41 | | 2.40 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 3.1 | | 0.1 | 0.2 | | 0.1 | 21.9 | 7.2 | 0.3 | 0.0 | 2.0 | 0.2 |
| Delay (s) | 31.6 | | 10.0 | 10.2 | | 21.9 | 50.2 | 42.9 | 17.0 | 18.9 | 36.1 | 1.5 |
| Level of Service | C | | B | B | | C | D | D | B | B | D | A |
| Approach Delay (s) | | 21.3 | | | 14.5 | | | 39.8 | | | 7.5 | |
| Approach LOS | | C | | | B | | | D | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.8 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.82 | | |
| Actuated Cycle Length (s) | 90.0 | Sum of lost time (s) | 17.0 |
| Intersection Capacity Utilization | 77.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp C |
| Date Performed | 1/5/2011 | Jurisdiction | |
| Analysis Time Period | AM Peak | Analysis Year | Year 2030 + 67% Inflation |

Project Description Year 2030 Analysis for the US 550 at Us 160 Section 4(f)

## Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{up}$ = ft
$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{down}$ = ft
$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 1940 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 2195 |
| Ramp | 2312 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 2507 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

## Merge Areas

### Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.631 using Equation 1

$V_{12}$= 1384 pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 4702 | See Exhibit 25-7 | No |
| $V_{R12}$ | 3891 | 4600:All | No |

### Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 22.8 (pc/ m/ln)

LOS = C (Exhibit 25-4)

### Speed Estimation

$M_S$ = 0.360 (Exibit 25-19)

$S_R$= 53.5 mph (Exhibit 25-19)

$S_0$= 58.9 mph (Exhibit 25-19)

S= 54.4 mph (Exhibit 25-14)

## Diverge Areas

### Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

### Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

### Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp C |
| Date Performed | 1/5/2011 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 + 67% Inflation |

Project Description Year 2030 Analysis for the US 550 at Us 160 Section 4(f)

## Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{up}$ = ft
$V_u$ = veh/h

Terrain Rolling

$S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph

Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$)

Downstream Adj Ramp
☐ Yes ☐ On
☐ No ☐ Off
$L_{down}$ = ft
$V_D$ = veh/h

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | $v=V/PHF\ f_{HV}\ f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 3440 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3893 |
| Ramp | 1975 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 2141 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

## Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.631 using Equation 1

$V_{12}$= 2455 pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 6034 | See Exhibit 25-7 | No |
| $V_{R12}$ | 4596 | 4600:All | No |

## Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$

$D_R$ = 28.4 (pc/ m/ln)

LOS = D (Exhibit 25-4)

## Speed Estimation

$M_S$ = 0.555 (Exibit 25-19)

$S_R$= 50.0 mph (Exhibit 25-19)

$S_0$= 56.6 mph (Exhibit 25-19)

S= 51.4 mph (Exhibit 25-14)

Diverge Areas

## Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

## Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

## Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

## Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# RAMPS AND RAMP JUNCTIONS WORKSHEET

## General Information / Site Information

| | | | |
|---|---|---|---|
| Analyst2 | SEH Inc. | Freeway/Dir of Travel | US 160 Westbound |
| Agency or Company | | Junction | Grandview Ramp C |
| Date Performed | 1/5/2011 | Jurisdiction | |
| Analysis Time Period | PM Peak | Analysis Year | Year 2030 +67% Inflation+5cars |

Project Description Year 2030 Analysis for the US 550 at Us 160 Section 4(f)

## Inputs

| Upstream Adj Ramp | Terrain Rolling | Downstream Adj Ramp |
|---|---|---|
| ☐ Yes ☐ On | | ☐ Yes ☐ On |
| ☐ No ☐ Off | | ☐ No ☐ Off |
| $L_{up}$ = ft | | $L_{down}$ = ft |
| $V_u$ = veh/h | $S_{FF}$ = 60.0 mph $S_{FR}$ = 40.0 mph<br>Sketch ( show lanes, $L_A$, $L_D$,$V_R$,$V_f$) | $V_D$ = veh/h |

## Conversion to pc/h Under Base Conditions

| (pc/h) | V (Veh/hr) | PHF | Terrain | Truck | %Rv | $f_{HV}$ | $f_p$ | v=V/PHF $f_{HV}$ $f_p$ |
|---|---|---|---|---|---|---|---|---|
| Freeway | 3440 | 0.95 | Rolling | 5 | 0 | 0.930 | 1.00 | 3893 |
| Ramp | 1980 | 0.95 | Rolling | 2 | 0 | 0.971 | 1.00 | 2147 |
| UpStream | | | | | | | | |
| DownStream | | | | | | | | |

Merge Areas

### Estimation of $v_{12}$

$V_{12} = V_F ( P_{FM})$

$L_{EQ}$ = (Equation 25-2 or 25-3)

$P_{FM}$= 0.631 using Equation 1

$V_{12}$= 2455 pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FO}$ | 6040 | See Exhibit 25-7 | No |
| $V_{R12}$ | 4602 | 4600:All | Yes |

### Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R$ = 28.5 (pc/ m/ln)

LOS = F (Exhibit 25-4)

### Speed Estimation

$M_S$ = 0.558 (Exibit 25-19)

$S_R$= 50.0 mph (Exhibit 25-19)

$S_0$= 56.6 mph (Exhibit 25-19)

S= 51.4 mph (Exhibit 25-14)

Diverge Areas

### Estimation of $v_{12}$

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ}$ = (Equation 25-8 or 25-9)

$P_{FD}$ = using Equation

$V_{12}$ = pc/h

### Capacity Checks

| | Actual | Maximum | LOS F? |
|---|---|---|---|
| $V_{FI}=V_F$ | | See Exhibit 25-14 | |
| $V_{12}$ | | 4400:All | |
| $V_{FO} = V_F - V_R$ | | See Exhibit 25-14 | |
| $V_R$ | | See Exhibit 25-3 | |

### Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R$ = (pc/ m/ln)

LOS= (Exhibit 25-4)

### Speed Estimation

$D_s$ = (Exhibit 25-19)

$S_R$= mph (Exhibit 25-19)

$S_0$= mph (Exhibit 25-19)

S = mph (Exhibit 25-15)

# Final Safety Analysis for the US 550 at US 160 Section 4(f)

# March 3, 2011

# STATE OF COLORADO

**DEPARTMENT OF TRANSPORTATION**

**TRAFFIC AND SAFETY UNIT**
**REGION 5**
3803 N. Main Avenue, Suite 100
Durango, CO 81301
(907) 385-8360
Fax (970) 385-8361

March 3, 2011

Federal Highway Administration
Attn: William Hansen, Operations Engineer (Region 5)
12300 W. Dakota Avenue
Lakewood, CO 80228

RE: Safety Analysis for the US 550 at US 160 Section 4(f)

Mr. Hansen,

The intent of this memo is to update the accident data for the proposed connection of US 550 to US 160, that were originally evaluated in the US Highway 160 from Durango to Bayfield Final Environmental Impact Statement (US 160 FEIS). Several years have passed since the Record of Decision, a review of more recent accident statistics for these segments needed to be performed.

**US 160A from mile post 87.5 to 91.48**

In the US 160 FEIS, this segment of US 160 had an accident analysis performed for the period of December 31, 1996 to December 31, 2001. The accident data indicated that there were a total of 210 accidents with 145 being property damage only, 63 being injury accidents, and 2 fatal accidents.

By comparison, this segment of US 160 was analyzed for the more recent period of December 31, 2003 to December 31, 2008 (December 31, 2008 is the most recent accident information available in our database). The analysis of the accident data showed that during the more recent five-year history (2003 to 2008) the total number of accidents was higher at 249 total accidents, but the total of injury (32) and fatal (1) accidents declined.

The decline in the severity of the accidents can be attributed to recent improvements to US 160. US 160 was widened from a three lane roadway (one through lane west bound and two through lanes east bound) to a five lane section (two through lanes in both the east and westbound directions with a continuous center left turn lane). Also US 160 at Three Springs (CR 233) was recently improved with turn lanes and a signalized intersection. All of these improvements would help to reduce the potential for severe crashes. This is reflected in the fact that property damage only crashes increased while the injury and fatal crashes decreased in the most recent five year analysis.

The overall number of crashes has continued to increase in this segment of US 160; this is an indication that the roadway segment needs additional improvements to reduce accidents as traffic continues to increase. The average daily traffic from 2001 to 2008 increased from 20,775 vehicles per day to 26,257 vehicles per day, this is an increase in traffic of more than 26 percent. Likewise, the total number of accidents increased from 210 to 249, an 18 percent increase. The interim measures of developing a five

lane highway section and signal improvements has helped to reduce the severity of crashes but until the major left-turn movements are eliminated by the planned interchange improvements the number of rear end and broadside accidents will not decrease in this corridor. The original safety analysis from the FEIS and the analysis of this document support that the measures for safety improvement are still accurate and needed for this segment of US 160.

See the attached appendix for detailed accident summary information.

**US 550A from mile post 15.61 to 16.56**

In the US 160 FEIS, this segment of US 550 had an accident analysis performed for the period of December 31, 1996 to December 31, 2001. The accident data indicated that there were a total of 23 accidents with 16 being property damage only, 7 being injury accidents, and there were no fatal accidents.

By comparison, this segment of US 550 was analyzed for the more recent period of December 31, 2003 to December 31, 2008 (December 31, 2008 is the most recent accident information available in our database). The analysis of the accident data showed that during the more recent five-year history (2003 to 2008) the total number of accidents was higher at 28 total accidents, but the total of injury (6) accidents decreased by one accident and there were no fatal accidents. Overall there were no comparable differences in the accident statistics between the 2001 analysis and the 2008 analysis.

A comparison between the two data sets does show an increase in weather related accidents. In the 1996 to 2001 analysis the number of winter weather related accidents totaled 2 (icy). In the 2003 to 2008 analysis the number of winter weather related accidents increased to 11 accidents (wet, snowy, icy). A key component of the US 160 FEIS was to improve the overall safety of US 550 at Farmington Hill. This segment of US 550 is on a steep winding grade (6% or greater) with a northern exposure which sees very little sun light in the winter months. The 2008 accident analysis supports the original position of the US 160 FEIS that this segment of US 550 needs roadway safety improvements to reduce or eliminate the potential for weather related accidents. The need for safety improvements from the US 160 FEIS is still valid and needed based upon the more recent accident information.

See the attached appendix for detailed accident summary information.

Sincerely,

Michael D. McVaugh
Region 5 Traffic and Safety Engineer

Attach: Accident Appendix
Cc: Kerrie Neet, Keith Powers, Ed Archuleta, Paul Jankowski, Lisa Schoch, Steven Cross

Safety Analysis for the US 550 at US 160 Section 4(f)

# Accident Appendix

# US 550 at US 160 Section 4f
# Accident and Safety Analysis

## US 160A from Mile Post 87.50 to 91.48

| Year | Property Damage Only | Injury | Fatal | Total |
|---|---|---|---|---|
| Dec. 1996 to Dec. 2001 | 145 | 63 | 2 | 210* |
| Dec. 2003 to Dec. 2008 | 216 | 32 | 1 | 249 |

| Significant Crash Types | 1996 to 2001 | 2003 to 2008 |
|---|---|---|
| Rear End | 106 | 107 |
| Sideswipe (Same) | 16 | 22 |
| Approach Turn | 12 | 24 |
| Head On | 9 | 2 |
| Broadside | 8 | 9 |

## US 550A from Mile Post 15.61 to 16.56

| Year | Property Damage Only | Injury | Fatal | Total |
|---|---|---|---|---|
| Dec. 1996 to Dec. 2001 | 16 | 7 | 0 | 23 |
| Dec. 2003 to Dec. 2008 | 22 | 6 | 0 | 28 |

| Significant Crash Types | 1996 to 2001 | 2003 to 2008 |
|---|---|---|
| Rear End | 6 | 4 |
| Sideswipe (Opposite) | 4 | 4 |
| Overturning | 4 | 5 |
| Overtaking Turn | 1 | 0 |
| Broadside | 1 | 0 |
| Sideswipe (Same) | 1 | 1 |

* When running the analysis for 1996 to 2001, the total accidents did not correlate with the numbers from the FEIS (211 vs. 210). There may have been an error in the data collected that has since been corrected.

DR2447 Format

# Colorado Department of Transportation
# Safety and Traffic Engineering
# General Accident Summary Report

Microsoft Visual FoxPro 9 SP2
02/28/2011

Job #: 20110228141010

**Highway:** 160A **Begin:** 87.50 **End:** 91.48 **From:** 12/31/1996 **To:** 12/31/2001

## Severity

| | | |
|---|---|---|
| PDO: | 145 | |
| INJ: | 63 | 104 :Injured |
| FAT: | 2 | 3 :Killed |
| **Total:** | **210** | |

## Number of Vehicles

| | |
|---|---|
| One Vehicle: | 37 |
| Two Vehicles: | 153 |
| Three or More: | 20 |
| Unknown: | 0 |
| **Total:** | **210** |

## Location

| | |
|---|---|
| On Road: | 190 |
| Off Road: | 20 |
| Unknown: | 0 |
| **Total:** | **210** |

## Accident Type

| | | | | | |
|---|---|---|---|---|---|
| Overturning: | 3 | Sideswipe (Same): | 16 | Bicycles: | 1 |
| Other Non Collision: | 2 | Sideswipe (Opposite): | 5 | Domestic Animal: | 1 |
| Pedestrians: | 1 | Approach Turn: | 12 | Wild Animal: | 20 |
| Broadside: | 8 | Overtaking Turn: | 5 | Fixed Objects: | 16 |
| Head On: | 9 | Parked Motor Vehicle: | 2 | Other Objects: | 3 |
| Rear End: | 106 | Railway Vehicle: | 0 | Unknown: | 0 |
| | | | | **Total:** | **210** |

## Lighting Conditions

| | |
|---|---|
| Daylight: | 159 |
| Dawn or Dusk: | 6 |
| Dark - Lighted: | 6 |
| Dark - Unlighted: | 37 |
| Unknown: | 2 |
| **Total:** | **210** |

## Mainline/Ramps/Frontage Rds

| | |
|---|---|
| Mainline: | 210 |
| Ramps: | 0 |
| Frontage Roads: | 0 |
| Intsx Frontage/Ramps: | 0 |
| HOV Lanes: | 0 |
| Unknown: | 0 |
| **Total:** | **210** |

## Weather Conditions

| | |
|---|---|
| None: | 190 |
| Rain: | 6 |
| Snow/Sleet/Hail: | 12 |
| Fog: | 0 |
| Dust: | 0 |
| Wind: | 0 |
| Unknown: | 2 |
| **Total:** | **210** |

## Vehicle Types

| | Vehicle 1 | Vehicle 2 | Vehicle 3 |
|---|---|---|---|
| Vehicle/Vehicle Combo (> 10k Lbs): | 12 | 6 | 0 |
| School Bus (All School Busses): | 0 | 0 | 0 |
| Non-School Bus (> 8) in Commerce: | 0 | 0 | 0 |
| Transit Bus: | 0 | 0 | 0 |
| Passenger Car/Van: | 121 | 111 | 15 |
| Passenger Car/Van w/Trailer: | 4 | 1 | 0 |
| Pickup Truck/Utility Van: | 5 | 3 | 1 |
| Pickup Truck/Utility Van w/Trailer: | 0 | 0 | 0 |
| SUV: | 60 | 49 | 4 |
| SUV w/Trailer: | 0 | 0 | 0 |
| Motor Home: | 0 | 0 | 0 |
| Bicycle: | 2 | 1 | 0 |
| Motorized Bicycle: | 1 | 1 | 0 |
| Farm Equipment: | 0 | 0 | 0 |
| Hit and Run - Unknown: | 0 | 0 | 0 |
| Light Rail: | 1 | 0 | 0 |
| Other: | 0 | 0 | 0 |
| Unknown: | 4 | 1 | 0 |
| **Total:** | **210** | **173** | **20** |

## Road Conditions

| | |
|---|---|
| Dry: | 178 |
| Wet: | 15 |
| Muddy: | 0 |
| Snowy: | 2 |
| Icy: | 9 |
| Slushy: | 2 |
| Foreign Material: | 0 |
| With Road Treatment: | 1 |
| Unknown: | 3 |
| **Total:** | **210** |

## Accident Rates

| | | |
|---|---|---|
| PDO: | 1.02 * | * MVMT |
| INJ: | 0.44 * | ** 100 MVMT |
| FAT: | 1.40 ** | **Total:** **1.47** * |

**ADT:** 20,775 **Length:** 3.75 **Coris File:** tcoris2001.dbf

DR2447 Format

# Colorado Department of Transportation
# Safety and Traffic Engineering
# General Accident Summary Report

Microsoft Visual FoxPro 9 SP2
02/28/2011

Job #: 20110228141900

**Highway:** 160A **Begin:** 87.50 **End:** 91.48 **From:** 12/31/2003 **To:** 12/31/2008

## Severity

| | | |
|---|---|---|
| PDO: | 216 | |
| INJ: | 32 | 83 :Injured |
| FAT: | 1 | 1 :Killed |
| **Total:** | **249** | |

## Number of Vehicles

| | |
|---|---|
| One Vehicle: | 71 |
| Two Vehicles: | 158 |
| Three or More: | 20 |
| Unknown: | 0 |
| **Total:** | **249** |

## Location

| | |
|---|---|
| On Road: | 228 |
| Off Road: | 21 |
| Unknown: | 0 |
| **Total:** | **249** |

## Accident Type

| | | | | | |
|---|---|---|---|---|---|
| Overturning: | 5 | Sideswipe (Same): | 22 | Bicycles: | 1 |
| Other Non Collision: | 1 | Sideswipe (Opposite): | 2 | Domestic Animal: | 0 |
| Pedestrians: | 1 | Approach Turn: | 24 | Wild Animal: | 44 |
| Broadside: | 9 | Overtaking Turn: | 3 | Fixed Objects: | 20 |
| Head On: | 2 | Parked Motor Vehicle: | 1 | Other Objects: | 5 |
| Rear End: | 107 | Railway Vehicle: | 0 | Unknown: | 1 |
| | | | | **Total:** | **249** |

## Lighting Conditions

| | |
|---|---|
| Daylight: | 174 |
| Dawn or Dusk: | 17 |
| Dark - Lighted: | 12 |
| Dark - Unlighted: | 43 |
| Unknown: | 3 |
| **Total:** | **249** |

## Mainline/Ramps/Frontage Rds

| | |
|---|---|
| Mainline: | 249 |
| Ramps: | 0 |
| Frontage Roads: | 0 |
| Intsx Frontage/Ramps: | 0 |
| HOV Lanes: | 0 |
| Unknown: | 0 |
| **Total:** | **249** |

## Weather Conditions

| | |
|---|---|
| None: | 223 |
| Rain: | 6 |
| Snow/Sleet/Hail: | 16 |
| Fog: | 0 |
| Dust: | 0 |
| Wind: | 1 |
| Unknown: | 3 |
| **Total:** | **249** |

## Vehicle Types

| | Vehicle 1 | Vehicle 2 | Vehicle 3 |
|---|---|---|---|
| Vehicle/Vehicle Combo (> 10k Lbs): | 15 | 8 | 0 |
| School Bus (All School Busses): | 0 | 0 | 0 |
| Non-School Bus (> 8) in Commerce: | 1 | 0 | 0 |
| Transit Bus: | 0 | 0 | 0 |
| Passenger Car/Van: | 125 | 99 | 14 |
| Passenger Car/Van w/Trailer: | 3 | 0 | 0 |
| Pickup Truck/Utility Van: | 2 | 6 | 0 |
| Pickup Truck/Utility Van w/Trailer: | 19 | 12 | 0 |
| SUV: | 70 | 50 | 5 |
| SUV w/Trailer: | 0 | 0 | 0 |
| Motor Home: | 0 | 0 | 1 |
| Bicycle: | 6 | 0 | 0 |
| Motorized Bicycle: | 0 | 1 | 0 |
| Farm Equipment: | 0 | 0 | 0 |
| Hit and Run - Unknown: | 0 | 0 | 0 |
| Light Rail: | 2 | 0 | 0 |
| Other: | 0 | 0 | 0 |
| Unknown: | 4 | 1 | 0 |
| **Total:** | **249** | **178** | **20** |

## Road Conditions

| | |
|---|---|
| Dry: | 215 |
| Wet: | 12 |
| Muddy: | 0 |
| Snowy: | 7 |
| Icy: | 7 |
| Slushy: | 5 |
| Foreign Material: | 0 |
| With Road Treatment: | 0 |
| Unknown: | 3 |
| **Total:** | **249** |

## Accident Rates

| | | |
|---|---|---|
| PDO: | 1.26 * | * MVMT |
| INJ: | 0.19 * | ** 100 MVMT |
| FAT: | 0.58 ** | **Total:** **1.45** * |

**ADT:** 26,257 **Length:** 3.56 **Coris File:** tcoris2008.dbf

DR2447 Format

# Colorado Department of Transportation
# Safety and Traffic Engineering
# General Accident Summary Report

Microsoft Visual FoxPro 9 SP2
02/28/2011

Job #: 20110228142322

**Highway:** 550A **Begin:** 15.61 **End:** 16.56 **From:** 12/31/1996 **To:** 12/31/2001

## Severity

| | | |
|---|---|---|
| PDO: | 16 | |
| INJ: | 7 | 9 :Injured |
| FAT: | 0 | 0 :Killed |
| **Total:** | **23** | |

## Number of Vehicles

| | |
|---|---|
| One Vehicle: | 9 |
| Two Vehicles: | 12 |
| Three or More: | 2 |
| Unknown: | 0 |
| **Total:** | **23** |

## Location

| | |
|---|---|
| On Road: | 15 |
| Off Road: | 8 |
| Unknown: | 0 |
| **Total:** | **23** |

## Accident Type

| | | | | | |
|---|---|---|---|---|---|
| Overturning: | 4 | Sideswipe (Same): | 1 | Bicycles: | 0 |
| Other Non Collision: | 0 | Sideswipe (Opposite): | 4 | Domestic Animal: | 0 |
| Pedestrians: | 0 | Approach Turn: | 0 | Wild Animal: | 0 |
| Broadside: | 1 | Overtaking Turn: | 1 | Fixed Objects: | 4 |
| Head On: | 0 | Parked Motor Vehicle: | 0 | Other Objects: | 2 |
| Rear End: | 6 | Railway Vehicle: | 0 | Unknown: | 0 |
| | | | | **Total:** | **23** |

## Lighting Conditions

| | |
|---|---|
| Daylight: | 15 |
| Dawn or Dusk: | 1 |
| Dark - Lighted: | 1 |
| Dark - Unlighted: | 6 |
| Unknown: | 0 |
| **Total:** | **23** |

## Mainline/Ramps/Frontage Rds

| | |
|---|---|
| Mainline: | 23 |
| Ramps: | 0 |
| Frontage Roads: | 0 |
| Intsx Frontage/Ramps: | 0 |
| HOV Lanes: | 0 |
| Unknown: | 0 |
| **Total:** | **23** |

## Weather Conditions

| | |
|---|---|
| None: | 23 |
| Rain: | 0 |
| Snow/Sleet/Hail: | 0 |
| Fog: | 0 |
| Dust: | 0 |
| Wind: | 0 |
| Unknown: | 0 |
| **Total:** | **23** |

## Vehicle Types

| | Vehicle 1 | Vehicle 2 | Vehicle 3 |
|---|---|---|---|
| Vehicle/Vehicle Combo (> 10k Lbs): | 1 | 2 | 0 |
| School Bus (All School Busses): | 0 | 0 | 0 |
| Non-School Bus (> 8) in Commerce: | 0 | 0 | 0 |
| Transit Bus: | 0 | 0 | 0 |
| Passenger Car/Van: | 18 | 5 | 2 |
| Passenger Car/Van w/Trailer: | 0 | 1 | 0 |
| Pickup Truck/Utility Van: | 0 | 0 | 0 |
| Pickup Truck/Utility Van w/Trailer: | 0 | 0 | 0 |
| SUV: | 2 | 5 | 0 |
| SUV w/Trailer: | 0 | 0 | 0 |
| Motor Home: | 0 | 0 | 0 |
| Bicycle: | 0 | 0 | 0 |
| Motorized Bicycle: | 0 | 0 | 0 |
| Farm Equipment: | 0 | 0 | 0 |
| Hit and Run - Unknown: | 0 | 0 | 0 |
| Light Rail: | 0 | 0 | 0 |
| Other: | 0 | 0 | 0 |
| Unknown: | 2 | 1 | 0 |
| | **Total: 23** | **Total: 14** | **Total: 2** |

## Road Conditions

| | |
|---|---|
| Dry: | 21 |
| Wet: | 0 |
| Muddy: | 0 |
| Snowy: | 0 |
| Icy: | 2 |
| Slushy: | 0 |
| Foreign Material: | 0 |
| With Road Treatment: | 0 |
| Unknown: | 0 |
| **Total:** | **23** |

## Accident Rates

| | | |
|---|---|---|
| PDO: | 1.16 * | * MVMT |
| INJ: | 0.51 * | ** 100 MVMT |
| FAT: | 0.00 ** | **Total: 1.67** * |

**ADT:** 7,549 **Length:** 1.00 **Coris File:** tcoris2001.dbf

DR2447 Format

# Colorado Department of Transportation
# Safety and Traffic Engineering
# General Accident Summary Report

Microsoft Visual FoxPro 9 SP2
02/28/2011

Job #: 20110228142118

**Highway:** 550A **Begin:** 15.61 **End:** 16.56 **From:** 12/31/2003 **To:** 12/31/2008

## Severity

| | | |
|---|---|---|
| PDO: | 22 | |
| INJ: | 6 | 10 :Injured |
| FAT: | 0 | 0 :Killed |
| **Total:** | **28** | |

## Number of Vehicles

| | |
|---|---|
| One Vehicle: | 18 |
| Two Vehicles: | 8 |
| Three or More: | 2 |
| Unknown: | 0 |
| **Total:** | **28** |

## Location

| | |
|---|---|
| On Road: | 13 |
| Off Road: | 15 |
| Unknown: | 0 |
| **Total:** | **28** |

## Accident Type

| | | | | | |
|---|---|---|---|---|---|
| Overturning: | 5 | Sideswipe (Same): | 1 | Bicycles: | 0 |
| Other Non Collision: | 1 | Sideswipe (Opposite): | 4 | Domestic Animal: | 0 |
| Pedestrians: | 0 | Approach Turn: | 0 | Wild Animal: | 3 |
| Broadside: | 0 | Overtaking Turn: | 0 | Fixed Objects: | 9 |
| Head On: | 0 | Parked Motor Vehicle: | 0 | Other Objects: | 1 |
| Rear End: | 4 | Railway Vehicle: | 0 | Unknown: | 0 |
| | | | | **Total:** | **28** |

## Lighting Conditions

| | |
|---|---|
| Daylight: | 15 |
| Dawn or Dusk: | 2 |
| Dark - Lighted: | 1 |
| Dark - Unlighted: | 10 |
| Unknown: | 0 |
| **Total:** | **28** |

## Mainline/Ramps/Frontage Rds

| | |
|---|---|
| Mainline: | 28 |
| Ramps: | 0 |
| Frontage Roads: | 0 |
| Intsx Frontage/Ramps: | 0 |
| HOV Lanes: | 0 |
| Unknown: | 0 |
| **Total:** | **28** |

## Weather Conditions

| | |
|---|---|
| None: | 21 |
| Rain: | 1 |
| Snow/Sleet/Hail: | 6 |
| Fog: | 0 |
| Dust: | 0 |
| Wind: | 0 |
| Unknown: | 0 |
| **Total:** | **28** |

## Vehicle Types

| | Vehicle 1 | Vehicle 2 | Vehicle 3 |
|---|---|---|---|
| Vehicle/Vehicle Combo (> 10k Lbs): | 1 | 0 | 1 |
| School Bus (All School Busses): | 0 | 0 | 0 |
| Non-School Bus (> 8) in Commerce: | 0 | 0 | 0 |
| Transit Bus: | 0 | 0 | 0 |
| Passenger Car/Van: | 18 | 3 | 1 |
| Passenger Car/Van w/Trailer: | 0 | 0 | 0 |
| Pickup Truck/Utility Van: | 1 | 0 | 0 |
| Pickup Truck/Utility Van w/Trailer: | 1 | 2 | 0 |
| SUV: | 5 | 4 | 0 |
| SUV w/Trailer: | 0 | 0 | 0 |
| Motor Home: | 0 | 0 | 0 |
| Bicycle: | 2 | 0 | 0 |
| Motorized Bicycle: | 0 | 0 | 0 |
| Farm Equipment: | 0 | 0 | 0 |
| Hit and Run - Unknown: | 0 | 0 | 0 |
| Light Rail: | 0 | 0 | 0 |
| Other: | 0 | 0 | 0 |
| Unknown: | 0 | 1 | 0 |
| | **Total: 28** | **Total: 10** | **Total: 2** |

## Road Conditions

| | |
|---|---|
| Dry: | 17 |
| Wet: | 2 |
| Muddy: | 0 |
| Snowy: | 2 |
| Icy: | 5 |
| Slushy: | 1 |
| Foreign Material: | 0 |
| With Road Treatment: | 1 |
| Unknown: | 0 |
| **Total:** | **28** |

## Accident Rates

| | | |
|---|---|---|
| PDO: | 1.52 * | * MVMT |
| INJ: | 0.41 * | ** 100 MVMT |
| FAT: | 0.00 ** | **Total:** **1.93** * |

**ADT:** 7,926 **Length:** 1.00 **Coris File:** tcoris2008.dbf