Interchange Modification Justification Study

I-90/Timberline Road Interchange, Exit 402

SIOUX FALLS MPO

Technical analysis to accompany companion Environmental Assessment

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Interchange Modification Justification Report

I-90/Timberline Avenue Interchange
Exit 402

Sioux Falls, South Dakota
February, 2013
Updated June, 2014

Prepared for:

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EXECUTIVE SUMMARY

This report is part of a supplement to a previously-approved Environmental Assessment and subsequent analyses of Interstate access. The documents are being supplemented to account for alignment changes to the roadway intersecting the Interstate system. The report format has also been updated to comply with the most recent guidance. The updated EA document is being prepared in conjunction with this report.

The proposed action is a reconfiguration and realignment of the existing Timberline Avenue (Exit 402) interchange on Interstate 90 near Sioux Falls, SD. The action is proposed to provide appropriate operational capacity for a new regional arterial highway, referred to as the Eastside Corridor, which is currently under phased construction. The Eastside Corridor is part of local and state transportation plans to serve growth in the Sioux Falls metropolitan area. No adverse impacts to the Interstate highway system are forecast due to the proposed change.

The Federal policy considerations and requirements have been addressed beginning on page 36 and summary responses to the eight requirements are provided below.

1. The proposed action is a modification of an existing interchange to correct design deficiencies and meet planned future travel needs of the metropolitan area.
2. No additional Interstate capacity or additional Interchange access points are required. The need can be met by providing updated interchange configuration and additional crossroad capacity.
3. The ramp terminal intersections will fail with the interchange no-build option, but continue to operate acceptably with build alternatives.
4. The proposed action is an update of an existing full public road interchange.
5. The proposed action is the result of land use and transportation plans prepared within the MPO process. A companion EA accompanies this report.
6. A comprehensive Interstate system study has recommended improvements at this interchange.
7. The proposed action is part of the overall planned transportation system.
8. An Environmental Assessment accompanies this report.

The analysis indicates that an update of the existing interchange is necessary to address future travel demand. Previous analyses selected a single-point interchange as the preferred alternative at this location and the subsequent analysis validates this recommendation.

Alternative improvements such as slight changes at adjacent interchanges, changes to the local street system, the increased use of transit, HOV/HOT lanes, etc. were deemed not to satisfy the need for an appropriate Interstate connection for the planned new regional arterial corridor.

Analysis techniques included evaluation of operational capacity using Highway Capacity Manual 2010 techniques via HCS 2010. Highway Safety Manual techniques were used to the extent possible in this report.

INTRODUCTION

Background

SDDOT is conducting a study to evaluate the design, operations, policy and funding implications of replacing the Timberline Avenue interchange (Exit 402) on I-90 east of Sioux Falls. This existing interchange will serve as the northern terminus of the planned Sioux Falls east-side regional arterial corridor. An Environmental Assessment (EA) and two Supplements to the EA have been completed for the route. An additional EA addressing environmental impacts associated with alignment shifts for the portion of the Eastside Corridor from Madison Street to I-90 is proceeding in conjunction with this document. Phased construction of portions of the corridor included in the approved environmental documents is underway with portions of the corridor constructed and open to traffic, other portions are programmed for construction, and other portions are receiving further environmental review to address small changes in the roadway alignment or configuration. The portion of the Eastside Corridor that includes the I-90 interchange is currently undergoing an EA. Interstate access justification work for this interchange was begun, but not completed or submitted to FHWA. The current study updates the previous work with recent data and seeks to meet revised guidance for preparation of Interstate access studies. This Interchange Modification Justification Report is being prepared in conjunction with the EA and will provide traffic analysis for the selection of a preferred alternative in the EA.

Purpose

The preliminary design for the Eastside Corridor shows the intersection of the improved crossroad will remain at the existing location at Exit 402. The change of classification of the crossroad from a county highway to a regional arterial highway brings an expected significant increase in the traffic using this interchange. This study will evaluate the operational and safety effects of several interchange configurations.

Project Location

The subject interchange is at mile reference marker 402 on Interstate 90, east of Sioux Falls, SD. This location is within the Sioux Falls MPO and also within the area identified for future Sioux Falls growth by local comprehensive planning. The adjacent interchanges on I-90 are I-229 (Exit 400) and South Dakota Highway 11 (SD 11) (Exit 406). Therefore, interchange spacing is approximately 2 miles to the west of the subject interchange and 4 miles to the east of the subject interchange.

There are few local roadways in the vicinity of the interchange. The existing crossroad has been identified as Timberline Avenue and Minnehaha County Highway 121. It is an asphalt-paved two-lane roadway that provides local service between Sioux Falls and rural residences and businesses. Timberline Avenue is intersected by Redwood Boulevard, a low-volume gravel road, just to the south of the existing interchange. Approximately ½ mile south of the interchange, Timberline Avenue is intersected from the west by 60th

Street North. The closest intersecting roadway north of the interchange is 259th Street, a low-volume gravel road over 1 mile away. Currently all intersections on the crossroad are controlled by stop signs.

The Eastside Corridor is planned to terminate at Exit 402 and transition back to the existing County Highway north of the interchange. The roadway designated at 60th Street North is planned to be realigned to intersect with the Eastside Corridor and Redwood Boulevard at a common signalized intersection. Access from the Eastside Corridor to Rice Street will be provided by an at-grade intersection.

The study area, therefore, has been defined as Interstate 90, from MRM 400 to MRM 406, including Exits 400, 402, and 406, and Timberline Avenue including the interchange and the 60th Street North intersection. The study area is shown in Figure 1.

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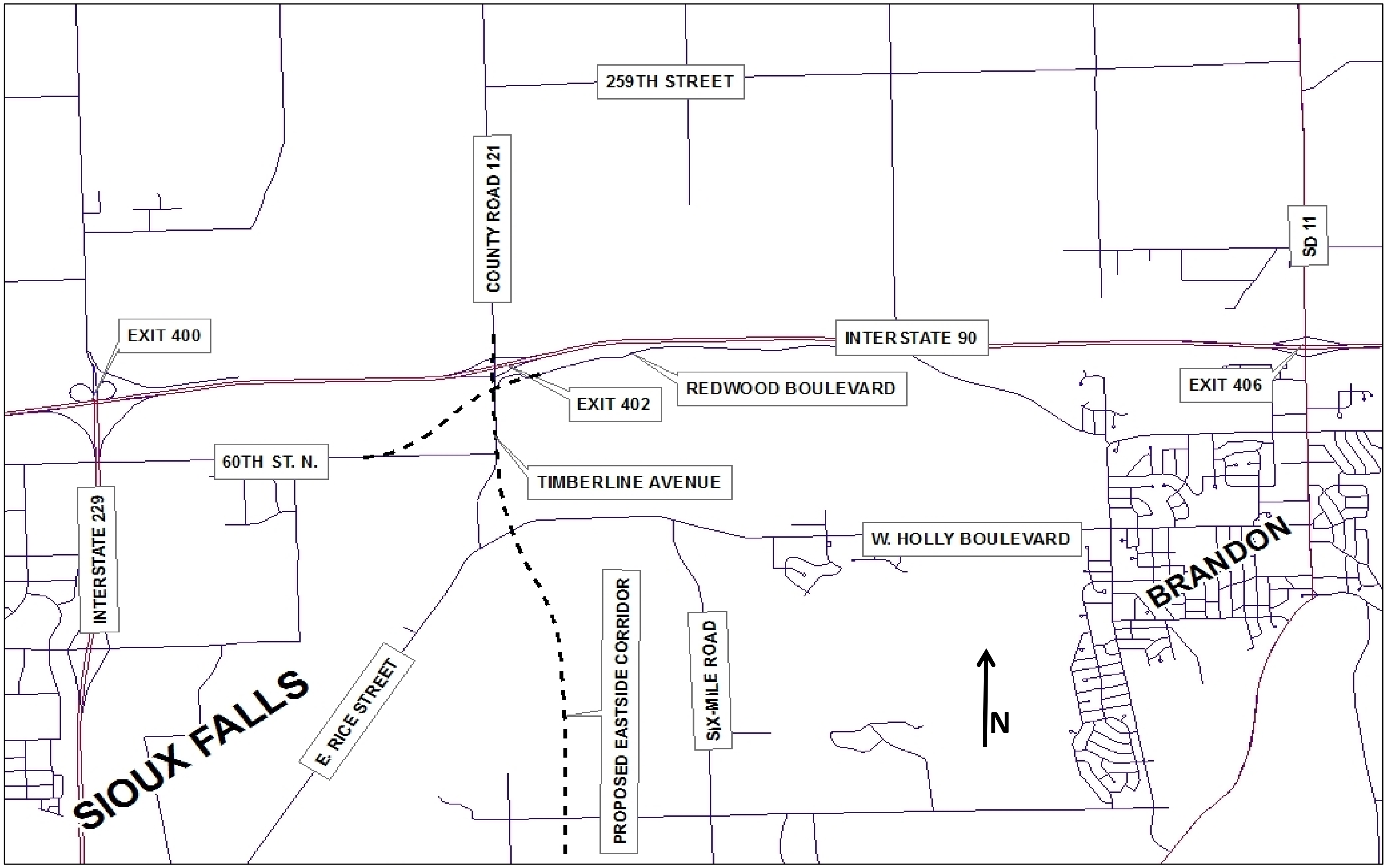
I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION REPORT

MAY
2014

FIGURE 1

PROJECT LOCATION



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I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION REPORT

MAY
2014

FIGURE 1A
STUDY AREA

METHODOLOGY

Preparation of this report included the following work tasks:

1. Data gathering
2. Review previous Interstate access work and EA documents, including feasible alternatives and the recommended alternative.
3. Update existing and future operational characteristics of Interstate and local street facilities.
4. Estimate the safety effects of each alternative.
5. Prepare deliverable report

Traffic forecasts were prepared using output from the regional travel demand model maintained by the City of Sioux Falls. Traffic operations were analyzed using Highway Capacity Manual techniques using HCS 2010.

This IMJR document is organized in accordance with Section 2.5.2 of FHWA's *Interstate System Access Information Guide,* August 2010.

EXISTING CONDITIONS

Demographics

The Sioux Falls metropolitan area enjoys a robust economy and sustained measured population growth. During the period 1980 – 2000 the population grew at a steady rate of between 2% and 3% per year. Even in the face of the recent recession, the population continued to grow and the 2010 Census shows the city with a population of 153,888, while the MSA had a population of 228,261 and the market area had a population of 1,043,450. (Market area is a term used in economics and human geography describing the area surrounding a central place, from which people are attracted to use the place's goods or services.)

Generally, employment for the Sioux Falls area has grown at approximately the same rate as the population and unemployment remains very low in comparison to national figures.

The study area is currently sparsely populated, with scattered rural residences and a few businesses near the existing interchange. The study area Traffic Analysis Zones (TAZ's) currently reflect the existing sparse population with relatively small population and employment inputs. The future-year TAZ's, however, show greatly increased population and employment inputs to reflect the planned development of regional commercial and housing activities. See the following section for more information on planned land uses.

Existing Land Use

The study area is currently occupied primarily by agricultural and recreation/conservation land uses, although a few scattered rural residences exist. Small commercial enterprises occupy the land on the north side of the subject interchange. They include an agricultural implement auction, a commercial campground and two fireworks vendors.

The future land use for this area is shown in Figure 2.

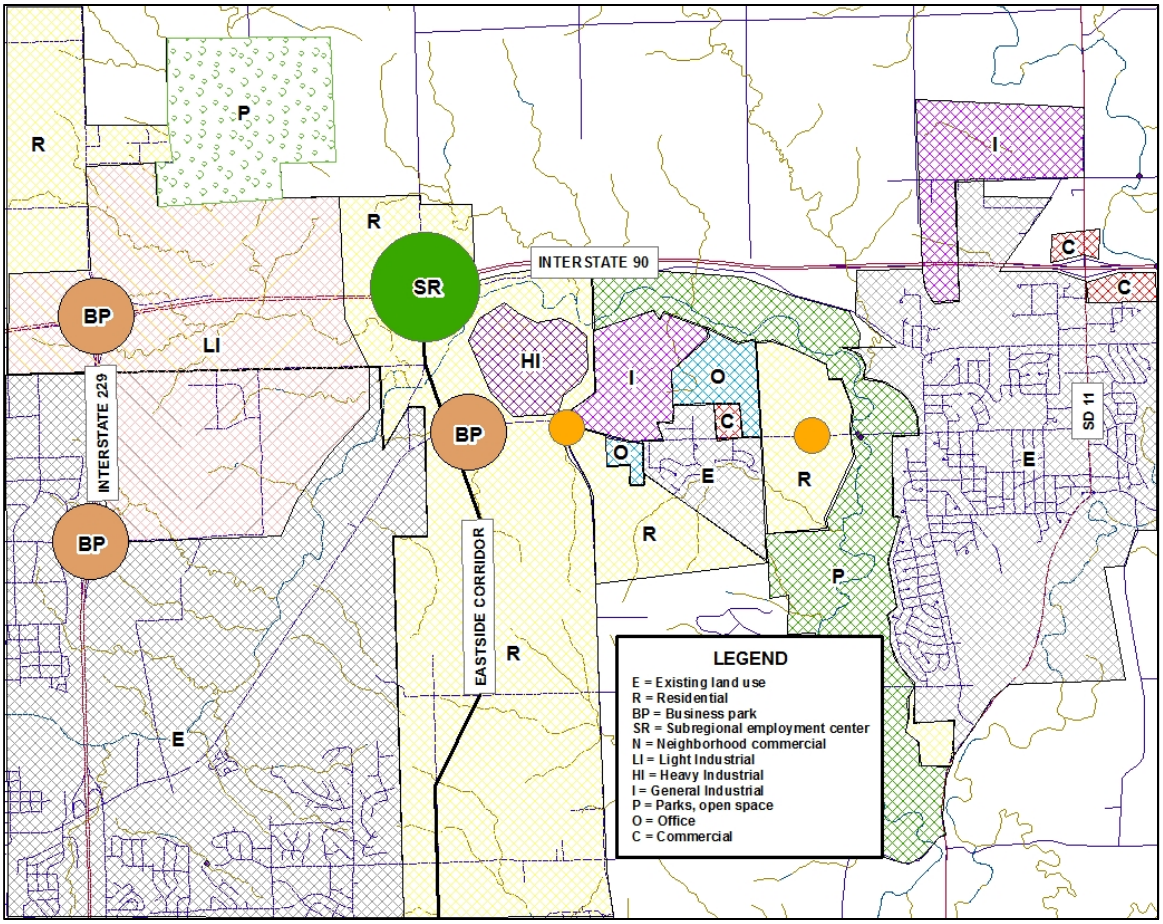


Figure 2 - Study Area Future Land Use (source Shape Sioux Falls comprehensive plan and Brandon Comprehensive Plan)

Existing Roadway Network

As previously identified, the existing roadways within the study area include:

- Interstate 90 – currently two lanes in each direction
- Interstate 229 – currently two lanes in each direction
- Timberline Avenue/Minnehaha County Highway 121 – two lane urban collector, frequent access
- 60^{th} Street North – two lane urban collector, new access controlled by City Design Standards
- South Dakota Highway 11 – three lane minor arterial north of I-90, five lane principal arterial south of I-90, access controlled by South Dakota Administrative Rule 70:09.
- Township local roads, including Redwood Boulevard and 259^{th} Street.

Alternative Travel Modes

Travel within the study area is primarily by automobile. Pedestrian and bicycle modes are used mainly for recreation, although a small number of bicycle commuters use Rice Street on the fringe of the study area. The area is not currently served by municipal transit routes, although demand transit service exists in Brandon on the fringe of the study area.

Interchanges

Interchanges within the study area include:

- I-90/I-229 (Exit 400) – a partial cloverleaf design with loops for westbound-to-southbound and northbound-to-westbound movements. Currently, I-229 terminates at this location and the mainline of I-229 feeds into an existing county highway north of the interchange. SDDOT has studied alternatives (see http://www.sddot.com/transportation/highways/planning/specialstudies/docs/IJR_I229-I90_Final%20Revised.pdf) for reconfiguration of this Interstate facility and although an updated interchange configuration has not been identified, the alternatives developed are not expected to have a configuration effect on the adjacent interchange at Exit 402. Also, portions of the Exit 400 interchange have recently been reconstructed with new surfacing.
- I-90/Timberline Avenue (Exit 402) – the subject interchange is a standard diamond configuration with stop-sign controlled ramp termini. It meets current needs, but will be insufficient to carry future travel demand. Construction of the planned Eastside Corridor route would require realignment and reconfiguration of the existing interchange. The *Decennial Interstate Corridor Study (SDDOT)* has identified the following interchange deficiencies:

    - Inslope for mainline and ramp junction
    - Bridge section width for SD100 mainline
    - Super-elevation rate for ramp roadway
    - Grades on the ramp roadway
    - Lane width and right shoulder width on ramp roadway
    - The K value for ramp roadway
    - On-ramp and off-ramp taper for ramp junction

- I-90/SD 11 (Exit 406) – a standard diamond configuration with stop-sign controlled ramp termini. Regional growth has increased the traffic load on this interchange and will likely require future reconfiguration to provide increased capacity. SDDOT has identified the need to revise the interchange in the future, but no detailed study has been completed.

Planned interchange between Exit 402 and Exit 406 – The Sioux Falls MPO Long Range Transportation Plan has included a new interchange at Exit 404 as a potential project need beyond the 2035 planning horizon. No funding has been assigned or detailed analysis conducted for this potential project.

Aerial photos of the existing interchanges have been included in the Appendix, Part 7.

Existing Data

Most study data was available from the participating agencies, including counts, crash data, and raw travel demand model output. The available data was supplemented with additional counts, travel time runs, and traffic observations. The data is recent and of high quality.

Operational Performance

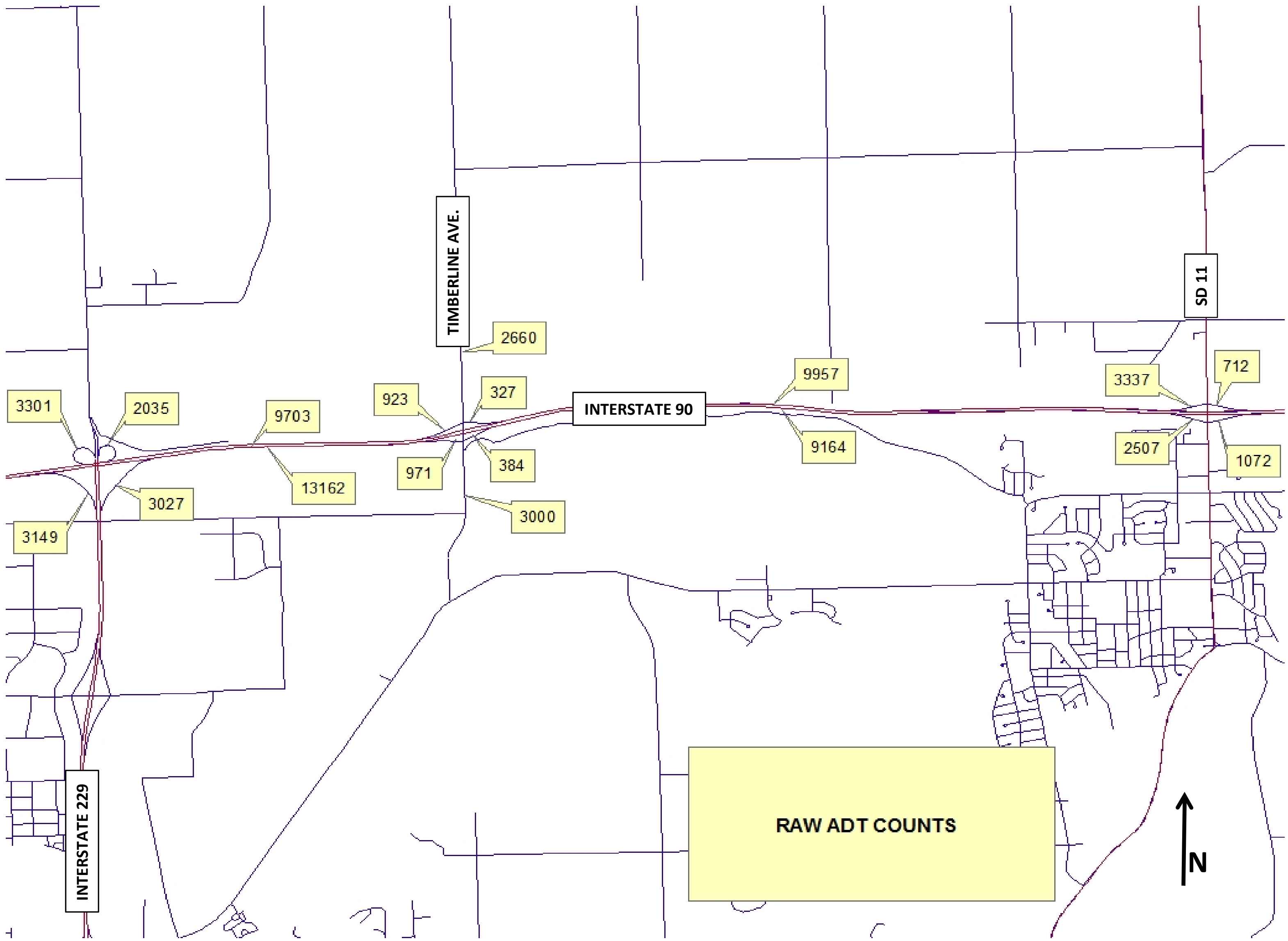
The existing study area roadways are in rural areas and performance was evaluated using techniques for Interstate highways and rural roads. Interstate 90 and Timberline Avenue both operate at acceptable levels of service under existing conditions. Traffic volumes and levels of service are summarized in Figures 3-6. Supporting analysis printouts are provided in the Appendix 1 and 2.

Operational performance for intersections is related to the delay experienced by drivers, as defined by the Highway Capacity Manual. The following table further outlines intersection level of service standards:

Level of Service Description

Level of Service	**SIGNALIZED Intersection Control Delay (sec.)**	**UNSIGNALIZED Intersection Control Delay (sec.)**	**Intersection LOS Description**
A	<=10.0	<=10.0	Free flow, insignificant delays.
B	10.1-20.0	10.1-15.0	Stable operation, minimal delays.
C	20.1-35.0	15.1-25.0	Stable operation, acceptable delays.
D	35.1-55.0	25.1-35.0	Restricted flow, regular delays.
E	55.1-80.0	35.1-50.0	Maximum capacity, extended delays. Volumes at or near capacity. Long queues form upstream from intersection.
F	>80.0	>50.0	Forced flow, excessive delays. Represents jammed conditions. Intersection operates below capacity with low volumes. Queues may block upstream intersections.

Source: *Highway Capacity Manual*, Transportation Research Board, 2010



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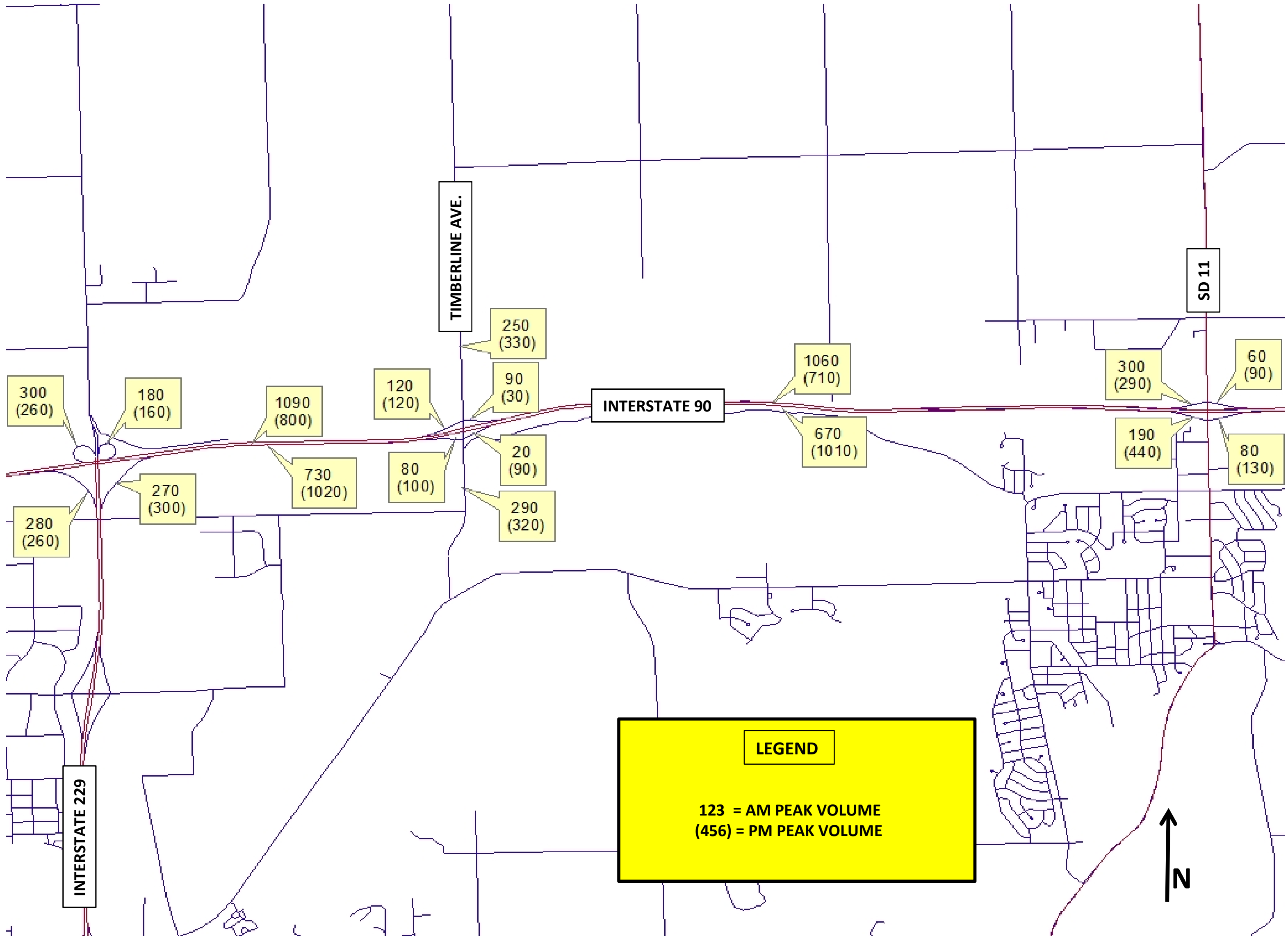
I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION STUDY

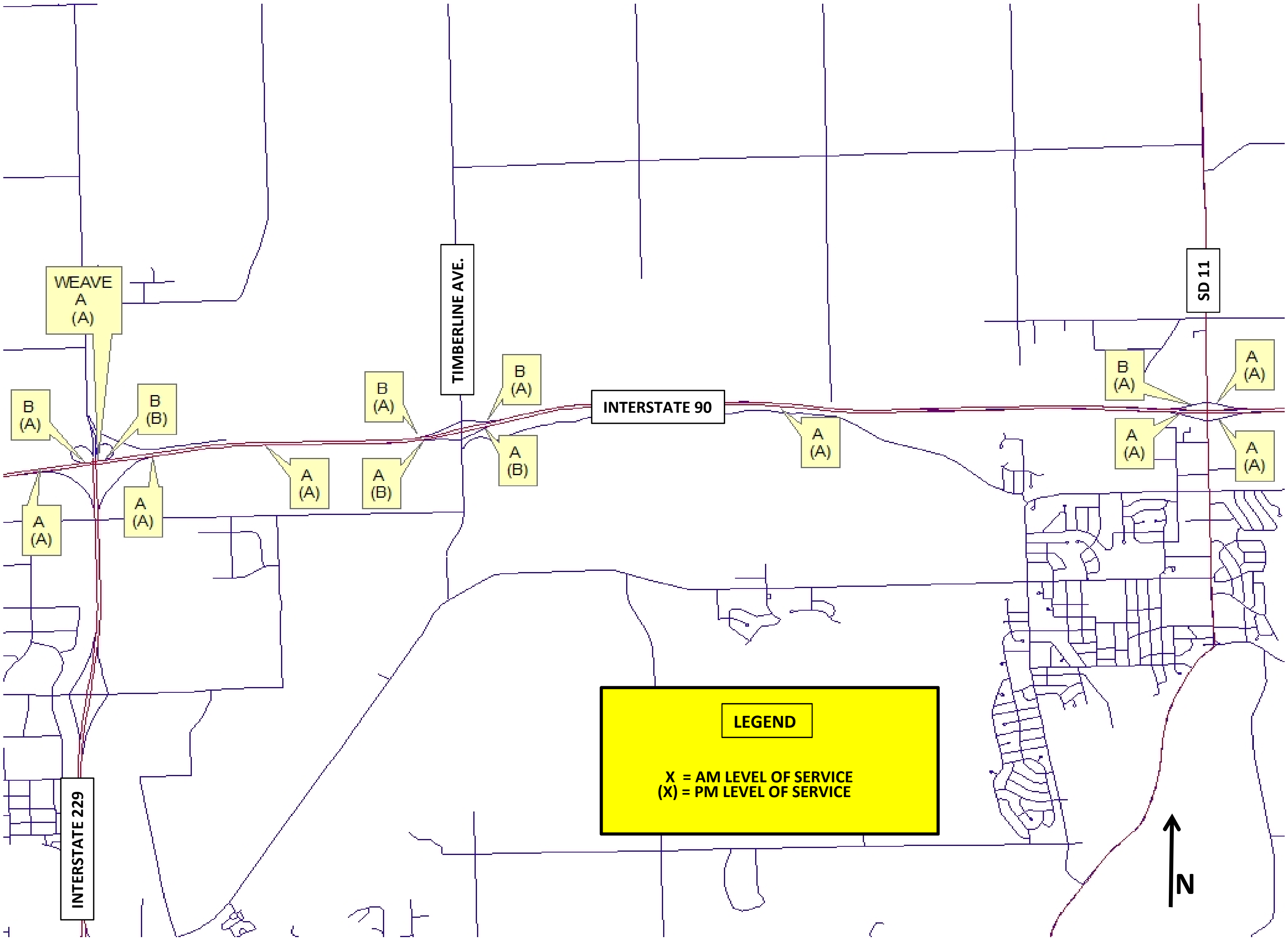
MAY 2014

FIGURE 3

2012 ADT VOLUMES



HDR	I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION STUDY	MAY 2014	FIGURE 4 2012 BALANCED PEAK HOUR VOLUMES



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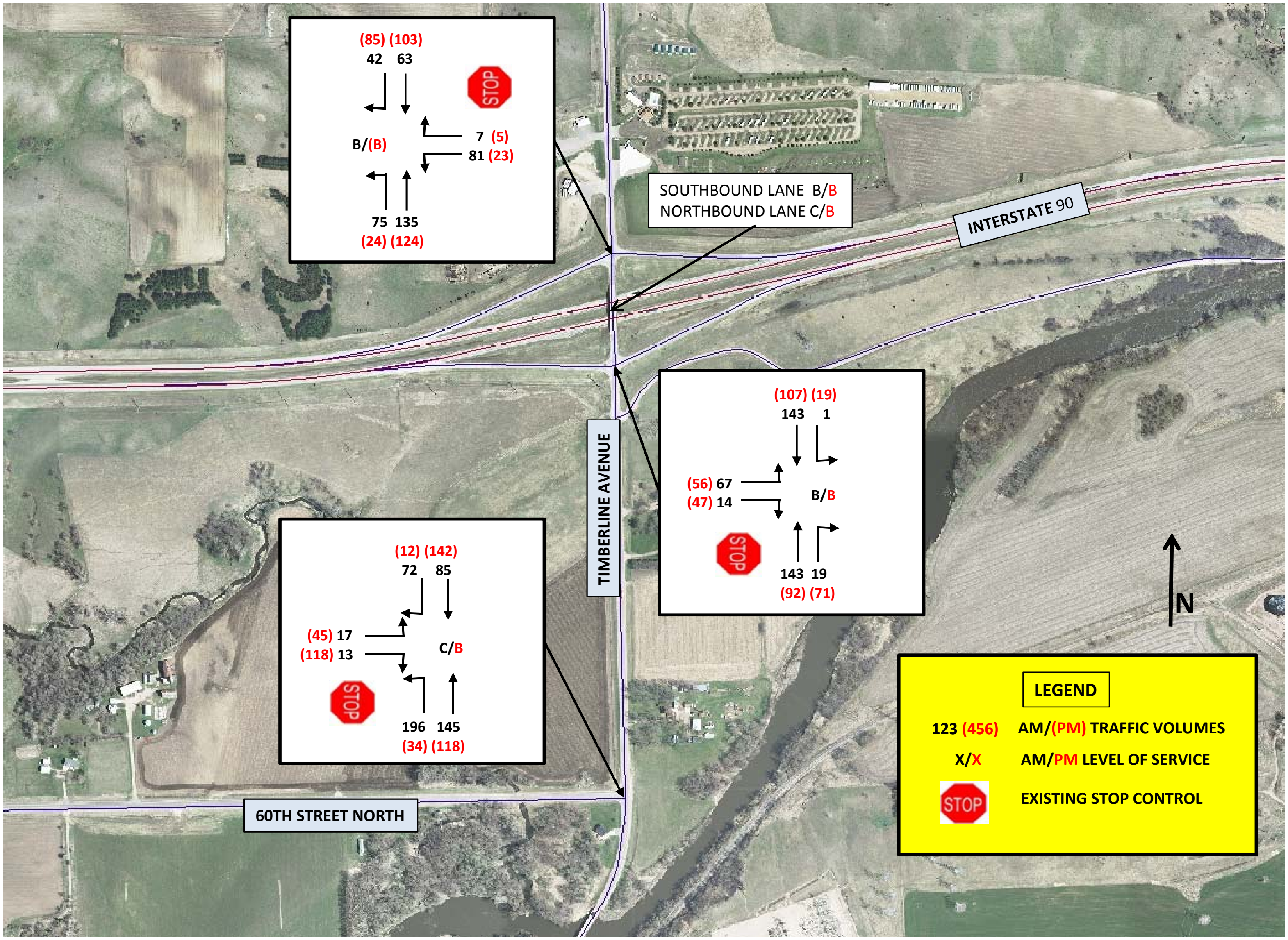
I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION STUDY

MAY
2014

FIGURE 5

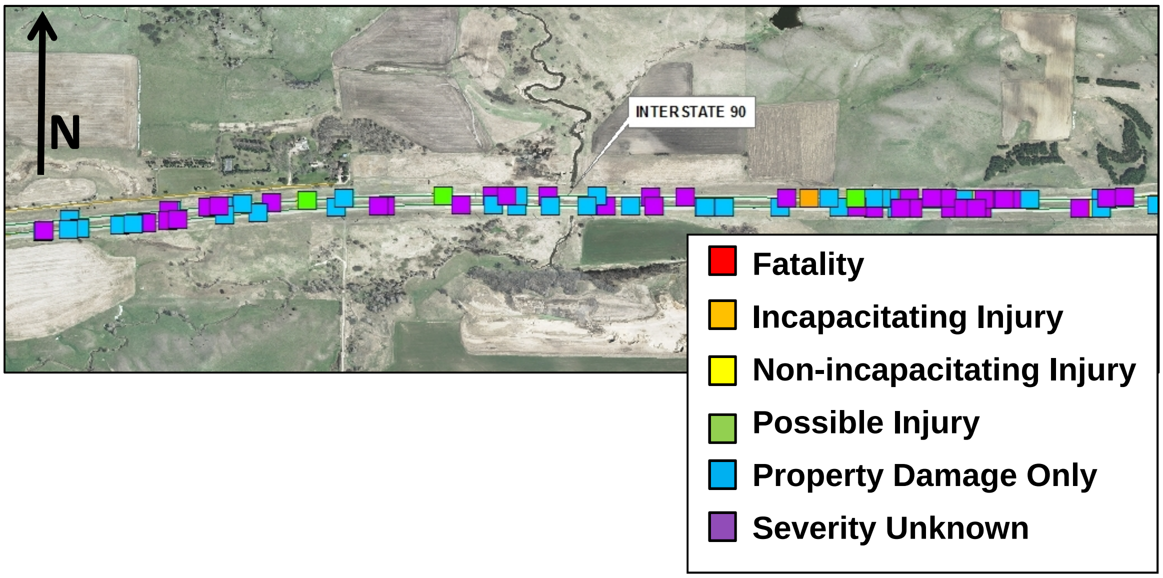
2012 INTERSTATE
LEVEL OF SERVICE



HDR	I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION STUDY	MAY 2014	FIGURE 6 2012 INTERSECTION VOLUMES AND LEVEL OF SERVICE

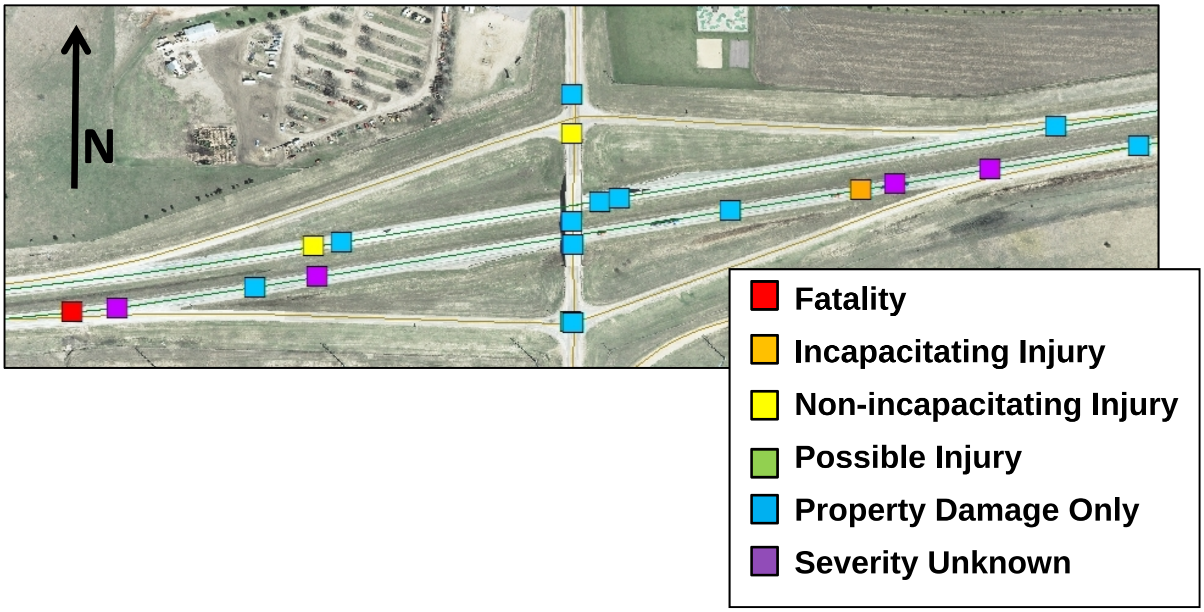
Existing Safety Conditions

The South Dakota Departments of Transportation and Public Safety make crash information available through GIS applications. GIS plots are used throughout this section to display the spatial distribution of crashes for a recent six-year period. The study corridor resides in an area that sees some of the highest frequencies of deer-related crashes in the state. Efforts are underway to reduce the deer herd and other measures have been studied to reduce the incidence of animal hits.



<u>I-90, I-229 to Timberline Avenue</u>: Potential crash trends on I-90 between the I-229 and Timberline Avenue interchange:

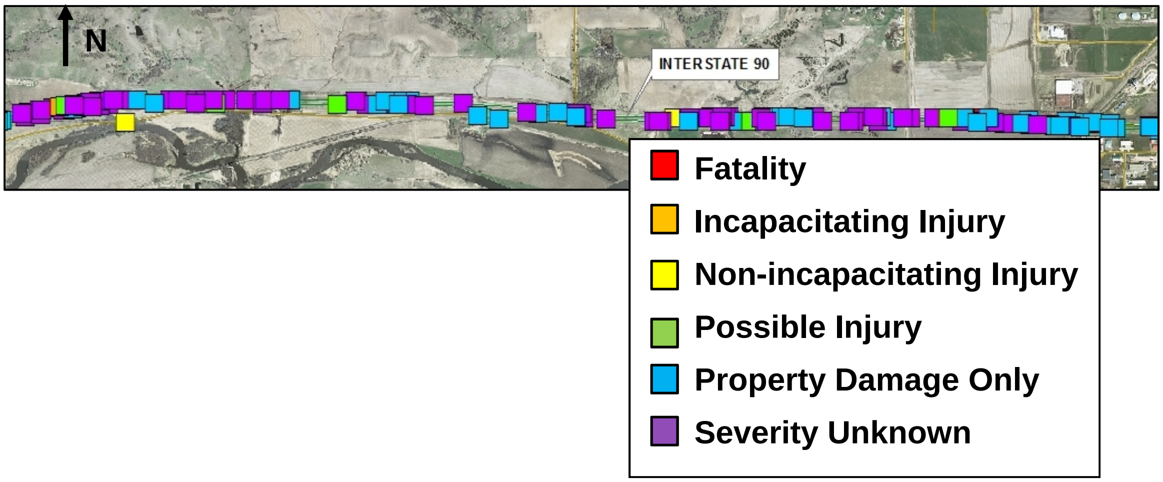
Year	Manner of Crash			Total Crashes	Documented Injury
	Weather Related	Animal	Other		
2008	8	8	2	18	1
2009	6	13	2	21	3
2010	9	13	3	25	2
2011	2	9	3	14	0
2012	1	8	1	10	0
2013	2	7	0	9	0
Total	**28**	**58**	**11**	**97**	**6**



<u>I-90/Timberline Avenue</u>: Potential crash trends at the I-90/Timberline Avenue interchange include:

Year	Manner of Crash			Total Crashes	Documented Injury
	Weather Related	Animal	Other		
2008	2	0	0	2	1[1]
2009	3	0	0	3	1
2010	1	1	0	2	0
2011	0	1	0	1	0
2012	3	2	2	7	2
2013	4	2	1	7	0
Total	**13**	**6**	**3**	**22**	**4**

[1] An overturn accident resulted in a fatality.



I-90 – Timberline Avenue to SD 11: Potential crash trends on I-90 between Timberline Avenue and the SD 11 interchanges include:

Year	Manner of Crash			Total Crashes	Documented Injury
	Weather Related	Animal	Other		
2008	9	13	3	25	1[1]
2009	4	25	3	32	2
2010	11	14	7	32	3[2]
2011	2	26	1	29	3
2012	3	14	5	22	1
2013	4	16	4	24	0
Total	**33**	**108**	**23**	**164**	**10**

1 A rear-end accident resulted in a fatality.

2 An over-turn accident under slippery conditions resulted in a fatality.

Existing Environmental Constraints

Environmental constraints are being evaluated through an EA that is being prepared simultaneously with this Interstate access report. The study area includes portions of the Big Sioux River floodplain and associated riparian and wooded areas. The previous approved 2003 EA, however, found no fatal flaws with development of the Eastside Corridor.

PROJECT NEED

The Eastside Corridor is under development to provide regional arterial transportation service to developing areas around the east and south sides of the Sioux Falls metropolitan area. The corridor is part of extensive regional comprehensive, land use and infrastructure planning. Sections of the Eastside Corridor have been built while others are either under construction or scheduled for construction.

The northern terminus of the Eastside Corridor is the I-90 Exit 402 interchange. Additional travel demand associated with the Eastside Corridor will overwhelm the capacity of the existing rural diamond interchange (Figure 12 shows that the ramp termini level of service falls to F during the peak hours).

The interchange, therefore, needs to be rebuilt to provide additional capacity and configured to provide a useful terminus of the Eastside Corridor.

The *Decennial Interstate Corridor Study, 2010* also identified the following geometric needs at the study interchange:

- Inslope for mainline and ramp junction
- Bridge section width for SD100 mainline
- Super-elevation rate for ramp roadway
- Grades on the ramp roadway
- Lane width and right shoulder width on ramp roadway
- The K value for ramp roadway
- On-ramp and off-ramp taper for ramp junction

ALTERNATIVES

The following interchange alternatives were developed and screened through the Environmental Assessment process:

- Alternative 1: Standard Diamond
- Alternative 2: Tight Diamond
- Alternative 3: Single Point
- No-build

Alternative 1: Standard Diamond Alternative (Figure 7):

This option is similar to the existing diamond interchange configuration. However, the spacing of the ramp intersections at the Eastside Corridor is moved further apart to accommodate signalized intersections. Due to the need for signals, the spacing between ramp intersections should be no less than 1,300 feet. In addition to the ROW impacts to the north, environmental constraints to the south caused by the Big Sioux River flood way control how far south of the proposed interchange 60th Street North can be constructed. The location of the SD100/60th Street North intersection creates undesirable intersection spacing between the eastbound ramp intersection and the 60th Street North intersection. The diamond interchange contains a diagonal one-way ramp in each quadrant allowing traffic to leave or enter the interstate at higher speeds.

- **Advantages**
  - Typical interchange – familiarity
  - Lowest construction cost of options developed
- **Disadvantages**
  - Increased right-of-way (ROW) needs as compared to Alternatives 2 and 3.
  - Spacing between the interchange eastbound ramp and 60th Street North/SD100 intersection is too close to provide adequate storage.

Alternative 2: Tight Diamond Alternative (Figure 8):

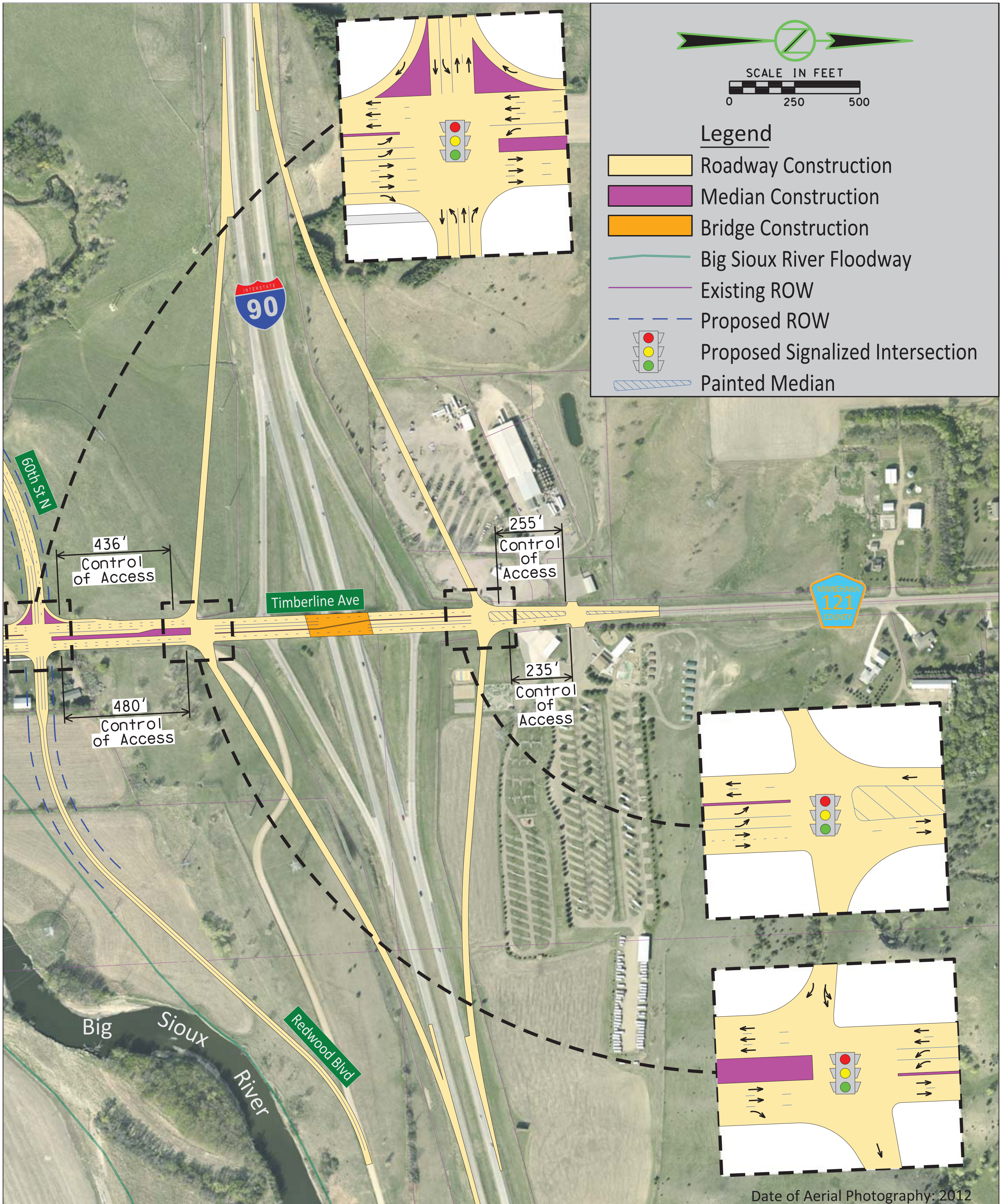
This type of interchange is similar to a diamond interchange in that it uses two traffic signals and typical diamond traffic movements. However, this interchange type utilizes less ROW by reducing the spacing between ramp intersections. Traffic is controlled in a similar method to a Single Point Interchange (SPI) in that the attempt is to store vehicles outside the interchange. However, two signals are utilized instead of one with a SPI.

- **Advantages**
  - Lowest ROW needs and business impacts when compared to Alternatives 1 and 3
  - Lower construction cost when compared to a SPI
- **Disadvantages**
  - Reduced traffic capacity (major concern)
  - Difficult signal timing (major concern)
  - Driver familiarity is higher for a SPI as there are more SPI interchanges than tight diamond interchanges around Sioux Falls.

Alternative 3: Single-Point Alternative (Figure 9):

This type of interchange is best suited for areas where right-of-way availability is limited. At this location, businesses located north of the interchange are a concern for acquiring additional ROW. The Single-Point Interchange essentially combines both ramp terminals into one large intersection which accommodates all vehicular movements and is controlled by a single traffic signal. The other unique concept of the Single-Point Interchange is that opposing left turning movements are to the left of each other.

- **Advantages**
  - Reduced ROW needs and business impacts as compared to Alternative 1
  - Increased traffic capacity compared to Alternative 2
  - Driver familiarity in Sioux Falls urban area
  - Single traffic signal, reducing operating delay in interchange area
  - Increase spacing to adjacent intersections along the Eastside Corridor
- **Disadvantages**
  - Higher construction cost



Drawn by: B. Miller
Date: 4/15/2014
Checked by: R. Loughlin
Date: 4/15/2014
Revision Date: 8/12/2014

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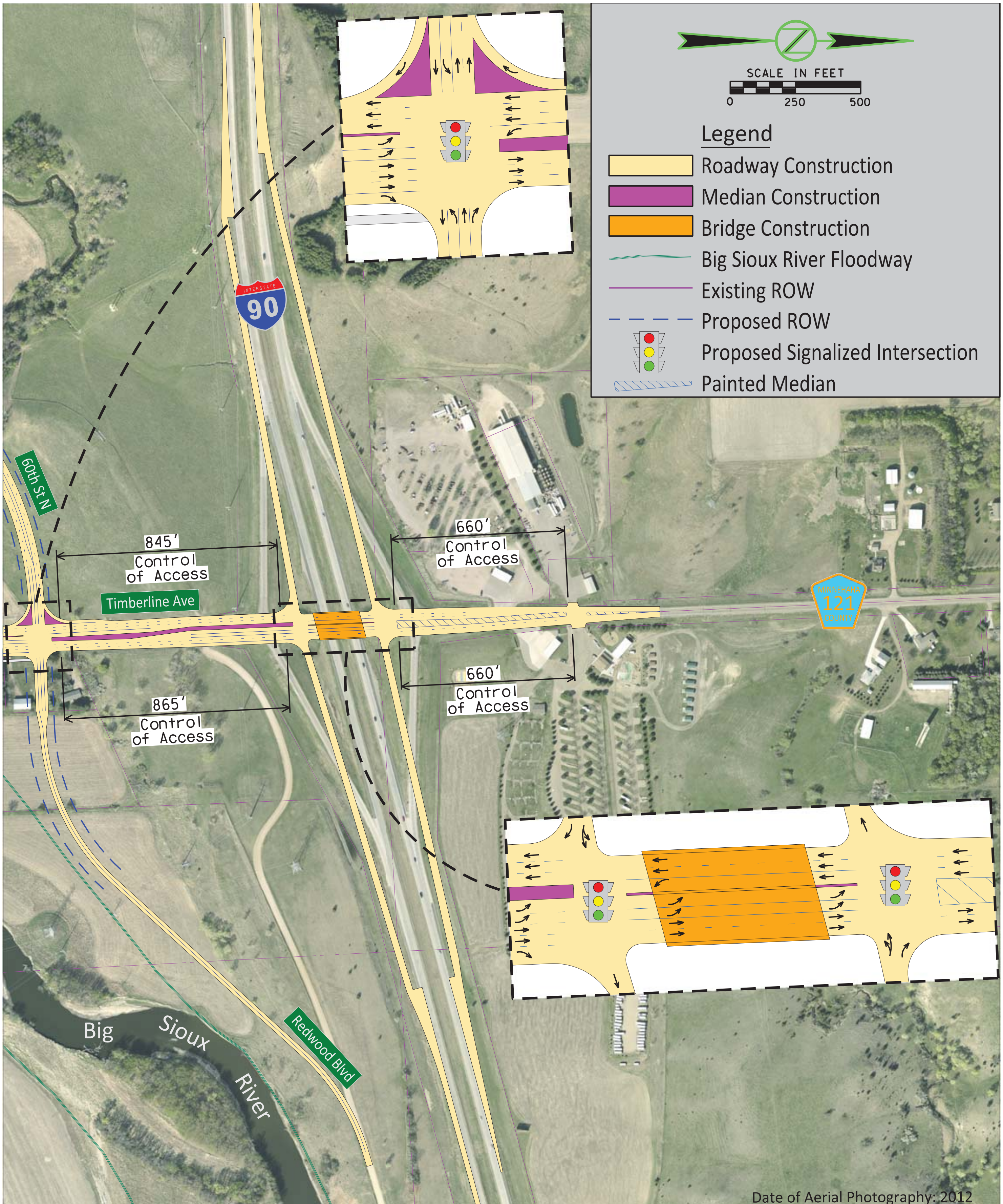
Interchange Alt. 1-Standard Diamond

I-90 Exit 402 Interchange
Interchange Justification Report
Minnehaha County, SD

Figure 7



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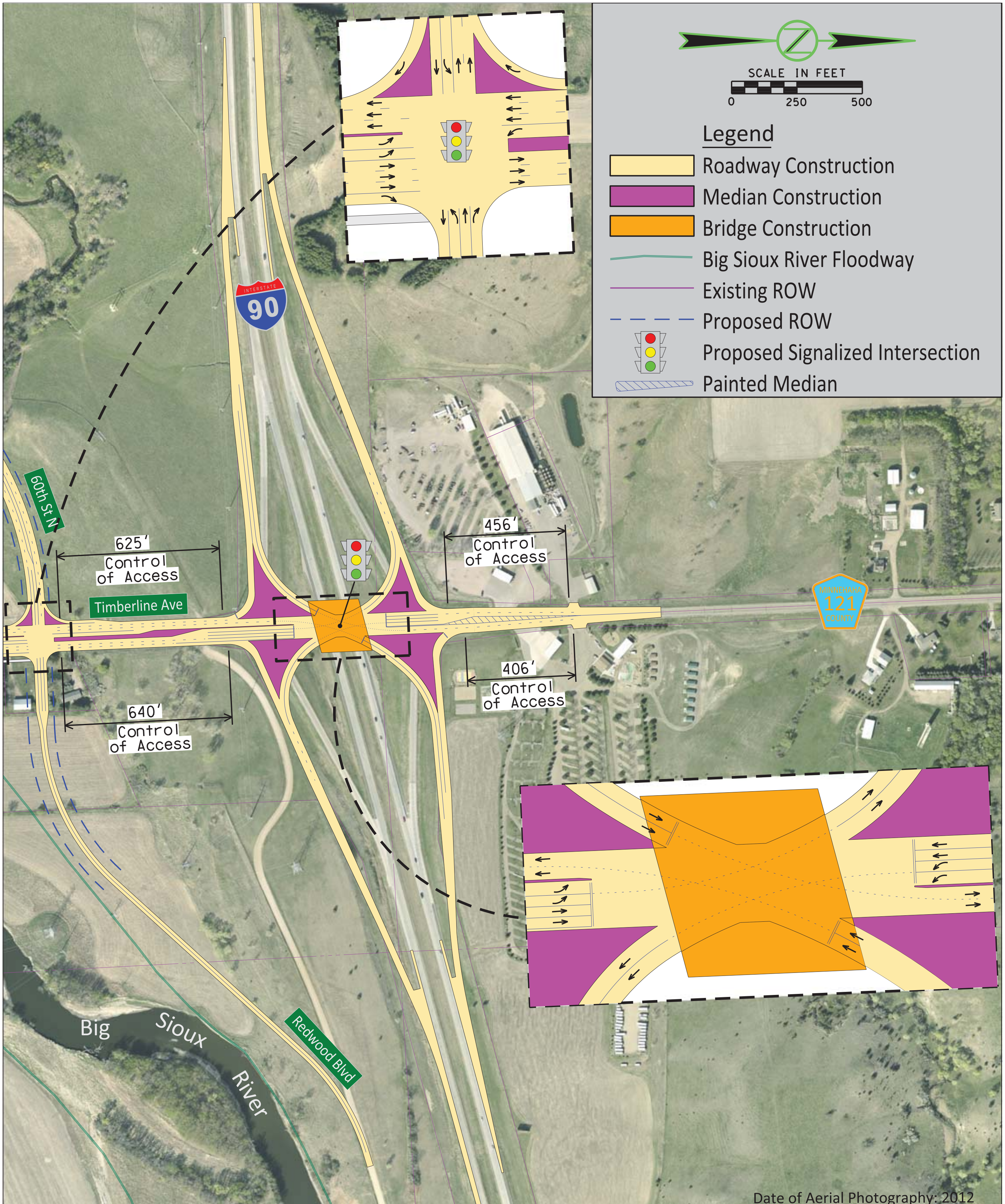
Interchange Alt. 2-Tight Diamond

I-90 Exit 402 Interchange
Interchange Justification Report

Minnehaha County, SD

Figure
8



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Date: 4/15/2014

Revision Date: 8/12/2014

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Interchange Alt. 3-Single Point Urban

I-90 Exit 402 Interchange

Interchange Justification Report

Minnehaha County, SD

Figure

9

Improvements to adjacent interchanges and Transportation System Management alternatives were not deemed able to satisfy the need of providing an interchange with the capacity and alignment to serve the future Eastside Corridor.

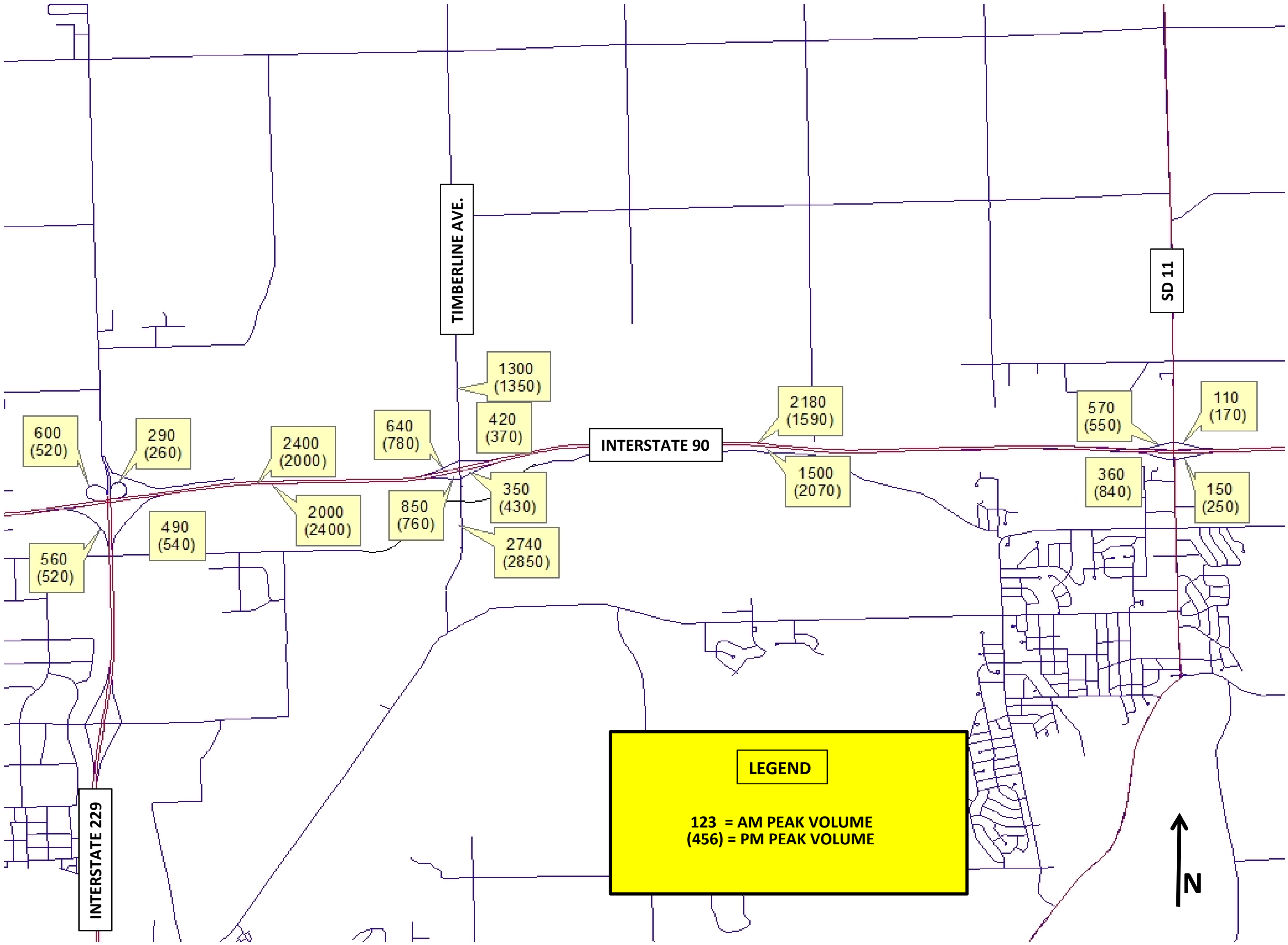
FUTURE YEAR TRAFFIC

Traffic forecasts for the study area were prepared using the regional travel demand model maintained by the City of Sioux Falls and the Sioux Falls MPO. The model horizon year is 2035 and is based on local land use plans. Forecast traffic volumes are shown in Figures 10 through 14, along with the results of the operational analysis.

Previous analysis conducted by the SDDOT identified ramp junctions operating at or below acceptable LOS (C/D) under the current four lane interstate configuration from the I-90/I-229 (Exit 400) interchange through the I-90/Timberline (Exit 402) interchange. The study[1] recommended an auxiliary lane between Exit 400 and Exit 402 which would result in significantly improved LOS for freeway operations. It should be noted that proposed I-90/I-229 interchange alternatives in conjunction with proposed I-90/Timberline interchange alternatives do not create either configuration or operational issues to the adjacent interchange.

The future year traffic analysis in this report is based on the 2035 model year, which does not meet the 20-year projection requirement from planned construction. The future 20-year traffic analysis for corridor and interchange will be reviewed by SDDOT, during final design, to confirm that the 20-year traffic projection from the planned year of construction provides an acceptable level of service established for this project using the 2040 model year.

[1] The study "Interstate 90/Interstate 229 Interstate Access Modification Request" is located at: http://www.sddot.com/transportation/highways/planning/specialstudies/docs/IJR_I229-I90_Final%20Revised.pdf



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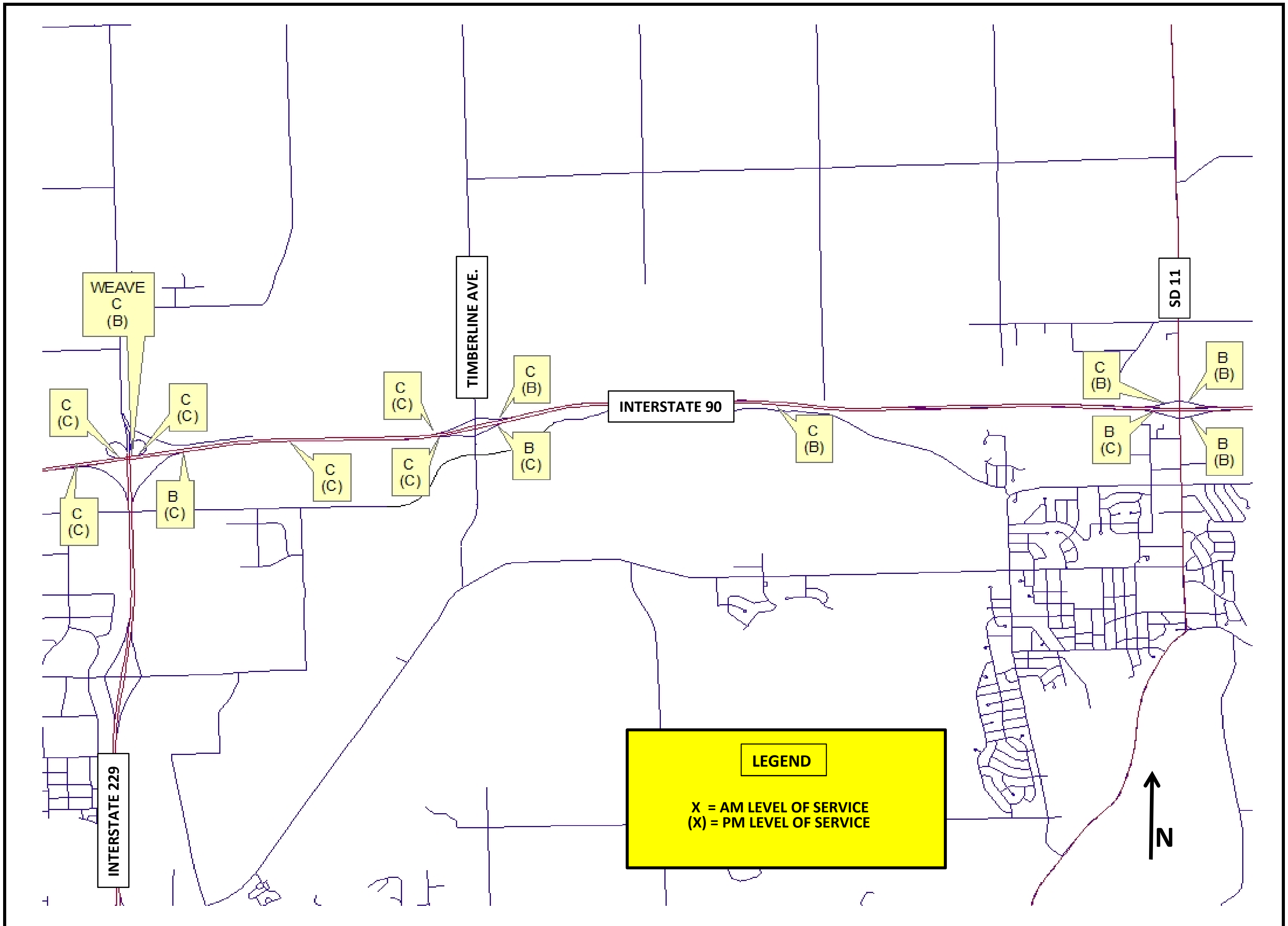
I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION STUDY

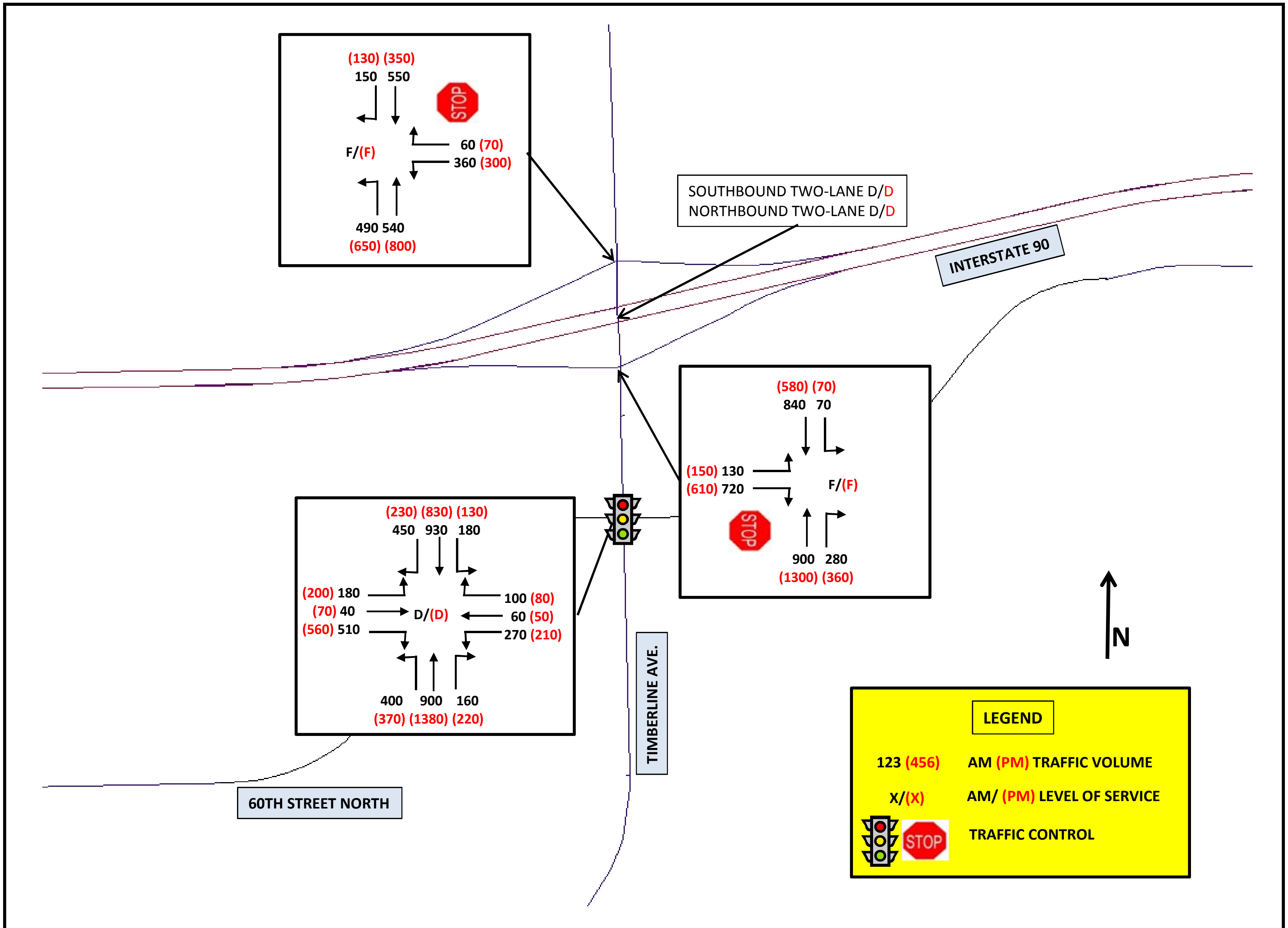
MAY
2014

FIGURE 10

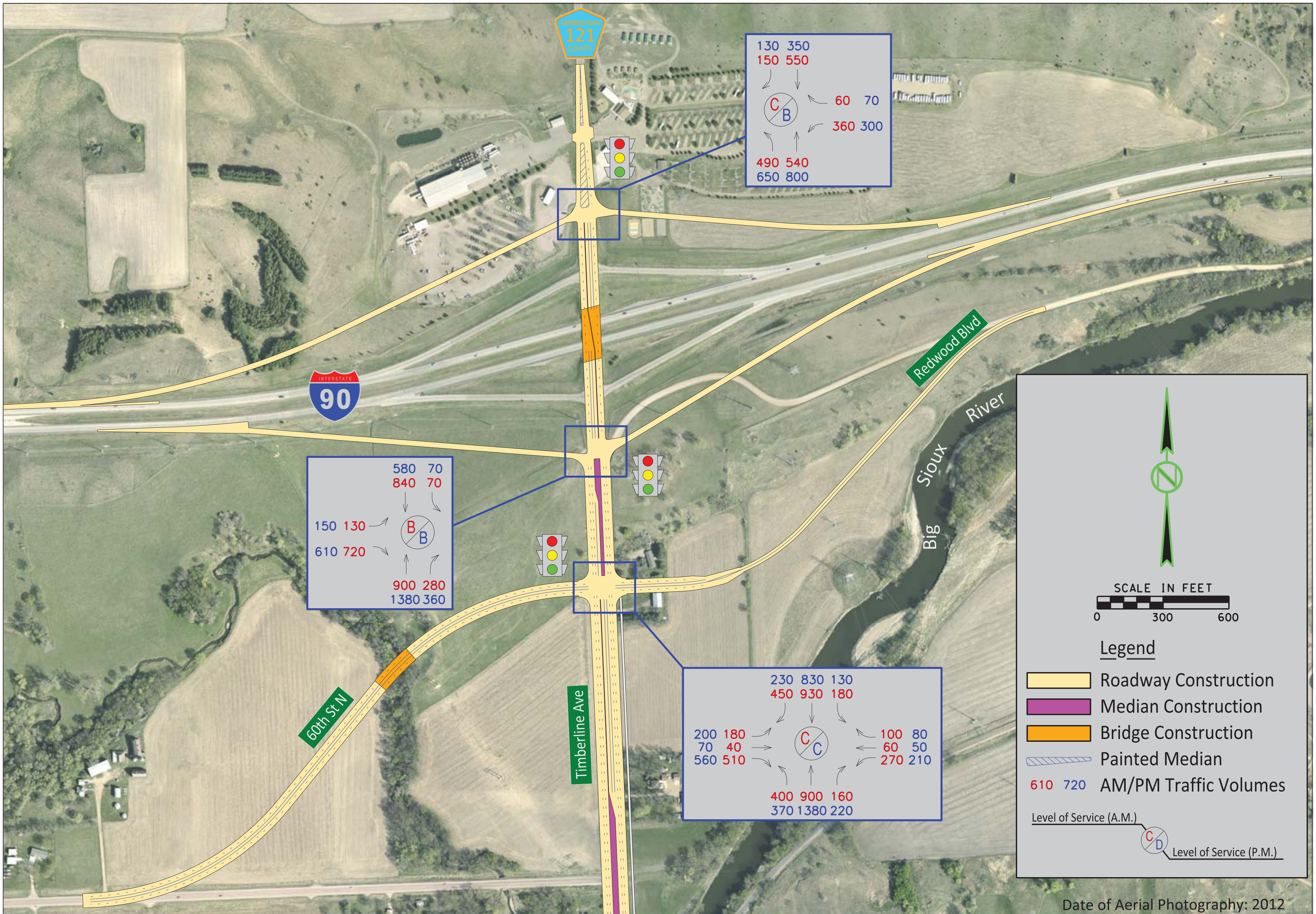
2035 FORECAST PEAK
HOUR VOLUMES



HDR	I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION STUDY	MAY 2014	FIGURE 11 2035 INTERSTATE LEVEL OF SERVICE



HDR	I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION STUDY	MAY 2014	FIGURE 12 2035 NO-BUILD INTERSECTION VOLUMES AND LEVEL OF SERVICE



Drawn by: B. Miller
Date: 4/15/2014

Checked by: R. Loughlin
Date: 4/15/2014

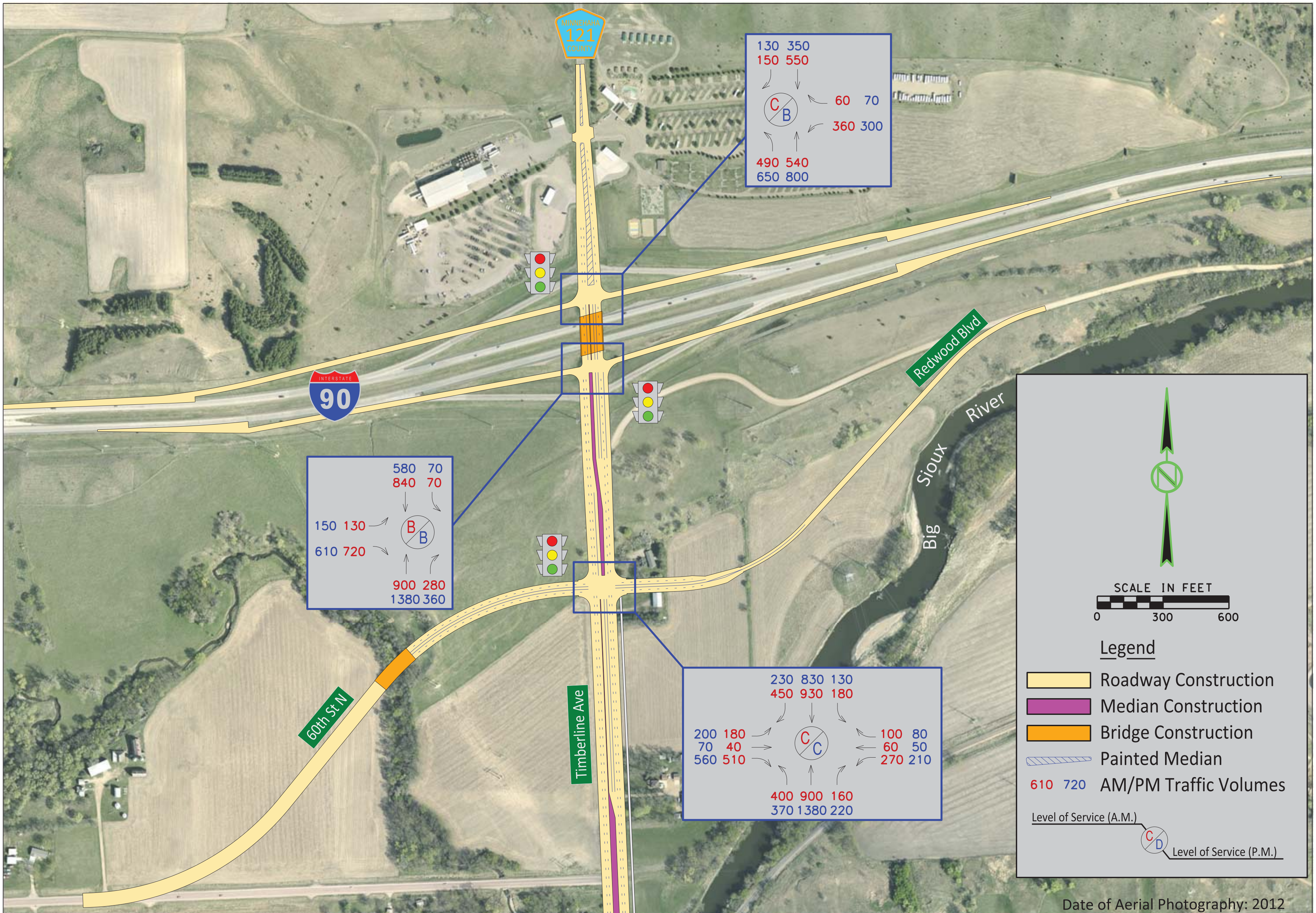
Revision Date: 5/22/2014

2035 Diamond Interchange Volumes and LOS

I-90 Exit 402 Interchange
Interchange Justification Report

Minnehaha County, SD

Figure 13



Drawn by: B. Miller
Date: 6/16/2014

Checked by: R. Loughlin
Date: 6/16/2014

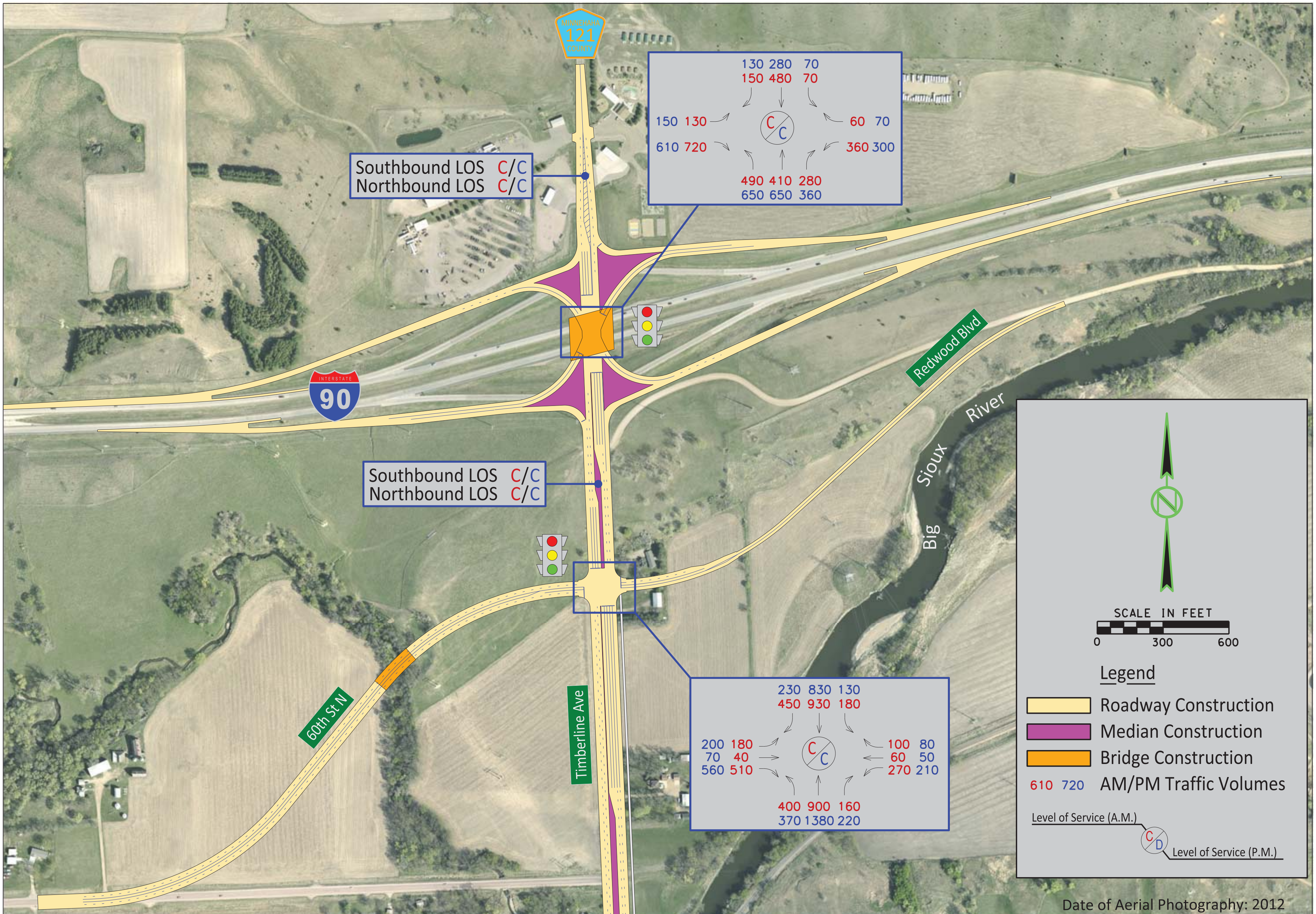
Revision Date:

2035 Tight Diamond Interchange Volumes and LOS

I-90 Exit 402 Interchange
Interchange Justification Report

Minnehaha County, SD

Figure 13a



Drawn by: B. Miller
Date: 4/15/2014

Checked by: R. Loughlin
Date: 4/15/2014

Revision Date: 5/22/2014

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2035 Single Point Interchange Volumes and LOS

I-90 Exit 402 Interchange

Interchange Justification Report

Minnehaha County, SD

Figure

14

ALTERNATIVES ANALYSIS

The retained interchange improvement alternatives were analyzed and compared to determine which may be most suitable for meeting the project need. The areas of analysis and comparison are discussed in the following sections.

Conformance with Transportation Plans

Local (MPO and City) and State transportation plans have identified a need for construction of the Eastside Corridor, a regional arterial highway corridor around the east and south sides of the Sioux Falls metropolitan area. All interchange alternatives satisfy the existing transportation planning considerations.

Compliance with Policies and Engineering Standards

Each of the interchange alternatives is a standard interchange configuration. Conceptual design has used the latest guidance from AASHTO and FHWA and it appears that final design may be accomplished without conflict with geometric design standards.

One potential access management conflict is posed by the signalized intersection spacing between the interchange and the planned 60th Street North/Eastside Corridor intersection. SDDOT access management standards call for signal spacing of at least ½ mile (2,640') on roadways like the Eastside Corridor. Other guidelines and research recommends signalized intersections no closer than ¼ mile (1,320') from interchange ramp terminals.

Alternative 1 (Standard Diamond) has a center to center spacing from the nearest ramp to 60th Street of approximately 600'. Alternative 2 (Tight Diamond) has a center to center spacing of approximately 1000'. Alternative 3 (Single Point) has a center to center spacing from the central intersection to 60th Street of approximately 1200'.

Access standards for the Eastside Corridor have been established through a cooperative planning process between the SDDOT and the Sioux Falls MPO agencies, which takes precedence over regular state and local access standards under South Dakota administrative rules. That study has accepted the concept of a signalized intersection at 60th Street North. Previous analysis looked at queue spillback and interactions between adjacent traffic signals and concluded that the tight diamond and single point alternatives should operate acceptably. The standard diamond alternative, however, may experience queue interference between adjacent traffic signals.

The existing configuration and the alternatives are affected by the close proximity of existing commercial driveways on the north side of I-90. Agreements have been made with the existing businesses and a resolution by the SDDOT Transportation Commission has addressed these driveways. A driveway will be maintained for each of the existing businesses, but no other driveways will be allowed through control of access and agreement. As a result, the property access within the vicinity of the interchange will satisfy the SDDOT Road Design Manual and the AASHTO Policy standards.

Environmental Impacts

The original EA recommended that the Eastside Corridor intersect with I-90 at the existing interchange; no interchange configuration was recommended, although the previous draft Interstate access report found that a slight realignment of the crossroad and a single point interchange were the best solution for the evolving design of the Eastside Corridor. Steep slopes, floodplain, and riparian areas exist adjacent to the interchange area, but it appears that no environmentally-sensitive features are being adversely impacted by interchange configuration. The EA is being prepared concurrently with this revision of the IMJR to address recent roadway alignment changes.

Each of the Build Alternative Concepts along with the No-Build Alternative was presented at a Public Hearing on January 17, 2007. Following the Public Hearing, the alternatives were re-evaluated based on comments received and further analysis and as a result, Alternatives 1 and 2 were eliminated from further consideration. The following sections describe reasons for eliminating alternatives as well as the selection of the preferred alternative.

Preferred Alternative

Each of the alternatives developed as the potential replacement of the existing I-90 Exit 402 interchange are considered as accepted interchange configurations per the SDDOT Road Design Manual, Chapter 13. Also, except for the No-Build alternative, when performing traffic analysis, each alternative does meet acceptable traffic operations both immediately following construction and into the future. However, when comparing the alternatives to each other with respect to adjacent land impacts, long-term operations, corridor compatibility, and driver familiarity, Alternative 3 is identified as the preferred alternative.

> Alternative 1: The larger footprint required by the Diamond Interchange configuration creates unnecessary impacts to adjacent land including negative impacts to businesses directly north of the interchange. Impacts to the Yogi Bear's Jellystone Park would require relocation of several camp amenities located directly adjacent to the interchange and Minnehaha County Road 121. The property in the northwest quadrant would lose a significant amount of their property that is currently used for consignment auctions. The loss would be significant and may require the business to relocate.
>
> For this primary reason, it was recommended that Alternative 1 be eliminated from further consideration.
>
> Alternative 2 & 3: The smaller footprint of the Tight Diamond Interchange (TDI) and Single Point Interchange (SPI) addresses the concerns with regards to negative impacts to adjacent land and businesses. Although an accepted interchange configuration, the TDI is not prevalent in South Dakota, which is a concern with regards to driver familiarity. Another concern is traffic operation performance of the TDI. In analysis for a research paper submitted to the Transportation Research Board (TRB), it was determined that a Single Point Interchange (SPI) provides greater traffic operations than the TDI. Over the range of tests, the SPI provided higher average travel speeds, fewer phase failures, a

lower percentage of stops and considerably higher capability to serve traffic. The results typically show that the TDI would reach capacity conditions when the SPI was operating at average conditions.

For these reasons, the Single Point Interchange is recommended as the preferred interchange configuration for the I-90 Exit 402 location.Compared to the other alternatives, Alternative 3 minimizes ROW impacts and is capable of accommodating future traffic volumes predicted to utilize this interchange. The key advantages of Alternative 3 are as follows:

- Reduced ROW needs and impacts to businesses
- Increased traffic capacity
- Driver familiarity, compared to tight diamond in Sioux Falls area
- Single traffic signal
- Increased spacing to adjacent intersections along the Eastside Corridor

While each alternative was specifically designed to meet the Project goals, only one or two drawbacks made Alternatives 1 and 2 prohibitive to construct. Alternative 1 served future capacity needs, but additional ROW and spacing issues between the eastbound ramp intersections and 60th Street North eliminated this alternative from further consideration. Alternative 2 also served future capacity needs within the planning horizon, but would experience capacity failure sooner than Alternative 3 in the period beyond 2035. For these reasons, Alternative 3 was considered superior to Alternatives 1 and 2.

Table 1
Summary of Long Term Impacts for the Interchange Alternatives

Resource	BUILD ALTERNATIVE OPTIONS		
	Alt. 1-Diamond	Alt. 2-Tight Diamond	Alt. 3-Single Point
Air Quality	No significant impact	No significant impact	No significant impact
Water Quality	No significant impact	No significant impact	No significant impact
Public Utility Relocations	Electrical power lines	Electrical power lines	Electrical power lines
Recreational Resources	No significant impact	No significant impact	No significant impact
Visual Impacts and Aesthetics	No significant impact	No significant impact	No significant impact
Pedestrians and Bicycles	No impact	No impact	No impact
Environmental Justice	No impact	No impact	No impact
Noise	No significant impact	No significant impact	No significant impact
Threatened and Endangered Species	In Agency Coordination	In Agency Coordination	In Agency Coordination
Archaeological and Historical Resources	No adverse effect	No adverse effect	No adverse effect
Section 4(f) and 6(f) Resources	No use	No use	No use
Regulated Materials	No significant impact	No significant impact	No significant impact
Land Use • Right-of-Way • Future Land Use	 20.3 acres Compatible	 2.57 acres Compatible	 10.55 acres Compatible
Floodway	0 acres	0 acres	0 acres
Floodplain • 100 year • 500 year	 0 acres 0 acres	 0 acres 0 acres	 0 acres 0 acres
Economic Resources	No significant impact	No significant impact	No significant impact
Residential Relocations	None	None	None
Business Relocations	1 permanent, 1 partial	1 permanent, 1 partial	1 permanent, 1 partial
Habitat, Fish, and Wildlife[1]	Minor	Minor	Minor
Wetlands and Other Waters of the U.S.[2] • Wetlands[3] • Waters of the US	 1.24 acres 0 linear feet	 1.24 acres 0 linear feet	 1.24 acres 0 linear feet

Notes:
[1] *Impacts for habitat are consistent with impacts for wetlands and other waters of the U.S. Impacted wetlands would be mitigated per Section 404 of the Clean Water Act.*
[2] *Other waters of the U.S. identified within the Study Area for this Project include only stream channels with the presence of a definable bed and bank.*
[3] *Jurisdiction is to be determined by the U.S. Army Corps of Engineers.*

Safety

While there are currently no Crash Modification Factors (CMF's) to directly compare the safety effects of different interchange configurations, there is an older tool, Interchange Safety Analysis Tool (ISAT), which facilitates comparison of safety in Interchanges. Therefore, ISAT was used to estimate safety performance. The results of these model runs are estimates based on general configuration geometrics and safety performance factors and should therefore be considered only as a planning-level measure of comparison between the interchange configurations.

The ISAT model estimates the following total crashes over the period 2012 – 2035 for the alternative interchange configurations:

- Standard Diamond – 895 crashes
- Tight Diamond – 848 crashes
- Single Point – 845 crashes

It appears, therefore, that the tight diamond and single point interchanges are expected to provide similar safety performance. The standard diamond configuration is expected to provide poorer safety performance than the other two configurations. The results of these model runs are estimates based on general configuration geometrics and safety performance factors and should therefore be considered only as a planning-level measure of comparison between the interchange configurations.

Operational Performance

The operations of the alternative interchange configurations were evaluated using appropriate level of service techniques. Performance was analyzed for forecast traffic conditions with the Eastside Corridor in place.

Interstate 90 and the Eastside Corridor both operate at acceptable levels of service under future conditions with the alternative interchanges in place. Use of the existing interchange configuration, however, results in poor interchange performance. The single-point interchange (Alternative 3) provides preferable performance because of its single signalized intersection at the interchange and better spacing to the adjacent intersection. Traffic volumes and levels of service are summarized in Figures 11-14. Supporting analysis printouts are provided in the Appendix 3 and 4.

Evaluation Matrix

Table 2 provides a comparison of the characteristics of each of the interchange alternatives. The table shows that the single-point interchange alternative provides the best technical solution to the transportation needs at this location, based on operational performance.

Table 2 – Evaluation Matrix

Alternative	Conformance with Plans	Compliance with Standards	Environmental Impacts	Safety	Operational Performance
No-Build	No	No	Didn't satisfy project need	N/A	Poor
Alt. 1 – Diamond	Yes	Yes	Extra ROW, relocation required	Good	Good
Alt. 2 – Tight Diamond	Yes	Yes	Little impact	Good	Good
Alt. 3 – Single Point	Yes	Yes	Little impact	Good	Best

Coordination

The Eastside Corridor, including its terminal interchange at Interstate 90, has been the subject of agency coordination and public involvement as part of the environmental assessment process, including public meetings. Further details are available in the Supplement to the EA. The interchange alternatives have also been the subject of review and public hearing through the regular meetings of the MPO committees.

FUNDING PLAN

The 2014-2017 Statewide Transportation Improvements Program (STIP) and the 2014—2017 MPO Transportation Improvements Program (TIP) contain projects for the further construction of the Eastside Corridor. Construction of the interchange project is currently expected in 2017 and the 2014-2017 STIP includes the funding allocations shown below. The inflated estimated cost for the overall 2017 project is $40.658 Million.

TABLE 3 – ANTICIPATED FUNDING ALLOCATION BREAKDOWN

State Funding Category	Federal Funding Category	Federal Funds	State Funds	Total Funds
Interstate Funding [IM 0909(75)402]	National Highway Performance Program	$9.274 Million	$1.416 Million	$10.690 Million
State Highway Urban Funding [NH 0100(104)420]	National Highway Performance Program	$21.134 Million	$5.739 Million	$26.873 Million
Total		$30.408 Million	$7.155 Million	$37.563 Million

Note: As funding is fluid, category breakdown may be different at time of project authorization.

RECOMMENDATIONS

The Environmental Assessment and the technical analysis contained in this Interstate access report have found that the best solution for transportation needs in the study area is to build a single point interchange, Alternative 3, connecting the new Eastside Corridor route to I-90. The proposed interchange is at the site of the existing I-90/Timberline Rd. interchange (Exit 402).

The eight considerations and requirements for Interstate access are addressed below:

1) The need being addressed by the request cannot be adequately satisfied by existing interchanges to the Interstate, and/or local roads and streets in the corridor can neither provide the desired access, nor can they be reasonably improved (such as access control along surface streets, improving traffic control, modifying ramp terminals and intersections, adding turn bays or lengthening storage) to satisfactorily accommodate the design-year traffic demands.

   State/local planning efforts have identified the need for a new regional arterial highway to serve growth around the east and south sides of the Sioux Falls metropolitan area. That regional arterial highway, called the Eastside Corridor, is currently under phased construction and is planned to intersect with I-90 at the existing I-90/Timberline Rd. interchange (Exit 402).

   The existing interchange does not provide sufficient capacity to handle the traffic associated with the Eastside Corridor, but will serve adequately with changes to configuration and design. The Environmental Assessment and this report have identified a single-point interchange as providing the best solution to transportation needs in the study area.

   The proposed change of configuration at Exit 402 will not result in any additional access points on I-90 and only a very slight change in interchange spacing.

2) The need being addressed by the request cannot be adequately satisfied by reasonable transportation system management (such as ramp metering, mass transit, and HOV facilities), geometric design, and alternative improvements to the Interstate with the proposed change(s) in access.

   The preferred alternative involves changes to the geometric design of an existing interchange to meet the transportation needs in the study area. Future transportation demand will require additional lanes on the crossroad, but no additional lanes at the ramp merge/diverge areas, nor additional lanes on the Interstate mainline. Mass transit and HOV facilities are not planned for this portion of the MPO area within the study planning horizon.

3) An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified

ramps, ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis shall, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access, shall be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network. Requests for a proposed change in access must include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network. Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative.

The operational and safety analysis contained in this study shows that Interstate mainline and ramp facilities will continue to operate within operational and safety goals with any of the proposed alternatives. A safety analysis of recent crash records has been provided in the "Existing Safety Analysis" section on page 15. It shows that the primary crash types in the study area involve animal hits and single-vehicle crashes during inclement weather. The ramp terminal intersections, however, will fail with the No-Build alternative, but will continue to operate acceptably with the other alternatives.

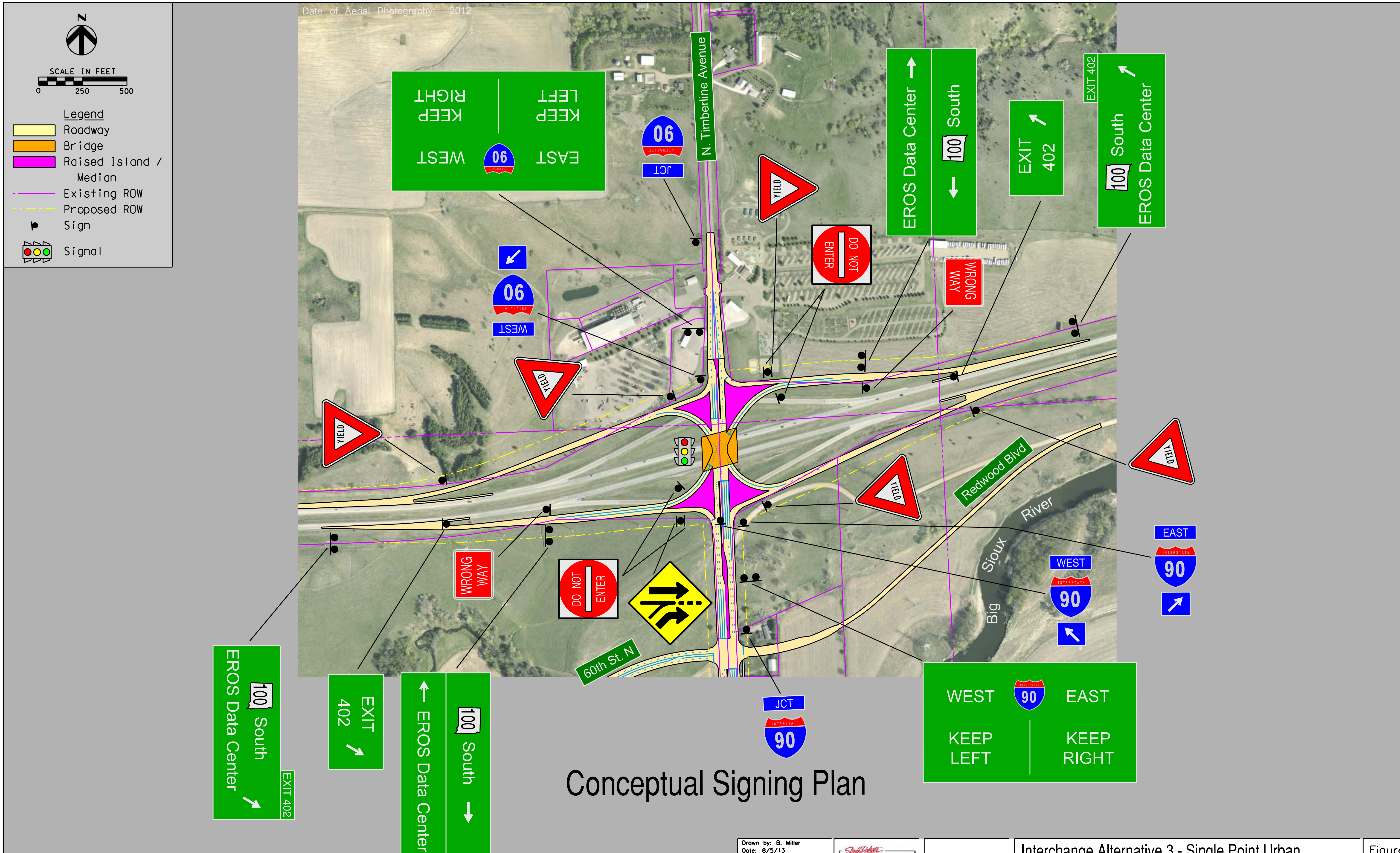
The conceptual signing plan for the Single Point interchange alternative is shown in Figure A6-3. Page 39.

4) The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access for managed lanes (e.g., transit, HOVs, HOT lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards.

   The proposed access is a reconfiguration of an existing interchange with a county road and includes all movements. The conceptual drawings have been prepared using current standards and design using current standards is anticipated.

5) The proposal considers and is consistent with local and regional land use and transportation plans. Prior to receiving final approval, all requests for new or revised access must be included in an adopted Metropolitan Transportation Plan, in the adopted Statewide or Metropolitan Transportation Improvement Program (STIP or TIP), and the Congestion Management Process within transportation management areas, as appropriate, and as specified.

   The proposal is the result of land use and transportation plans prepared within the MPO process. This Interstate Modification Justification Report supplements a previously approved EA which has resulted in construction being programmed in the 2014 STIP and TIP.



Conceptual Signing Plan

Drawn by: B. Miller Date: 8/5/13 Checked by: R. Loughlin Date: 8/5/13 Revision Date:	South Dakota DOT — Connecting South Dakota and the Nation	HDR	Interchange Alternative 3 - Single Point Urban SD100 / I-90 Interchange — Minnehaha County, SD P0100(101)405 PCN 00T7 — Interchange Justification Report
			Figure A6-3

6) In corridors where the potential exists for future multiple interchange additions, a comprehensive corridor or network study must accompany all requests for new or revised access with recommendations that address all of the proposed and desired access changes within the context of a longer-range system or network plan.

   SDDOT has prepared the Decennial Interstate Corridor Study (2010), which considered all proposed additions to the Interstate Highways System within the state of South Dakota. The proposed interchange reconfiguration was addressed in the Decennial study and no other interchanges were anticipated within the study area. The Sioux Falls MPO Long Range Transportation Plan has included a new interchange at Exit 404 as a potential project need beyond the 2035 planning horizon. No funding has been assigned or detailed analysis conducted for this potential project.

7) When a new or revised access point is due to a new, expanded, or substantial change in current or planned future development or land use, requests must demonstrate appropriate coordination has occurred between the development and any proposed transportation system improvements. The request must describe the commitments agreed upon to assure adequate collection and dispersion of the traffic resulting from the development with the adjoining local street network and Interstate access point.

   The proposed access change results not from any particular development, but from overall growth within the metropolitan area. It is part of a planned program of transportation improvements throughout the metropolitan area to address future transportation needs.

8) The proposal can be expected to be included as an alternative in the required environmental evaluation, review and processing. The proposal should include supporting information and current status of environmental processing.

   An original EA for the Eastside Corridor was signed on March 20, 2003. Currently, an EA for the northern segment (Madison Street north) is being prepared to address changes in alignment identified in the 2003 EA that occurred during preliminary design.

APPENDIX

1 – 2012 Interstate Level of Service
2 – 2012 Crossroad Level of Service
3 – 2035 Interstate Level of Service
4 – 2035 Crossroad Level of Service
5 – Crash Forecasts
6 – Signing Plans
7 – Interchange Area Air Photos

Appendix Part 1—2012 Interstate Level of Service

I-90/Timberline Road Interchange

HCS 2010: Basic Freeway Segments Release 6.50

Phone: Fax:
E-mail:

Operational Planning Analysis

Analyst:	HDR
Agency or Company:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	AM PEAK
Freeway/Direction:	
From/To:	I-229/TIMBERLINE
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Flow Inputs and Adjustments

Annual average daily traffic, AADT	20270	veh/day
Peak-hour proportion of AADT, K	0.09	
Peak-hour direction percent, D	60	%
Volume, DDHV	1095	veh/h
Peak Hour factor, PHF	0.90	
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicles PCE, ER	2.0	
Heavy Vehicle adjustment, fHV	0.858	
Driver population factor, fp	1.00	
Flow rate, vp	709	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Interchange density	1.20	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.8	mi/h
Free-flow speed	71.6	mi/h

LOS and Performance Measures

Flow rate, vp	709	pc/h/ln
Free-flow speed, FFS	71.6	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	

Density, D	10.1	pc/mi/ln
Level of Service, LOS	A	

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

HCS 2010: Basic Freeway Segments Release 6.50

Phone: Fax:
E-mail:

Operational Planning Analysis

Analyst:	HDR
Agency or Company:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	PM PEAK
Freeway/Direction:	I-90
From/To:	I-229/TIMBERLINE
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Flow Inputs and Adjustments

Annual average daily traffic, AADT	20270	veh/day
Peak-hour proportion of AADT, K	0.10	
Peak-hour direction percent, D	56	%
Volume, DDHV	1135	veh/h
Peak Hour factor, PHF	0.90	
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicles PCE, ER	2.0	
Heavy Vehicle adjustment, fHV	0.858	
Driver population factor, fp	1.00	
Flow rate, vp	735	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Interchange density	1.20	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.8	mi/h
Free-flow speed	71.6	mi/h

LOS and Performance Measures

Flow rate, vp	735	pc/h/ln
Free-flow speed, FFS	71.6	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	

Density, D	10.5	pc/mi/ln
Level of Service, LOS	A	

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

HCS 2010: Basic Freeway Segments Release 6.50

Phone: Fax:
E-mail:

Operational Planning Analysis

Analyst:	HDR
Agency or Company:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	AM PEAK
Freeway/Direction:	I-90
From/To:	TIMBERLINE/SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Flow Inputs and Adjustments

Annual average daily traffic, AADT	17560	veh/day
Peak-hour proportion of AADT, K	0.09	
Peak-hour direction percent, D	60	%
Volume, DDHV	948	veh/h
Peak Hour factor, PHF	0.90	
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicles PCE, ER	2.0	
Heavy Vehicle adjustment, fHV	0.858	
Driver population factor, fp	1.00	
Flow rate, vp	614	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Interchange density	0.50	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	1.8	mi/h
Free-flow speed	73.6	mi/h

LOS and Performance Measures

Flow rate, vp	614	pc/h/ln
Free-flow speed, FFS	73.6	mi/h
Average passenger-car speed, S	75.0	mi/h
Number of lanes, N	2	

Density, D	8.2	pc/mi/ln
Level of Service, LOS	A	

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

HCS 2010: Basic Freeway Segments Release 6.50

Phone: Fax:
E-mail:

Operational Planning Analysis

Analyst:	HDR
Agency or Company:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	PM PEAK
Freeway/Direction:	I-90
From/To:	TIMBERLINE/SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Flow Inputs and Adjustments

Annual average daily traffic, AADT	17560	veh/day
Peak-hour proportion of AADT, K	0.10	
Peak-hour direction percent, D	56	%
Volume, DDHV	983	veh/h
Peak Hour factor, PHF	0.90	
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicles PCE, ER	2.0	
Heavy Vehicle adjustment, fHV	0.858	
Driver population factor, fp	1.00	
Flow rate, vp	636	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Interchange density	0.50	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	1.8	mi/h
Free-flow speed	73.6	mi/h

LOS and Performance Measures

Flow rate, vp	636	pc/h/ln
Free-flow speed, FFS	73.6	mi/h
Average passenger-car speed, S	75.0	mi/h
Number of lanes, N	2	

Density, D	8.5	pc/mi/ln
Level of Service, LOS	A	

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

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	740	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	280	vph
Length of first accel/decel lane	610	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	270	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2930	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	740		280		270	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	206		78		75	v
Trucks and buses	11		6		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.917       0.917
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          958         339         327       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L   =             (Equation 13-12 or 13-13)
                   EQ
                  P   =    1.000   Using Equation  0
                   FD
                  v   = v  + (v - v ) P  =  958    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                958           4720            No
      Fi   F
     v  = v - v            619           4720            No
      FO   F   R
     v                     339           2100            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 958                    (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                958           4400                  No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   7.0     pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.264
                                              S
Space mean speed in ramp influence area,     S  = 59.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.7    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst: HDR
Agency/Co.: SDDOT
Date performed: 1/2014
Analysis time period: PM PEAK
Freeway/Dir of Travel: I-90/EB
Junction: I-229
Jurisdiction: MINNEHAHA CO.
Analysis Year: Existing
Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	980	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	260	vph
Length of first accel/decel lane	610	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	300	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2930	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	980		260		300	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	272		72		83	v
Trucks and buses	11		6		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.917       0.917
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           1269        315         363        pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =           (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1269   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1269          4720            No
      Fi   F
     v  = v - v            954           4720            No
      FO   F   R
     v                     315           2100            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1269                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1269          4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   9.7     pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.261
                                              S
Space mean speed in ramp influence area,     S  = 59.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.7    mph
_______________________________________________________________________________
```

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	460	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	55.0	mph
Volume on ramp	270	vph
Length of first accel/decel lane	880	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	280	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2930	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	460	270	280	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	128	75	78	v
Trucks and buses	11	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV            0.858        0.917        0.917
Driver population factor, fP             1.00         1.00         1.00
Flow rate, vp                            595          327          339       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  595    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     922           4720            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 595                    (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                922           4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.0     pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.234
                                              S
Space mean speed in ramp influence area,     S  = 60.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	720	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	55.0	mph
Volume on ramp	300	vph
Length of first accel/decel lane	880	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	260	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2930	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	720	300	260	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	200	83	72	v
Trucks and buses	11	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.917       0.917
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           932         363         315       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =           (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  932    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1295          4720            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 932                    (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1295          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   9.9     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.238
                                              S
Space mean speed in ramp influence area,     S  = 60.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.3    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	730	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	80	vph
Length of first accel/decel lane	340	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	20	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1890	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	730		80		20	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	203		22		6	v
Trucks and buses	11		1		11	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.985       0.858
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          945         90          26         pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  945    pc/h
                   12   R      F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  945           4800            No
      Fi   F
     v  = v - v              855           4800            No
      FO   F   R
     v                       90            2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34        12
If yes, v    = 945                      (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                        Actual        Max Desirable        Violation?
     v                  945           4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   9.3     pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.306
                                              S
Space mean speed in ramp influence area,     S  = 61.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1020	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	100	vph
Length of first accel/decel lane	340	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	90	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1890	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1020		100		90	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	283		28		25	v
Trucks and buses	11		4		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.943       0.917
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           1320        118         109       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L   =            (Equation 13-12 or 13-13)
                   EQ
                  P   =    1.000   Using Equation  0
                   FD
                  v   = v  + (v - v ) P  =  1320   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1320          4800            No
      Fi   F
     v  = v - v            1202          4800            No
      FO   F   R
     v                     118           2100            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1320                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1320          4400                  No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   12.5    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.309
                                              S
Space mean speed in ramp influence area,     S  = 61.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	650	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	20	vph
Length of first accel/decel lane	760	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	80	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1890	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	650	20	80	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	181	6	22	v
Trucks and buses	11	11	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.858       0.985
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           841         26          90         pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  841    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     867           4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 841                    (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                867           4600                  No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.5     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.262
                                              S
Space mean speed in ramp influence area,     S  = 62.7    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.7    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	920	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	90	vph
Length of first accel/decel lane	760	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	100	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1890	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	920	90	100	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	256	25	28	v
Trucks and buses	11	6	4	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV            0.858        0.917        0.943
Driver population factor, fP             1.00         1.00         1.00
Flow rate, vp                            1191         109          118        pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1191   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1300          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1191                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1300          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   10.8    pc/mi/ln
         R                    R           12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.267
                                              S
Space mean speed in ramp influence area,     S  = 62.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.5    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	670	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	190	vph
Length of first accel/decel lane	620	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	80	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1960	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	670		190		80	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	186		53		22	v
Trucks and buses	11		5		5	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

Heavy vehicle adjustment, fHV	0.858	0.930	0.930	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	867	227	96	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 867 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	867	4800	No
$v_{FO} = v_F - v_R$	640	4800	No
v_R	227	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 867 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	867	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 6.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	D_S = 0.318	
Space mean speed in ramp influence area,	S_R = 61.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.1	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1010	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	440	vph
Length of first accel/decel lane	620	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	130	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1960	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1010		440		130	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	281		122		36	v
Trucks and buses	11		5		5	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.930       0.930
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           1307        526         155        pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L   =            (Equation 13-12 or 13-13)
                   EQ
                  P   =    1.000   Using Equation  0
                   FD
                  v   = v  + (v - v ) P  =  1307   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  1307          4800            No
      Fi   F
     v  = v - v              781           4800            No
      FO   F   R
     v                       526           2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 1307                     (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable        Violation?
     v                1307          4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   9.9     pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.345
                                              S
Space mean speed in ramp influence area,     S  = 60.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.3    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	480	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	80	vph
Length of first accel/decel lane	670	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	190	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1960	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	480	80	190	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	133	22	53	v
Trucks and buses	11	5	5	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.930       0.930
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          621         96          227       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L   =            (Equation 13-6 or 13-7)
                   EQ
                  P   =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  621    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     717           4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 621                      (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                717           4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   6.8     pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.269
                                              S
Space mean speed in ramp influence area,     S  = 62.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.5    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	570	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	130	vph
Length of first accel/decel lane	670	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	440	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1960	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	570		130		440	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	158		36		122	v
Trucks and buses	11		5		5	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade		%		%		%
Length		mi		mi		mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.930       0.930
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          738         155         526       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  738    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     893           4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 738                    (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                893           4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   8.2     pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.270
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	820	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	60	vph
Length of first accel/decel lane	510	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	300	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1980	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	820		60		300	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	228		17		83	v
Trucks and buses	11		5		5	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.930       0.930
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           1061        72          358       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L   =            (Equation 13-12 or 13-13)
                   EQ
                  P   =    1.000   Using Equation  0
                   FD
                  v   = v  + (v - v ) P  =  1061   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  1061          4800            No
      Fi   F
     v  = v - v              989           4800            No
      FO   F   R
     v                       72            2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 1061                    (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable         Violation?
     v                1061          4400                  No
      12
_________________Level of Service Determination (if not F)______________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   8.8     pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.304
                                              S
Space mean speed in ramp influence area,     S  = 61.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.5    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	510	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	90	vph
Length of first accel/decel lane	510	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	290	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1980	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	510		90		290	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	142		25		81	v
Trucks and buses	11		5		5	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV              0.858       0.930       0.930
Driver population factor, fP               1.00        1.00        1.00
Flow rate, vp                              660         107         346       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  660    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  660           4800            No
      Fi   F
     v  = v - v              553           4800            No
      FO   F   R
     v                       107           2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 660                      (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                        Actual        Max Desirable        Violation?
     v                  660           4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,                 D = 4.252 + 0.0086 v  - 0.009  L   =   5.3     pc/mi/ln
                          R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.308
                                              S
Space mean speed in ramp influence area,     S  = 61.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	760	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	300	vph
Length of first accel/decel lane	730	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	60	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1980	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	760	300	60	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	211	83	17	v
Trucks and buses	11	5	5	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV           0.858        0.930        0.930
Driver population factor, fP            1.00         1.00         1.00
Flow rate, vp                           984          358          72         pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  984    pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     1342          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 984                    (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1342          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   11.2    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.270
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	420	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	290	vph
Length of first accel/decel lane	730	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	90	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1980	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	420	290	90	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	117	81	25	v
Trucks and buses	11	5	5	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.930       0.930
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          544         346         107       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  544    pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     890           4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 544                    (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                890           4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   7.7     pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.265
                                              S
Space mean speed in ramp influence area,     S  = 62.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.6    mph
________________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1060	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	90	vph
Length of first accel/decel lane	530	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	120	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2020	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1060		90		120	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	294		25		33	v
Trucks and buses	11		11		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV            0.858        0.858        0.971
Driver population factor, fP             1.00         1.00         1.00
Flow rate, vp                            1372         117          137        pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1372   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks__________________________________

                             Actual        Maximum         LOS F?
     v  = v                  1372          4800            No
      Fi   F
     v  = v - v              1255          4800            No
      FO   F   R
     v                       117           2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 1372                     (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area______________________
                        Actual        Max Desirable        Violation?
     v                  1372          4400                 No
      12
_________________Level of Service Determination (if not F)______________________

Density,                 D = 4.252 + 0.0086 v  - 0.009  L   =   11.3    pc/mi/ln
                          R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation___________________________________

Intermediate speed variable,                 D  = 0.309
                                              S
Space mean speed in ramp influence area,     S  = 61.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.4    mph
________________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	710	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	30	vph
Length of first accel/decel lane	530	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	120	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2020	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	710		30		120	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	197		8		33	v
Trucks and buses	11		8		4	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.893       0.943
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           919         37          141       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  919    pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  919           4800            No
      Fi   F
     v  = v - v              882           4800            No
      FO   F   R
     v                       37            2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 919                      (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                919           4400                  No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   7.4     pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.301
                                              S
Space mean speed in ramp influence area,     S  = 61.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.6    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst: HDR
Agency/Co.: SDDOT
Date performed: 1/2014
Analysis time period: AM PEAK
Freeway/Dir of Travel: I-90/WB
Junction: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Analysis Year: Existing
Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	970	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	120	vph
Length of first accel/decel lane	680	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	90	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2020	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	970	120	90	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	269	33	25	v
Trucks and buses	11	2	11	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.971       0.858
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1256        137         117       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1256   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1393          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34        12
If yes, v    = 1256                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1393          4600                  No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   12.0    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.276
                                              S
Space mean speed in ramp influence area,     S  = 62.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.3    mph
_______________________________________________________________________________
```

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	680	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	120	vph
Length of first accel/decel lane	680	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	30	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2020	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	680	120	30	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	189	33	8	v
Trucks and buses	11	4	8	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.943       0.893
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          880         141         37         pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  880    pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1021          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 880                    (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1021          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   9.1     pc/mi/ln
          R                   R          12             A
Level of service for ramp-freeway junction areas of influence  A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.271
                                              S
Space mean speed in ramp influence area,     S  = 62.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	1090	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	180	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	300	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1090	180	300	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	303	50	83	v
Trucks and buses	11	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.917       0.917
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1411        218         363       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1411   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1629          4720            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1411                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1629          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   13.4    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.289
                                              S
Space mean speed in ramp influence area,     S  = 59.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.1    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	800	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	160	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	260	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	800	160	260	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	222	44	72	v
Trucks and buses	11	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.917       0.917
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1036        194         315        pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1036   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     1230          4720            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1036                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1230          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   10.3    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.283
                                              S
Space mean speed in ramp influence area,     S  = 59.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.2    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Weaving Release 6.50

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Weaving Location:	I-229 ON TO I-229 OFF
Analysis Year:	Existing
Description:	I-90/SD 100 IMJR

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	740	ft
Freeway free-flow speed, FFS	66	mi/h
Minimum segment speed, SMIN	40	mi/h
Freeway maximum capacity, cIFL	2350	pc/h/ln
Terrain type	Rolling	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	790	180	300	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	219	50	83	0	
Trucks and buses	11	6	6	0	%
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	0.858	0.917	0.917	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	1023	218	363	0	pc/h

Volume ratio, VR 0.362

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.5	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	581	lc/h
Weaving lane changes, LCW	683	lc/h
Non-weaving vehicle index, INW	38	
Non-weaving lane change, LCNW	34	lc/h
Total lane changes, LCALL	717	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W 0.220

Average weaving speed, SW	61.3	mi/h
Average non-weaving speed, SNW	59.3	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	60.0	mi/h
Weaving segment density, D	8.9	pc/mi/ln
Level of service, LOS	A	
Weaving segment v/c ratio	0.277	
Weaving segment flow rate, v	1377	veh/h
Weaving segment capacity, cW	4965	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6261	740	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2350	1928	c
		Maximum	Analyzed	
v/c ratio		1.00	0.277	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.50

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Weaving Location:	I-229 ON TO I-229 OFF
Analysis Year:	Existing
Description:	I-90/SD 100 IMJR

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	740	ft
Freeway free-flow speed, FFS	66	mi/h
Minimum segment speed, SMIN	40	mi/h
Freeway maximum capacity, cIFL	2350	pc/h/ln
Terrain type	Rolling	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	540	160	260	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	150	44	72	0	
Trucks and buses	11	6	6	0	%
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	0.858	0.917	0.917	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	699	194	315	0	pc/h

Volume ratio, VR 0.421

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.5	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	509	lc/h
Weaving lane changes, LCW	611	lc/h
Non-weaving vehicle index, INW	26	
Non-weaving lane change, LCNW	0	lc/h
Total lane changes, LCALL	611	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W 0.194

Average weaving speed, SW	61.8	mi/h
Average non-weaving speed, SNW	60.4	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	61.0	mi/h
Weaving segment density, D	6.6	pc/mi/ln
Level of service, LOS	A	
Weaving segment v/c ratio	0.215	
Weaving segment flow rate, v	1037	veh/h
Weaving segment capacity, cW	4833	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6922	740	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2350	1877	c
		Maximum	Analyzed	
v/c ratio		1.00	0.215	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	1270	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	300	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	180	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1270		300		180	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	353		83		50	v
Trucks and buses	11		6		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.917       0.917
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1644        363         218       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1644   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1644          4720            No
      Fi   F
     v  = v - v            1281          4720            No
      FO   F   R
     v                     363           2000            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1644                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1644          4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   11.7    pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.461
                                              S
Space mean speed in ramp influence area,     S  = 54.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 54.9    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	Existing

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	960	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	260	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	160	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	960		260		160	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	267		72		44	v
Trucks and buses	11		6		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.917       0.917
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1243        315         194       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1243   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1243          4720            No
      Fi   F
     v  = v - v            928           4720            No
      FO   F   R
     v                     315           2000            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1243                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable        Violation?
     v                1243          4400                 No
      12
_________________Level of Service Determination (if not F)______________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   8.3     pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence A

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                D  = 0.456
                                             S
Space mean speed in ramp influence area,    S  = 55.0    mph
                                             R
Space mean speed in outer lanes,            S  =  N/A    mph
                                             0
Space mean speed for all vehicles,          S  = 55.0    mph
_______________________________________________________________________________
```

Appendix Part 2—2012 Crossroad Level of Service

I-90/Timberline Road Interchange

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: 60TH ST. N.
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	196	145			85	72
Peak-Hour Factor, PHF	0.68	0.68			0.83	0.83
Hourly Flow Rate, HFR	288	213			102	86
Percent Heavy Vehicles	5	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				17		13
Peak Hour Factor, PHF				0.81		0.81
Hourly Flow Rate, HFR				20		16
Percent Heavy Vehicles				4		4
Percent Grade (%)		2			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	288						36	
C(m) (vph)	1368						345	
v/c	0.21						0.10	
95% queue length	0.80						0.35	
Control Delay	8.3						16.6	
LOS	A						C	
Approach Delay							16.6	
Approach LOS							C	

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: Existing
Project ID:
East/West Street: 60TH ST. N.
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume	196	145			85	72
Peak-Hour Factor, PHF	0.68	0.68			0.83	0.83
Peak-15 Minute Volume	72	53			26	22
Hourly Flow Rate, HFR	288	213			102	86
Percent Heavy Vehicles	5	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				17		13
Peak Hour Factor, PHF				0.81		0.81
Peak-15 Minute Volume				5		4
Hourly Flow Rate, HFR				20		16
Percent Heavy Vehicles				4		4
Percent Grade (%)		2			0	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0		0
Configuration					LR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	213	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1		6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		5					4		4
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				2.00	2.00	2.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70		0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.2					6.4		6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	5					4		4
t(f)	2.2					3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	188					934		145
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		145
Potential Capacity		897
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		897
Probability of Queue free St.	1.00	0.98

Step 2: LT from Major St.	4	1
Conflicting Flows		188
Potential Capacity		1368
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1368
Probability of Queue free St.	1.00	0.79
Maj L-Shared Prob Q free St.		0.76

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.76	0.76
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		934
Potential Capacity		293
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.76	
Maj. L, Min T Adj. Imp Factor.	0.81	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.79
Movement Capacity		231

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.76	0.76
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		934
Potential Capacity		293
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.76	
Maj. L, Min T Adj. Imp Factor.	0.81	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.79
Movement Capacity		231
Results for Two-stage process:		
a		
y		
C t		231

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				20		16
Movement Capacity (vph)				231		897
Shared Lane Capacity (vph)					345	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				231		897
Volume				20		16
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					345	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	288						36	
C(m) (vph)	1368						345	
v/c	0.21						0.10	
95% queue length	0.80						0.35	
Control Delay	8.3						16.6	
LOS	A						C	
Approach Delay							16.6	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.79	1.00
v(il), Volume for stream 2 or 5	213	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.76	
d(M,LT), Delay for stream 1 or 4	8.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	2.0	

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year:
Project ID: I-90/SD 100 IMJR
East/West Street: 60TH ST. N.
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	34	118			142	12
Peak-Hour Factor, PHF	0.82	0.82			0.81	0.81
Hourly Flow Rate, HFR	41	143			175	14
Percent Heavy Vehicles	5	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				45		118
Peak Hour Factor, PHF				0.61		0.61
Hourly Flow Rate, HFR				73		193
Percent Heavy Vehicles				4		4
Percent Grade (%)		2			0	
Flared Approach: Exists?/Storage			/			No /
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	41						266	
C(m) (vph)	1367						756	
v/c	0.03						0.35	
95% queue length	0.09						1.62	
Control Delay	7.7						12.3	
LOS	A						B	
Approach Delay							12.3	
Approach LOS							B	

```
                    HCS+: Unsignalized Intersections Release 5.6




Phone:                                          Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS______________________

Analyst:              HDR
Agency/Co.:           SDDOT
Date Performed:       1/2014
Analysis Time Period: PM PEAK
Intersection:         TIMBERLINE RD.
Jurisdiction:         MINNEHAHA CO.
Units: U. S. Customary
Analysis Year:
Project ID:  I-90/SD 100 IMJR
East/West Street:     60TH ST. N.
North/South Street:   TIMBERLINE RD.
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments________________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                     34     118                  142    12
Peak-Hour Factor, PHF      0.82   0.82                 0.81   0.81
Peak-15 Minute Volume      10     36                   44     4
Hourly Flow Rate, HFR      41     143                  175    14
Percent Heavy Vehicles     5      --     --            --     --
Median Type/Storage         Undivided            /
RT Channelized?
Lanes                         0   1                    1    0
Configuration                  LT                         TR
Upstream Signal?                  No                   No
_______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                                           45            118
Peak Hour Factor, PHF                            0.61          0.61
Peak-15 Minute Volume                            18            48
Hourly Flow Rate, HFR                            73            193
Percent Heavy Vehicles                           4             4
Percent Grade (%)                 2                    0
Flared Approach:  Exists?/Storage                /                No     /
RT Channelized?
Lanes                                               0        0
Configuration                                          LR
_______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
_______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	143	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1					7.1		6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		5					4		4
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				2.00	2.00	2.00	0.00	0.00	0.00
t(3,lt)		0.00					0.70		0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.2					6.4		6.2
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	5					4		4
t(f)	2.2					3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)					
Arrival Type					
Effective Green, g (sec)					
Cycle Length, C (sec)					
Rp (from Exhibit 16-11)					
Proportion vehicles arriving on green P					
g(q1)					
g(q2)					
g(q)					

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	189					407		182
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		182
Potential Capacity		855
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		855
Probability of Queue free St.	1.00	0.77

Step 2: LT from Major St.	4	1
Conflicting Flows		189
Potential Capacity		1367
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1367
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.97

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		407
Potential Capacity		596
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.97	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.75	0.97
Movement Capacity		578

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		407
Potential Capacity		596
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.97	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.75	0.97
Movement Capacity		578

Results for Two-stage process:		
a		
y		
C t		578

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				73		193
Movement Capacity (vph)				578		855
Shared Lane Capacity (vph)					756	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				578		855
Volume				73		193
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					756	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	41						266	
C(m) (vph)	1367						756	
v/c	0.03						0.35	
95% queue length	0.09						1.62	
Control Delay	7.7						12.3	
LOS	A						B	
Approach Delay							12.3	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	143	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.97	
d(M,LT), Delay for stream 1 or 4	7.7	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

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TWO-WAY STOP CONTROL SUMMARY

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 EB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume		143	19	1	143	
Peak-Hour Factor, PHF		0.90	0.90	0.89	0.89	
Hourly Flow Rate, HFR		158	21	1	160	
Percent Heavy Vehicles		--	--	5	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume				67		14
Peak Hour Factor, PHF				0.88		0.88
Hourly Flow Rate, HFR				76		15
Percent Heavy Vehicles				1		1
Percent Grade (%)		2			2	
Flared Approach: Exists?/Storage			/			No /
Lanes				0		0
Configuration					LR	

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT					LR	
v (vph)		1					91	
C(m) (vph)		1379					673	
v/c		0.00					0.14	
95% queue length		0.00					0.47	
Control Delay		7.6					11.2	
LOS		A					B	
Approach Delay							11.2	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 EB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		143	19	1	143	
Peak-Hour Factor, PHF		0.90	0.90	0.89	0.89	
Peak-15 Minute Volume		40	5	0	40	
Hourly Flow Rate, HFR		158	21	1	160	
Percent Heavy Vehicles		--	--	5	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				67		14
Peak Hour Factor, PHF				0.88		0.88
Peak-15 Minute Volume				19		4
Hourly Flow Rate, HFR				76		15
Percent Heavy Vehicles				1		1
Percent Grade (%)		2			2	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0		0
Configuration					LR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		160
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1				7.1		6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			5				1		1
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				2.00	2.00	2.00	2.00	2.00	2.00
t(3,lt)			0.00				0.70		0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.2				6.8		6.4
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		5				1		1
t(f)		2.2				3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x		179				330		160
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		160
Potential Capacity		880
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		880
Probability of Queue free St.	1.00	0.98

Step 2: LT from Major St.	4	1
Conflicting Flows	179	
Potential Capacity	1379	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1379	
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.	1.00	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		330
Potential Capacity		643
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	0.98	1.00
Movement Capacity		643

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		330
Potential Capacity		643
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	0.98	1.00
Movement Capacity		643
Results for Two-stage process:		
a		
y		
C t		643

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				76		15
Movement Capacity (vph)				643		880
Shared Lane Capacity (vph)					673	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				643		880
Volume				76		15
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					673	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT					LR	
v (vph)		1					91	
C(m) (vph)		1379					673	
v/c		0.00					0.14	
95% queue length		0.00					0.47	
Control Delay		7.6					11.2	
LOS		A					B	
Approach Delay							11.2	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5		160
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		1.00
d(M,LT), Delay for stream 1 or 4		7.6
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.0

```
                 HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              HDR
Agency/Co.:           SDDOT
Date Performed:       1/2014
Analysis Time Period: PM PEAK
Intersection:         TIMBERLINE RD.
Jurisdiction:         MINNEHAHA CO.
Units: U. S. Customary
Analysis Year:        Existing
Project ID:  I-90/Timberline IMJR
East/West Street:     I-90 EB
North/South Street:   TIMBERLINE RD.
Intersection Orientation: NS                 Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments__________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
_______________________________________________________________________________
Volume                             92     71       19     107
Peak-Hour Factor, PHF              0.77   0.77     0.83   0.83
Hourly Flow Rate, HFR              119    92       22     128
Percent Heavy Vehicles             --     --       5      --     --
Median Type/Storage         Undivided            /
RT Channelized?
Lanes                              1    0             0   1
Configuration                          TR              LT
Upstream Signal?                   No                     No
_______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
_______________________________________________________________________________
Volume                                             56            47
Peak Hour Factor, PHF                              0.76          0.76
Hourly Flow Rate, HFR                              73            61
Percent Heavy Vehicles                             4             4
Percent Grade (%)                  2                      2
Flared Approach:  Exists?/Storage               /              No     /
Lanes                                                 0        0
Configuration                                             LR
_______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service____________________
Approach            NB     SB         Westbound             Eastbound
Movement            1      4   |  7      8      9    |  10     11     12
Lane Config                LT  |                     |         LR
_______________________________________________________________________________
v (vph)                    22                                  134
C(m) (vph)                 1342                                725
v/c                        0.02                                0.18
95% queue length           0.05                                0.68
Control Delay              7.7                                 11.1
LOS                         A                                   B
Approach Delay                                                 11.1
Approach LOS                                                    B
_______________________________________________________________________________
```

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 EB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		92	71	19	107	
Peak-Hour Factor, PHF		0.77	0.77	0.83	0.83	
Peak-15 Minute Volume		30	23	6	32	
Hourly Flow Rate, HFR		119	92	22	128	
Percent Heavy Vehicles		--	--	5	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume				56		47
Peak Hour Factor, PHF				0.76		0.76
Peak-15 Minute Volume				18		15
Hourly Flow Rate, HFR				73		61
Percent Heavy Vehicles				4		4
Percent Grade (%)		2			2	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0		0
Configuration					LR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		128
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1				7.1		6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			5				4		4
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				2.00	2.00	2.00	2.00	2.00	2.00
t(3,lt)			0.00				0.70		0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.2				6.8		6.4
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		5				4		4
t(f)		2.2				3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		211				337		128
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		128
Potential Capacity		910
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		910
Probability of Queue free St.	1.00	0.93

Step 2: LT from Major St.	4	1
Conflicting Flows	211	
Potential Capacity	1342	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1342	
Probability of Queue free St.	0.98	1.00
Maj L-Shared Prob Q free St.	0.98	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		337
Potential Capacity		630
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.98	
Maj. L, Min T Adj. Imp Factor.	0.99	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.98
Movement Capacity		620

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		337
Potential Capacity		630
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.98	
Maj. L, Min T Adj. Imp Factor.	0.99	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.98
Movement Capacity		620
Results for Two-stage process:		
a		
y		
C t		620

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				73		61
Movement Capacity (vph)				620		910
Shared Lane Capacity (vph)					725	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				620		910
Volume				73		61
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					725	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT					LR	
v (vph)		22					134	
C(m) (vph)		1342					725	
v/c		0.02					0.18	
95% queue length		0.05					0.68	
Control Delay		7.7					11.1	
LOS		A					B	
Approach Delay							11.1	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.98
v(il), Volume for stream 2 or 5		128
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.98
d(M,LT), Delay for stream 1 or 4		7.7
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

```
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_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              HDR
Agency/Co.:           SDDOT
Date Performed:       1/2014
Analysis Time Period: AM PEAK
Intersection:         TIMBERLINE RD.
Jurisdiction:         MINNEHAHA CO.
Units: U. S. Customary
Analysis Year:        Existing
Project ID:  I-90/Timberline IMJR
East/West Street:     I-90 WB
North/South Street:   TIMBERLINE RD.
Intersection Orientation: NS                 Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach        Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      75     135                    63     42
Peak-Hour Factor, PHF       0.88   0.88                   0.71   0.71
Hourly Flow Rate, HFR       85     153                    88     59
Percent Heavy Vehicles      5      --     --              --     --
Median Type/Storage         Undivided            /
RT Channelized?
Lanes                          0   1                      1    0
Configuration                   LT                             TR
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach        Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      81            7
Peak Hour Factor, PHF       0.71          0.71
Hourly Flow Rate, HFR       114           9
Percent Heavy Vehicles      11            11
Percent Grade (%)                  2                      0
Flared Approach:  Exists?/Storage         Yes    /50                   /
Lanes                          0        0
Configuration                      LR
______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach           NB     SB         Westbound            Eastbound
Movement           1      4    |  7      8      9    |  10     11     12
Lane Config        LT          |         LR          |
______________________________________________________________________________
v (vph)            85                    123
C(m) (vph)         1417                  538
v/c                0.06                  0.23
95% queue length   0.19                  0.89
Control Delay      7.7                   14.0
LOS                 A                     B
Approach Delay                           14.0
Approach LOS                              B
______________________________________________________________________________
```

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 WB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	75	135			63	42
Peak-Hour Factor, PHF	0.88	0.88			0.71	0.71
Peak-15 Minute Volume	21	38			22	15
Hourly Flow Rate, HFR	85	153			88	59
Percent Heavy Vehicles	5	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	81		7			
Peak Hour Factor, PHF	0.71		0.71			
Peak-15 Minute Volume	29		2			
Hourly Flow Rate, HFR	114		9			
Percent Heavy Vehicles	11		11			
Percent Grade (%)		2			0	
Flared Approach: Exists?/Storage			Yes	/50		/
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	153	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1		7.1		6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		5		11		11			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				2.00	2.00	2.00	0.00	0.00	0.00
t(3,lt)		0.00		0.70		0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.2		6.9		6.5			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	5		11		11			
t(f)	2.2		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	147		441		153			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	153	
Potential Capacity	863	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	863	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		147
Potential Capacity		1417
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1417
Probability of Queue free St.	1.00	0.94
Maj L-Shared Prob Q free St.		0.93

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	441	
Potential Capacity	531	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.93
Maj. L, Min T Adj. Imp Factor.		0.95
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	499	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	441	
Potential Capacity	531	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.93
Maj. L, Min T Adj. Imp Factor.		0.95
Cap. Adj. factor due to Impeding mvmnt	0.94	0.94
Movement Capacity	499	
Results for Two-stage process:		
a		
y		
C t	499	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	114		9			
Movement Capacity (vph)	499		863			
Shared Lane Capacity (vph)		515				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	499		863			
Volume	114		9			
Delay	14.3		9.2			
Q sep	0.45		0.02			
Q sep +1	1.45		1.02			
round (Qsep +1)	1		1			
n max		1				
C sh		515				
SUM C sep		538				
n		50				
C act		538				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	85			123				
C(m) (vph)	1417			538				
v/c	0.06			0.23				
95% queue length	0.19			0.89				
Control Delay	7.7			14.0				
LOS	A			B				
Approach Delay				14.0				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.94	1.00
v(il), Volume for stream 2 or 5	153	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.93	
d(M,LT), Delay for stream 1 or 4	7.7	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.5	

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TWO-WAY STOP CONTROL SUMMARY

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year:
Project ID: I-90/Timberline IMJR
East/West Street: I-90 WB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS   Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	24	124			103	85
Peak-Hour Factor, PHF	0.88	0.88			0.77	0.77
Hourly Flow Rate, HFR	27	140			133	110
Percent Heavy Vehicles	5	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	23		5			
Peak Hour Factor, PHF	0.78		0.78			
Hourly Flow Rate, HFR	29		6			
Percent Heavy Vehicles	8		8			
Percent Grade (%)		2			0	
Flared Approach: Exists?/Storage			Yes	/50		/
Lanes	0		0			
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	27			35				
C(m) (vph)	1306			690				
v/c	0.02			0.05				
95% queue length	0.06			0.16				
Control Delay	7.8			11.2				
LOS	A			B				
Approach Delay				11.2				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.6

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Phone:                                          Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS______________________

Analyst:              HDR
Agency/Co.:           SDDOT
Date Performed:       1/2014
Analysis Time Period: PM PEAK
Intersection:         TIMBERLINE RD.
Jurisdiction:         MINNEHAHA CO.
Units: U. S. Customary
Analysis Year:
Project ID:  I-90/Timberline IMJR
East/West Street:     I-90 WB
North/South Street:   TIMBERLINE RD.
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments________________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                     24     124                   103    85
Peak-Hour Factor, PHF      0.88   0.88                  0.77   0.77
Peak-15 Minute Volume      7      35                    33     28
Hourly Flow Rate, HFR      27     140                   133    110
Percent Heavy Vehicles     5      --     --             --     --
Median Type/Storage         Undivided            /
RT Channelized?
Lanes                        0   1                      1    0
Configuration                 LT                            TR
Upstream Signal?                 No                     No
_______________________________________________________________________________
Minor Street Movements      7      8      9     10     11     12
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                     23            5
Peak Hour Factor, PHF      0.78          0.78
Peak-15 Minute Volume      7             2
Hourly Flow Rate, HFR      29            6
Percent Heavy Vehicles     8             8
Percent Grade (%)                2                      0
Flared Approach:  Exists?/Storage        Yes    /50                  /
RT Channelized?
Lanes                        0        0
Configuration                    LR
_______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments_______________________
Movements                    13     14     15     16
_______________________________________________________________________________
Flow (ped/hr)                0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	140	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	5		8		8			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			2.00	2.00	2.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.2		6.9		6.5			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	5		8		8			
t(f)	2.2		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	243		382		140			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	140	
Potential Capacity	885	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	885	
Probability of Queue free St.	0.99	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		243
Potential Capacity		1306
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1306
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.98

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	382	
Potential Capacity	584	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	572	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	382	
Potential Capacity	584	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	572	

Results for Two-stage process:		
a		
y		
C t	572	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	29		6			
Movement Capacity (vph)	572		885			
Shared Lane Capacity (vph)		609				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	572		885			
Volume	29		6			
Delay	11.6		9.1			
Q sep	0.09		0.02			
Q sep +1	1.09		1.02			
round (Qsep +1)	1		1			
n max		1				
C sh		609				
SUM C sep		690				
n		50				
C act		690				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	27			35				
C(m) (vph)	1306			690				
v/c	0.02			0.05				
95% queue length	0.06			0.16				
Control Delay	7.8			11.2				
LOS	A			B				
Approach Delay				11.2				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5	140	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.98	
d(M,LT), Delay for stream 1 or 4	7.8	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.2	

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	HDR
Agency/Co.	SDDOT
Date Performed	1/2014
Analysis Time Period	AM PEAK
Highway	TIMBERLINE ROAD
From/To	NORTH OF I-90 TO SOUTH OF 60TH
Jurisdiction	MINNEHAHA CO.
Analysis Year	Existing

Description I-90/Timberline IMJR

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.88	
Shoulder width	6.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	60	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	210	veh/h
Opposing direction volume, Vo	144	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.2		2.4	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.933		0.923	
Grade adj. factor,(note-1) fg	0.78		0.72	
Directional flow rate,(note-2) vi	328	pc/h	246	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	45.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	41.8	mi/h
Adjustment for no-passing zones, fnp	2.8	mi/h
Average travel speed, ATSd	34.4	mi/h
Percent Free Flow Speed, PFFS	82.5	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.7		1.8	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.960		0.954	
Grade adjustment factor,(note-1) fg	0.82		0.77	
Directional flow rate,(note-2) vi	303	pc/h	223	pc/h

Base percent time-spent-following,(note-4) BPTSFd	31.4	%
Adjustment for no-passing zones, fnp	52.2	
Percent time-spent-following, PTSFd	61.5	%

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.19	
Peak 15-min vehicle-miles of travel, VMT15	89	veh-mi
Peak-hour vehicle-miles of travel, VMT60	315	veh-mi
Peak 15-min total travel time, TT15	2.6	veh-h
Capacity from ATS, CdATS	1215	veh/h
Capacity from PTSF, CdPTSF	1321	veh/h
Directional Capacity	1215	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	1.5	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	34.4	mi/h
Percent time-spent-following, PTSFd (from above)	61.5	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	
Percent free flow speed including passing lane, PFFSpl	0.0	%

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	E	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	40
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	238.6
Effective width of outside lane, We	24.00
Effective speed factor, St	4.17
Bicycle LOS Score, BLOS	2.93
Bicycle LOS	C

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	HDR
Agency/Co.	SDDOT
Date Performed	1/2014
Analysis Time Period	AM PEAK
Highway	TIMBERLINE ROAD
From/To	NORTH OF I-90 TO SOUTH OF 60TH
Jurisdiction	MINNEHAHA CO.
Analysis Year	Existing
Description	I-90/Timberline IMJR

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.88	
Shoulder width	6.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	60	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	144	veh/h
Opposing direction volume, Vo	210	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.4		2.2	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.923		0.933	
Grade adj. factor,(note-1) fg	0.72		0.78	
Directional flow rate,(note-2) vi	246	pc/h	328	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	45.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	41.8	mi/h
Adjustment for no-passing zones, fnp	2.4	mi/h
Average travel speed, ATSd	34.9	mi/h
Percent Free Flow Speed, PFFS	83.6	%

```
_________________________Percent Time-Spent-Following__________________________

Direction                                      Analysis(d)        Opposing (o)
PCE for trucks, ET                                 1.8                1.7
PCE for RVs, ER                                    1.0                1.0
Heavy-vehicle adjustment factor, fHV               0.954              0.960
Grade adjustment factor,(note-1) fg                0.77               0.82
Directional flow rate,(note-2) vi                  223    pc/h        303     pc/h
Base percent time-spent-following,(note-4) BPTSFd  26.0   %
Adjustment for no-passing zones, fnp                        52.2
Percent time-spent-following, PTSFd                         48.1   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                                       B
Volume to capacity ratio, v/c                               0.15
Peak 15-min vehicle-miles of travel, VMT15                  61      veh-mi
Peak-hour vehicle-miles of travel, VMT60                    216     veh-mi
Peak 15-min total travel time, TT15                         1.7     veh-h
Capacity from ATS, CdATS                                    1324    veh/h
Capacity from PTSF, CdPTSF                                  1395    veh/h
Directional Capacity                                        1324    veh/h

_____________________________Passing Lane Analysis______________________________

Total length of analysis segment, Lt                                  1.5     mi
Length of two-lane highway upstream of the passing lane, Lu           -       mi
Length of passing lane including tapers, Lpl                          -       mi
Average travel speed, ATSd (from above)                               34.9    mi/h
Percent time-spent-following, PTSFd (from above)                      48.1
Level of service, LOSd (from above)                                   B

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde              -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld           -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                             -
Average travel speed including passing lane, ATSpl                    -
Percent free flow speed including passing lane, PFFSpl                0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde             -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld             -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                              -
Percent time-spent-following
    including passing lane, PTSFpl                                    -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl              E
Peak 15-min total travel time, TT15                         -       veh-h

__________________________ Bicycle Level of Service ___________________________
```

Posted speed limit, Sp	40
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	163.6
Effective width of outside lane, We	29.04
Effective speed factor, St	4.17
Bicycle LOS Score, BLOS	1.40
Bicycle LOS	A

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	HDR
Agency/Co.	SDDOT
Date Performed	1/2014
Analysis Time Period	PM PEAK
Highway	TIMBERLINE ROAD
From/To	NORTH OF I-90 TO SOUTH OF 60TH
Jurisdiction	MINNEHAHA CO.
Analysis Year	Existing

Description I-90/Timberline IMJR

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.88	
Shoulder width	6.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	60	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	148	veh/h
Opposing direction volume, Vo	126	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.4		2.5	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.923		0.917	
Grade adj. factor,(note-1) fg	0.72		0.70	
Directional flow rate,(note-2) vi	253	pc/h	223	pc/h

Free-Flow Speed from Field Measurement:

Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h

Estimated Free-Flow Speed:

Base free-flow speed,(note-3) BFFS	45.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	41.8	mi/h
Adjustment for no-passing zones, fnp	3.0	mi/h
Average travel speed, ATSd	35.1	mi/h
Percent Free Flow Speed, PFFS	84.0	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.8		1.8	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.954		0.954	
Grade adjustment factor,(note-1) fg	0.78		0.76	
Directional flow rate,(note-2) vi	226	pc/h	197	pc/h
Base percent time-spent-following,(note-4) BPTSFd	23.9	%		
Adjustment for no-passing zones, fnp	57.6			
Percent time-spent-following, PTSFd	54.7	%		

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.15	
Peak 15-min vehicle-miles of travel, VMT15	63	veh-mi
Peak-hour vehicle-miles of travel, VMT60	222	veh-mi
Peak 15-min total travel time, TT15	1.8	veh-h
Capacity from ATS, CdATS	1183	veh/h
Capacity from PTSF, CdPTSF	1298	veh/h
Directional Capacity	1183	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	1.5	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	35.1	mi/h
Percent time-spent-following, PTSFd (from above)	54.7	
Level of service, LOSd (from above)	B	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	
Percent free flow speed including passing lane, PFFSpl	0.0	%

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	E	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	40
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	168.2
Effective width of outside lane, We	28.68
Effective speed factor, St	4.17
Bicycle LOS Score, BLOS	1.52
Bicycle LOS	B

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

HCS 2010: Two-Lane Highways Release 6.50

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	HDR
Agency/Co.	SDDOT
Date Performed	1/2014
Analysis Time Period	PM PEAK
Highway	TIMBERLINE ROAD
From/To	NORTH OF I-90 TO SOUTH OF 60TH
Jurisdiction	MINNEHAHA CO.
Analysis Year	Existing
Description	I-90/Timberline IMJR

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.88	
Shoulder width	6.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	60	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	126	veh/h
Opposing direction volume, Vo	148	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5		2.4	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.917		0.923	
Grade adj. factor,(note-1) fg	0.70		0.72	
Directional flow rate,(note-2) vi	223	pc/h	253	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	45.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	41.8	mi/h
Adjustment for no-passing zones, fnp	2.8	mi/h
Average travel speed, ATSd	35.2	mi/h
Percent Free Flow Speed, PFFS	84.4	%

```
_________________________Percent Time-Spent-Following__________________________

Direction                                     Analysis(d)         Opposing (o)
PCE for trucks, ET                                1.8                 1.8
PCE for RVs, ER                                   1.0                 1.0
Heavy-vehicle adjustment factor, fHV              0.954               0.954
Grade adjustment factor,(note-1) fg               0.76                0.78
Directional flow rate,(note-2) vi                 197    pc/h         226     pc/h
Base percent time-spent-following,(note-4) BPTSFd  21.9   %
Adjustment for no-passing zones, fnp                       57.6
Percent time-spent-following, PTSFd                        48.7   %

________________Level of Service and Other Performance Measures________________

Level of service, LOS                                      B
Volume to capacity ratio, v/c                              0.13
Peak 15-min vehicle-miles of travel, VMT15                 54      veh-mi
Peak-hour vehicle-miles of travel, VMT60                   189     veh-mi
Peak 15-min total travel time, TT15                        1.5     veh-h
Capacity from ATS, CdATS                                   1221    veh/h
Capacity from PTSF, CdPTSF                                 1321    veh/h
Directional Capacity                                       1221    veh/h

_____________________________Passing Lane Analysis______________________________

Total length of analysis segment, Lt                                 1.5     mi
Length of two-lane highway upstream of the passing lane, Lu          -       mi
Length of passing lane including tapers, Lpl                         -       mi
Average travel speed, ATSd (from above)                              35.2    mi/h
Percent time-spent-following, PTSFd (from above)                     48.7
Level of service, LOSd (from above)                                  B

___________________Average Travel Speed  with Passing Lane_____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde             -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld          -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                            -
Average travel speed including passing lane, ATSpl                   -
Percent free flow speed including passing lane, PFFSpl               0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde            -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld            -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                             -
Percent time-spent-following
    including passing lane, PTSFpl                                   -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl             E
Peak 15-min total travel time, TT15                        -       veh-h

__________________________ Bicycle Level of Service __________________________
```

Posted speed limit, Sp	40
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	143.2
Effective width of outside lane, We	30.66
Effective speed factor, St	4.17
Bicycle LOS Score, BLOS	0.85
Bicycle LOS	A

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Appendix Part 3—2035 Interstate Level of Service

I-90/Timberline Road Interchange

HCS 2010: Basic Freeway Segments Release 6.50

Phone: Fax:
E-mail:

Operational Planning Analysis

Analyst:	HDR
Agency or Company:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	AM PEAK
Freeway/Direction:	I-90
From/To:	I-229/TIMBERLINE
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Flow Inputs and Adjustments

Annual average daily traffic, AADT	48900	veh/day
Peak-hour proportion of AADT, K	0.09	
Peak-hour direction percent, D	55	%
Volume, DDHV	2421	veh/h
Peak Hour factor, PHF	0.90	
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicles PCE, ER	2.0	
Heavy Vehicle adjustment, fHV	0.858	
Driver population factor, fp	1.00	
Flow rate, vp	1567	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Interchange density	1.20	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.8	mi/h
Free-flow speed	71.6	mi/h

LOS and Performance Measures

Flow rate, vp	1567	pc/h/ln
Free-flow speed, FFS	71.6	mi/h
Average passenger-car speed, S	68.4	mi/h
Number of lanes, N	2	

Density, D	22.9	pc/mi/ln
Level of Service, LOS	C	

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

HCS 2010: Basic Freeway Segments Release 6.50

Phone: Fax:
E-mail:

Operational Planning Analysis

Analyst:	HDR
Agency or Company:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	PM PEAK
Freeway/Direction:	I-90
From/To:	I-229/TIMBERLINE
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Flow Inputs and Adjustments

Annual average daily traffic, AADT	48900	veh/day
Peak-hour proportion of AADT, K	0.09	
Peak-hour direction percent, D	55	%
Volume, DDHV	2421	veh/h
Peak Hour factor, PHF	0.90	
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicles PCE, ER	2.0	
Heavy Vehicle adjustment, fHV	0.858	
Driver population factor, fp	1.00	
Flow rate, vp	1567	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Interchange density	1.20	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	3.8	mi/h
Free-flow speed	71.6	mi/h

LOS and Performance Measures

Flow rate, vp	1567	pc/h/ln
Free-flow speed, FFS	71.6	mi/h
Average passenger-car speed, S	68.4	mi/h
Number of lanes, N	2	

Density, D	22.9	pc/mi/ln
Level of Service, LOS	C	

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

HCS 2010: Basic Freeway Segments Release 6.50

Phone: Fax:
E-mail:

Operational Planning Analysis

Analyst:	HDR
Agency or Company:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	AM PEAK
Freeway/Direction:	I-90
From/To:	TIMBERLINE/SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Flow Inputs and Adjustments

Annual average daily traffic, AADT	40700	veh/day
Peak-hour proportion of AADT, K	0.09	
Peak-hour direction percent, D	57	%
Volume, DDHV	2088	veh/h
Peak Hour factor, PHF	0.90	
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicles PCE, ER	2.0	
Heavy Vehicle adjustment, fHV	0.858	
Driver population factor, fp	1.00	
Flow rate, vp	1351	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Interchange density	0.50	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	1.8	mi/h
Free-flow speed	73.6	mi/h

LOS and Performance Measures

Flow rate, vp	1351	pc/h/ln
Free-flow speed, FFS	73.6	mi/h
Average passenger-car speed, S	73.6	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.

HCS 2010: Basic Freeway Segments Release 6.50

Phone: Fax:
E-mail:

Operational Planning Analysis

Analyst: HDR
Agency or Company: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK
Freeway/Direction: I-90
From/To: TIMBERLINE/SD 11
Jurisdiction: MINNEHAHA CO.
Analysis Year: 2035
Description: I-90/SD 100 IMJR

Flow Inputs and Adjustments

Annual average daily traffic, AADT	40700	veh/day
Peak-hour proportion of AADT, K	0.09	
Peak-hour direction percent, D	56	%
Volume, DDHV	2051	veh/h
Peak Hour factor, PHF	0.90	
Trucks and buses	11	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicles PCE, ER	2.0	
Heavy Vehicle adjustment, fHV	0.858	
Driver population factor, fp	1.00	
Flow rate, vp	1327	pc/h/ln

Speed Inputs and Adjustments

Lane width	12.0	ft
Right-side lateral clearance	6.0	ft
Interchange density	0.50	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	0.0	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
Interchange density adjustment, fID	1.8	mi/h
Free-flow speed	73.6	mi/h

LOS and Performance Measures

Flow rate, vp	1327	pc/h/ln
Free-flow speed, FFS	73.6	mi/h
Average passenger-car speed, S	73.8	mi/h
Number of lanes, N	2	

Density, D	18.0-	pc/mi/ln
Level of Service, LOS	B	

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

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	2070	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	560	vph
Length of first accel/decel lane	610	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	490	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2930	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2070		560		490	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	575		156		136	v
Trucks and buses	11		6		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV              0.858        0.917        0.917
Driver population factor, fP               1.00         1.00         1.00
Flow rate, vp                              2680         678          593        pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2680   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2680          4720            No
      Fi   F
     v  = v - v            2002          4720            No
      FO   F   R
     v                     678           2100            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 2680                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                2680          4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   21.8    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.294
                                              S
Space mean speed in ramp influence area,     S  = 58.9    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.9    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	2380	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	520	vph
Length of first accel/decel lane	610	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	540	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2930	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2380		520		540	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	661		144		150	v
Trucks and buses	11		6		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.917       0.917
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           3081        630         654       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L   =            (Equation 13-12 or 13-13)
                   EQ
                  P   =    1.000   Using Equation  0
                   FD
                  v   = v  + (v - v ) P  =  3081   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  3081          4720            No
      Fi   F
     v  = v - v              2451          4720            No
      FO   F   R
     v                       630           2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 3081                     (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                3081          4400                  No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   25.3    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.290
                                              S
Space mean speed in ramp influence area,     S  = 59.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.0    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	1510	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	55.0	mph
Volume on ramp	490	vph
Length of first accel/decel lane	880	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	560	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2930	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1510	490	560	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	419	136	156	v
Trucks and buses	11	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.917       0.917
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           1955        593         678        pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1955   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     2548          4720            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1955                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area______________________
                      Actual        Max Desirable        Violation?
     v                2548          4600                 No
      R12
_________________Level of Service Determination (if not F)______________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   19.6    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.274
                                              S
Space mean speed in ramp influence area,     S  = 59.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	1860	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	55.0	mph
Volume on ramp	540	vph
Length of first accel/decel lane	880	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	520	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2930	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1860	540	520	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	517	150	144	v
Trucks and buses	11	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.917       0.917
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           2408        654         630       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2408   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3062          4720            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 2408                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                3062          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   23.5    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.308
                                              S
Space mean speed in ramp influence area,     S  = 58.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 58.6    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2000	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	850	vph
Length of first accel/decel lane	340	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	350	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1890	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2000		850		350	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	556		236		97	v
Trucks and buses	11		1		11	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.985       0.858
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           2589        959         453       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2589   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2589          4800            No
      Fi   F
     v  = v - v            1630          4800            No
      FO   F   R
     v                     959           2100            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 2589                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable        Violation?
     v                2589          4400                 No
      12
_________________Level of Service Determination (if not F)______________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   23.5    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.384
                                              S
Space mean speed in ramp influence area,     S  = 59.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.2    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2400	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	760	vph
Length of first accel/decel lane	340	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	430	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1890	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2400		760		430	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	667		211		119	v
Trucks and buses	11		4		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV         0.858       0.943       0.917
Driver population factor, fP          1.00        1.00        1.00
Flow rate, vp                         3107        895         521       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  3107   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  3107          4800            No
      Fi   F
     v  = v - v              2212          4800            No
      FO   F   R
     v                       895           2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 3107                     (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable         Violation?
     v                3107          4400                  No
      12
_________________Level of Service Determination (if not F)______________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   27.9    pc/mi/ln
                        R                   12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.379
                                              S
Space mean speed in ramp influence area,     S  = 59.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1150	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	350	vph
Length of first accel/decel lane	760	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	850	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1890	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1150	350	850	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	319	97	236	v
Trucks and buses	11	11	1	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.858       0.985
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1489        453         959       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1489   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1942          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1489                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1942          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.6    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.280
                                              S
Space mean speed in ramp influence area,     S  = 62.2    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.2    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1640	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	430	vph
Length of first accel/decel lane	760	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	760	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1890	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1640	430	760	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	456	119	211	v
Trucks and buses	11	6	4	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.917       0.943
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                           2123        521         895       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2123   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     2644          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 2123                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                2644          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   21.1    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.307
                                              S
Space mean speed in ramp influence area,     S  = 61.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1500	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	360	vph
Length of first accel/decel lane	620	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	150	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1960	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1500		360		150	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	417		100		42	v
Trucks and buses	11		5		5	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.930       0.930
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1942        430         179       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1942   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                1942          4800            No
      Fi   F
     v  = v - v            1512          4800            No
      FO   F   R
     v                     430           2100            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1942                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1942          4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   15.4    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.337
                                              S
Space mean speed in ramp influence area,     S  = 60.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.6    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2070	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	840	vph
Length of first accel/decel lane	620	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	250	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1960	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2070		840		250	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	575		233		69	v
Trucks and buses	11		5		5	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.930       0.930
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          2680        1003        299       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L   =            (Equation 13-12 or 13-13)
                   EQ
                  P   =    1.000   Using Equation  0
                   FD
                  v   = v  + (v - v ) P  =  2680   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2680          4800            No
      Fi   F
     v  = v - v            1677          4800            No
      FO   F   R
     v                     1003          2100            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 2680                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable         Violation?
     v                2680          4400                  No
      12
_________________Level of Service Determination (if not F)______________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   21.7    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.388
                                              S
Space mean speed in ramp influence area,     S  = 59.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 59.1    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1140	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	150	vph
Length of first accel/decel lane	670	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	360	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1960	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1140	150	360	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	317	42	100	v
Trucks and buses	11	5	5	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.930       0.930
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1476        179         430       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1476   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1655          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1476                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1655          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   14.1    pc/mi/ln
         R                    R           12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.281
                                              S
Space mean speed in ramp influence area,     S  = 62.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.1    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/EB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1230	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	250	vph
Length of first accel/decel lane	670	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	840	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1960	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1230	250	840	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	342	69	233	v
Trucks and buses	11	5	5	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.930       0.930
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1592        299         1003      pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1592   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     1891          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1592                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                1891          4600                  No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   15.9    pc/mi/ln
          R                   R           12            A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.287
                                              S
Space mean speed in ramp influence area,     S  = 62.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.0    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1720	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	110	vph
Length of first accel/decel lane	510	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	570	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1980	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1720		110		570	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	478		31		158	v
Trucks and buses	11		5		5	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV            0.858       0.930       0.930
Driver population factor, fP             1.00        1.00        1.00
Flow rate, vp                            2226        131         681       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2226   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  2226          4800            No
      Fi   F
     v  = v - v              2095          4800            No
      FO   F   R
     v                       131           2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 2226                     (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable        Violation?
     v                2226          4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   18.8    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.310
                                              S
Space mean speed in ramp influence area,     S  = 61.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.3    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst: HDR
Agency/Co.: SDDOT
Date performed: 1/2014
Analysis time period: PM PEAK
Freeway/Dir of Travel: I-90/WB
Junction: SD 11
Jurisdiction: MINNEHAHA CO.
Analysis Year: 2035
Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1210	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	170	vph
Length of first accel/decel lane	510	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	550	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	1980	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1210		170		550	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	336		47		153	v
Trucks and buses	11		5		5	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.930       0.930
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1566        203         657       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  1566   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  1566          4800            No
      Fi   F
     v  = v - v              1363          4800            No
      FO   F   R
     v                       203           2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 1566                     (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                1566          4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   13.1    pc/mi/ln
                        R                  12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.316
                                              S
Space mean speed in ramp influence area,     S  = 61.1    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.1    mph
_______________________________________________________________________________
```

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1610	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	570	vph
Length of first accel/decel lane	730	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	110	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1980	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1610	570	110	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	447	158	31	v
Trucks and buses	11	5	5	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.858	0.930	0.930	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2084	681	131	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2084 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2765	4800	No

v_3 or v_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 2084 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2765	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 22.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.317	
Space mean speed in ramp influence area,	S_R = 61.1	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.1	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	SD 11
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1040	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	550	vph
Length of first accel/decel lane	730	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	170	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	1980	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1040	550	170	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	289	153	47	v
Trucks and buses	11	5	5	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.930       0.930
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           1346        657         203       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1346   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     2003          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1346                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                2003          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   16.2    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.284
                                              S
Space mean speed in ramp influence area,     S  = 62.0    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 62.0    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2180	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	420	vph
Length of first accel/decel lane	530	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	640	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2020	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2180		420		640	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	606		117		178	v
Trucks and buses	11		11		2	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.858       0.971
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          2822        544         732       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =           (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2822   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v  = v                2822          4800            No
      Fi   F
     v  = v - v            2278          4800            No
      FO   F   R
     v                     544           2100            No
      R
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 2822                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                2822          4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   23.8    pc/mi/ln
                        R                 12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.347
                                              S
Space mean speed in ramp influence area,     S  = 60.3    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.3    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1590	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	45.0	mph
Volume on ramp	370	vph
Length of first accel/decel lane	530	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	780	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2020	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	1590		370		780	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	442		103		217	v
Trucks and buses	11		8		4	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.893       0.943
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           2058        460         919       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2058   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  2058          4800            No
      Fi   F
     v  = v - v              1598          4800            No
      FO   F   R
     v                       460           2100            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 2058                     (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                2058          4400                 No
      12
_________________Level of Service Determination (if not F)_____________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   17.2    pc/mi/ln
                        R                   12          D
Level of service for ramp-freeway junction areas of influence B

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 D  = 0.339
                                              S
Space mean speed in ramp influence area,     S  = 60.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.5    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1760	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	640	vph
Length of first accel/decel lane	680	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	420	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2020	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1760	640	420	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	489	178	117	v
Trucks and buses	11	2	11	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.971       0.858
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          2278        732         544       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =             (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2278   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3010          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 2278                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                3010          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   24.4    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.339
                                              S
Space mean speed in ramp influence area,     S  = 60.5    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 60.5    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	TIMBERLINE RD.
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1220	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	45.0	mph
Volume on ramp	780	vph
Length of first accel/decel lane	680	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	370	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2020	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1220	780	370	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	339	217	103	v
Trucks and buses	11	4	8	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.943       0.893
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          1579        919         460       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  1579   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     2498          4800            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 1579                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable         Violation?
     v                2498          4600                  No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   20.3    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.307
                                              S
Space mean speed in ramp influence area,     S  = 61.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 61.4    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	2400	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	290	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	600	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2400	290	600	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	667	81	167	v
Trucks and buses	11	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.917       0.917
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           3107        351         727       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  3107   pc/h
                   12   F   FM

_______________________________Capacity Checks_________________________________

                           Actual        Maximum         LOS F?
     v                     3458          4720            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34         12
If yes, v    = 3107                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                3458          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   27.6    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation__________________________________

Intermediate speed variable,                 M  = 0.393
                                              S
Space mean speed in ramp influence area,     S  = 56.6    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 56.6    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	2000	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	35.0	mph
Volume on ramp	260	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	520	vph
Position of adjacent Ramp	Downstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2000	260	520	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	556	72	144	v
Trucks and buses	11	6	6	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

```
Heavy vehicle adjustment, fHV           0.858       0.917       0.917
Driver population factor, fP            1.00        1.00        1.00
Flow rate, vp                           2589        315         630       pcph

_________________________Estimation of V12 Merge Areas_________________________

                  L  =            (Equation 13-6 or 13-7)
                   EQ
                  P  =    1.000   Using Equation  0
                   FM
                  v  = v  (P  ) =  2589   pc/h
                   12   F   FM

_______________________________Capacity Checks_______________________________

                           Actual        Maximum         LOS F?
     v                     2904          4720            No
      FO
     v  or v               0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?           No
      3     av34
Is   v  or v      > 1.5 v  /2            No
      3     av34        12
If yes, v    = 2589                   (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

________________________Flow Entering Merge Influence Area_____________________
                      Actual        Max Desirable        Violation?
     v                2904          4600                 No
      R12
_________________Level of Service Determination (if not F)_____________________

Density, D = 5.475 + 0.00734 v  + 0.0078 v   - 0.00627 L   =   23.3    pc/mi/ln
          R                   R           12             A
Level of service for ramp-freeway junction areas of influence  C

_____________________________Speed Estimation_________________________________

Intermediate speed variable,                 M  = 0.340
                                              S
Space mean speed in ramp influence area,     S  = 57.8    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 57.8    mph
_______________________________________________________________________________
```

HCS 2010: Freeway Weaving Release 6.50

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Weaving Location:	I-229 ON TO I-229 OFF
Analysis Year:	2035
Description:	I-90/SD 100 IMJR

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	740	ft
Freeway free-flow speed, FFS	66	mi/h
Minimum segment speed, SMIN	40	mi/h
Freeway maximum capacity, cIFL	2350	pc/h/ln
Terrain type	Rolling	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	1800	290	600	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	500	81	167	0	
Trucks and buses	11	6	6	0	%
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	0.858	0.917	0.917	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2330	351	727	0	pc/h
Volume ratio, VR		0.316			

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.5	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	1078	lc/h
Weaving lane changes, LCW	1180	lc/h
Non-weaving vehicle index, INW	86	
Non-weaving lane change, LCNW	303	lc/h
Total lane changes, LCALL	1483	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W	0.391

Average weaving speed, SW	58.7	mi/h
Average non-weaving speed, SNW	52.8	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	54.5	mi/h
Weaving segment density, D	20.8	pc/mi/ln
Level of service, LOS	C	
Weaving segment v/c ratio	0.578	
Weaving segment flow rate, v	2926	veh/h
Weaving segment capacity, cW	5063	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	5760	740	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2350	1966	c
		Maximum	Analyzed	
v/c ratio		1.00	0.578	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.50

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date Performed:	1/2014
Analysis Time Period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Weaving Location:	I-229 ON TO I-229 OFF
Analysis Year:	2035
Description:	I-90/SD 100 IMJR

Inputs

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	740	ft
Freeway free-flow speed, FFS	66	mi/h
Minimum segment speed, SMIN	40	mi/h
Freeway maximum capacity, cIFL	2350	pc/h/ln
Terrain type	Rolling	
Grade	0.00	%
Length	0.00	mi

Conversion to pc/h Under Base Conditions

	Volume Components				
	VFF	VRF	VFR	VRR	
Volume, V	1480	260	520	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	411	72	144	0	
Trucks and buses	11	6	6	0	%
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	0.858	0.917	0.917	1.000	
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	1916	315	630	0	pc/h

Volume ratio, VR 0.330

Configuration Characteristics

Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.5	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	945	lc/h
Weaving lane changes, LCW	1047	lc/h
Non-weaving vehicle index, INW	71	
Non-weaving lane change, LCNW	218	lc/h
Total lane changes, LCALL	1265	lc/h

Weaving and Non-Weaving Speeds

Weaving intensity factor, W 0.345

Average weaving speed, SW	59.3	mi/h
Average non-weaving speed, SNW	54.6	mi/h

Weaving Segment Speed, Density, Level of Service and Capacity

Weaving segment speed, S	56.1	mi/h
Weaving segment density, D	17.0	pc/mi/ln
Level of service, LOS	B	
Weaving segment v/c ratio	0.488	
Weaving segment flow rate, v	2456	veh/h
Weaving segment capacity, cW	5032	veh/h

Limitations on Weaving Segments

If limit reached, see note.

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	5911	740	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2350	1954	c
		Maximum	Analyzed	
v/c ratio		1.00	0.488	d

Notes:

a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.

b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."

c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.

d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	AM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	2690	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	600	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	290	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2690		600		290	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	747		167		81	v
Trucks and buses	11		6		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

Heavy vehicle adjustment, fHV	0.858	0.917	0.917	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3482	727	351	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3482 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3482	4720	No
$v_{FO} = v_F - v_R$	2755	4720	No
v_R	727	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 3482 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3482	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 27.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.493

Space mean speed in ramp influence area, S_R = 54.2 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 54.2 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.50

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	HDR
Agency/Co.:	SDDOT
Date performed:	1/2014
Analysis time period:	PM PEAK
Freeway/Dir of Travel:	I-90/WB
Junction:	I-229
Jurisdiction:	MINNEHAHA CO.
Analysis Year:	2035

Description: I-90/SD 100 IMJR

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	66.0	mph
Volume on freeway	2260	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	520	vph
Length of first accel/decel lane	740	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	260	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	740	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph)	2260		520		260	vph
Peak-hour factor, PHF	0.90		0.90		0.90	
Peak 15-min volume, v15	628		144		72	v
Trucks and buses	11		6		6	%
Recreational vehicles	0		0		0	%
Terrain type:	Rolling		Rolling		Rolling	
Grade	0.00	%	0.00	%	0.00	%
Length	0.00	mi	0.00	mi	0.00	mi
Trucks and buses PCE, ET	2.5		2.5		2.5	
Recreational vehicle PCE, ER	2.0		2.0		2.0	

```
Heavy vehicle adjustment, fHV          0.858       0.917       0.917
Driver population factor, fP           1.00        1.00        1.00
Flow rate, vp                          2925        630         315       pcph

_________________________Estimation of V12 Diverge Areas_______________________

                  L  =            (Equation 13-12 or 13-13)
                   EQ
                  P  =    1.000   Using Equation  0
                   FD
                  v  = v  + (v - v ) P  =  2925   pc/h
                   12   R     F   R   FD

_______________________________Capacity Checks_________________________________

                             Actual        Maximum         LOS F?
     v  = v                  2925          4720            No
      Fi   F
     v  = v - v              2295          4720            No
      FO   F   R
     v                       630           2000            No
      R
     v  or v                 0    pc/h     (Equation 13-14 or 13-17)
      3     av34
Is   v  or v      > 2700 pc/h?             No
      3     av34
Is   v  or v      > 1.5 v  /2              No
      3     av34         12
If yes, v    = 2925                     (Equation 13-15, 13-16, 13-18, or 13-19)
         12A

______________________Flow Entering Diverge Influence Area______________________
                      Actual        Max Desirable        Violation?
     v                2925          4400                 No
      12
_________________Level of Service Determination (if not F)______________________

Density,               D = 4.252 + 0.0086 v  - 0.009  L   =   22.7    pc/mi/ln
                        R                   12          D
Level of service for ramp-freeway junction areas of influence C

_____________________________Speed Estimation__________________________________

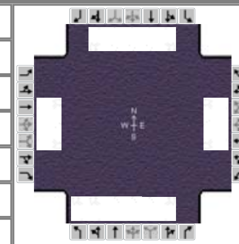
Intermediate speed variable,                 D  = 0.485
                                              S
Space mean speed in ramp influence area,     S  = 54.4    mph
                                              R
Space mean speed in outer lanes,             S  =  N/A    mph
                                              0
Space mean speed for all vehicles,           S  = 54.4    mph
_______________________________________________________________________________
```

Appendix Part 4—2035 Crossroad Level of Service

I-90/Timberline Road Interchange

HCS 2010 Signalized Intersection Results Summary

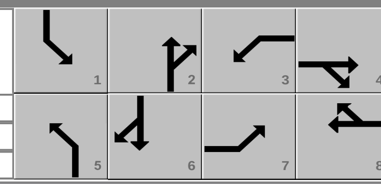
General Information				Intersection Information	
Agency	SDDOT			Duration, h	1.00
Analyst	HDR	Analysis Date	Jan 13, 2014	Area Type	Other
Jurisdiction	MINNEHAHA CO.	Time Period	AM PEAK	PHF	1.00
Intersection	60TH ST. N.	Analysis Year	2035	Analysis Period	1> 7:00
File Name	60-TIMBER AM 2035.xus				
Project Description	2035 AM NO-BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	180	40	0	270	60	100	400	900	160	180	930	0

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	11.0	21.0	16.0	16.0	0.0	0.0
Yellow	3.5	3.5	3.5	3.5	0.0	0.0
Red	0.5	0.5	0.5	0.5	0.0	0.0



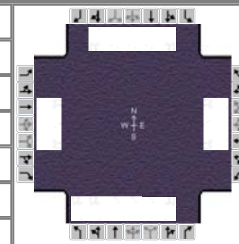
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8	5	2	1	6
Case Number	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Phase Duration, s	20.0	20.0	20.0	20.0	15.0	25.0	15.0	25.0
Change Period, ($Y+R_c$), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Allow Headway (*MAH*), s	3.0	3.1	3.0	3.1	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s	9.7	3.5	14.2	6.1	12.1		10.6	
Green Extension Time (g_e), s	0.2	0.2	0.1	0.2	0.0	0.0	0.0	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00		1.00	
Max Out Probability	0.03	0.00	1.00	0.00	1.00		1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	180	40	0	270	60	90	400	900	144	180	930	0
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1681	1765	1496	1681	1765	1496	1570	1542	1439	1617	1542	1439
Queue Service Time (g_s), s	7.7	1.5	0.0	12.2	2.3	4.1	10.1	14.3	6.6	8.6	14.8	0.0
Cycle Queue Clearance Time (g_c), s	7.7	1.5	0.0	12.2	2.3	4.1	10.1	14.3	6.6	8.6	14.8	0.0
Green Ratio (*g/C*)	0.20	0.20	0.20	0.20	0.20	0.20	0.14	0.26	0.26	0.14	0.26	0.26
Capacity (*c*), veh/h	336	353	299	336	353	299	432	1214	378	222	1214	378
Volume-to-Capacity Ratio (*X*)	0.536	0.113	0.000	0.803	0.170	0.301	0.926	0.741	0.381	0.809	0.766	0.000
Available Capacity (c_a), veh/h	336	353	299	336	353	299	432	1214	378	222	1214	378
Back of Queue (*Q*), veh/ln (50th percentile)	2.9	0.6	0.0	5.8	0.9	1.4	5.7	5.2	2.4	4.5	5.5	0.0
Queue Storage Ratio (*RQ*) (50th percentile)	0.37	0.00	0.00	0.74	0.00	0.17	0.15	0.00	0.00	0.58	0.00	0.00
Uniform Delay (d_1), s/veh	28.7	26.2	0.0	30.5	26.5	27.2	34.1	27.0	24.2	33.5	27.2	0.0
Incremental Delay (d_2), s/veh	0.9	0.1	0.0	13.4	0.1	0.2	35.7	4.2	2.9	21.0	4.8	0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	29.6	26.2	0.0	43.9	26.6	27.4	69.8	31.2	27.1	54.5	32.0	0.0
Level of Service (LOS)	C	C		D	C	C	E	C	C	D	C	
Approach Delay, s/veh / LOS	29.0	C		37.9	D		41.5	D		35.7	D	
Intersection Delay, s/veh / LOS	38.1						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.5	C	3.4	C	2.4	B	2.8	C
Bicycle LOS Score / LOS	0.9	A	1.2	A	1.3	A	1.1	A

HCS 2010 Signalized Intersection Results Summary

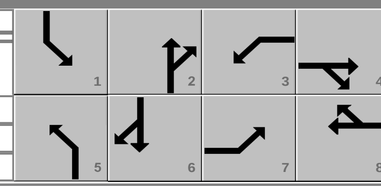
General Information				Intersection Information	
Agency	SDDOT			Duration, h	1.00
Analyst	HDR	Analysis Date	Jan 13, 2014	Area Type	Other
Jurisdiction	MINNEHAHA CO.	Time Period	PM PEAK	PHF	1.00
Intersection	60TH ST. N.	Analysis Year	2035	Analysis Period	1> 7:00
File Name	60-TIMBER PM 2035.xus				
Project Description	2035 PM - NO BUILD				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	200	70	0	210	50	80	370	1380	220	130	830	0

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	7.0	1.0	20.0	14.0	2.0	16.0
Yellow	3.5	3.5	3.5	3.5	0.0	3.5
Red	0.5	0.5	0.5	0.5	0.0	0.5



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8	5	2	1	6
Case Number	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Phase Duration, s	20.0	22.0	18.0	20.0	16.0	29.0	11.0	24.0
Change Period, ($Y+R_c$), s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Max Allow Headway (*MAH*), s	3.0	3.1	3.0	3.1	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s	10.6	4.6	11.4	5.1	11.1		8.4	
Green Extension Time (g_e), s	0.2	0.3	0.1	0.2	0.1	0.0	0.0	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00		1.00	
Max Out Probability	0.09	0.00	1.00	0.00	1.00		1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	200	70	0	210	50	70	370	1380	204	130	830	0
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1681	1765	1496	1681	1765	1496	1570	1542	1439	1617	1542	1439
Queue Service Time (g_s), s	8.6	2.6	0.0	9.4	1.9	3.1	9.1	23.4	9.1	6.4	13.1	0.0
Cycle Queue Clearance Time (g_c), s	8.6	2.6	0.0	9.4	1.9	3.1	9.1	23.4	9.1	6.4	13.1	0.0
Green Ratio (*g/C*)	0.20	0.22	0.22	0.18	0.20	0.20	0.15	0.31	0.31	0.09	0.25	0.25
Capacity (*c*), veh/h	336	397	336	294	353	299	471	1446	450	142	1156	360
Volume-to-Capacity Ratio (*X*)	0.595	0.176	0.000	0.714	0.142	0.234	0.785	0.955	0.454	0.919	0.718	0.000
Available Capacity (c_a), veh/h	336	397	336	294	353	299	471	1446	450	142	1156	360
Back of Queue (*Q*), veh/ln (50th percentile)	3.4	1.0	0.0	4.1	0.7	1.1	3.7	10.5	3.2	5.5	4.8	0.0
Queue Storage Ratio (*RQ*) (50th percentile)	0.43	0.00	0.00	0.52	0.00	0.13	0.10	0.00	0.00	0.72	0.00	0.00
Uniform Delay (d_1), s/veh	29.1	25.0	0.0	31.1	26.3	26.9	32.8	26.9	22.0	36.2	27.4	0.0
Incremental Delay (d_2), s/veh	2.0	0.1	0.0	7.1	0.1	0.1	8.3	20.9	3.3	79.3	3.9	0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	31.1	25.1	0.0	38.3	26.4	27.0	41.0	47.8	25.3	115.5	31.3	0.0
Level of Service (LOS)	C	C		D	C	C	D	D	C	F	C	
Approach Delay, s/veh / LOS	29.5	C		34.1	C		44.2	D		42.7	D	
Intersection Delay, s/veh / LOS	41.7						D					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.5	C	3.4	C	2.4	B	2.8	C
Bicycle LOS Score / LOS	0.9	A	1.0	A	1.6	A	1.0	A

 HCS 2010™ Streets Version 6.60 Generated: 8/25/2014 8:50:39 AM

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_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              HDR
Agency/Co.:           SDDOT
Date Performed:       1/2014
Analysis Time Period: AM PEAK
Intersection:         TIMBERLINE RD.
Jurisdiction:         MINNEHAHA CO.
Units: U. S. Customary
Analysis Year:        2035
Project ID:
East/West Street:     I-90 EB
North/South Street:   TIMBERLINE RD.
Intersection Orientation: NS                Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                             900    280      70     840
Peak-Hour Factor, PHF              0.90   0.90     0.90   0.90
Hourly Flow Rate, HFR              1000   311      77     933
Percent Heavy Vehicles             --     --       5      --     --
Median Type/Storage         Undivided            /
RT Channelized?
Lanes                              1    0             0   1
Configuration                          TR              LT
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                                             130           720
Peak Hour Factor, PHF                              0.90          0.90
Hourly Flow Rate, HFR                              144           800
Percent Heavy Vehicles                             1             1
Percent Grade (%)                  2                      2
Flared Approach:  Exists?/Storage               /              No     /
Lanes                                                 0        0
Configuration                                             LR
______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach           NB     SB         Westbound            Eastbound
Movement           1      4   |  7      8      9    |  10     11     12
Lane Config               LT  |                     |         LR
______________________________________________________________________________
v (vph)                   77                                  944
C(m) (vph)                518                                 130
v/c                       0.15                                7.26
95% queue length          0.52                                410.45
Control Delay             13.2                                11335
LOS                        B                                   F
Approach Delay                                                11335
Approach LOS                                                   F
______________________________________________________________________________
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Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: 2035
Project ID:
East/West Street: I-90 EB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		900	280	70	840	
Peak-Hour Factor, PHF		0.90	0.90	0.90	0.90	
Peak-15 Minute Volume		250	78	19	233	
Hourly Flow Rate, HFR		1000	311	77	933	
Percent Heavy Vehicles		--	--	5	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				130		720
Peak Hour Factor, PHF				0.90		0.90
Peak-15 Minute Volume				36		200
Hourly Flow Rate, HFR				144		800
Percent Heavy Vehicles				1		1
Percent Grade (%)		2			2	
Flared Approach: Exists?/Storage			/			No /
RT Channelized?						
Lanes				0		0
Configuration					LR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		933
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1				7.1		6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			5				1		1
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				2.00	2.00	2.00	2.00	2.00	2.00
t(3,lt)			0.00				0.70		0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.2				6.8		6.4
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		5				1		1
t(f)		2.2				3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		1311				2243		933
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		933
Potential Capacity		308
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		308
Probability of Queue free St.	1.00	0.00

Step 2: LT from Major St.	4	1
Conflicting Flows	1311	
Potential Capacity	518	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	518	
Probability of Queue free St.	0.85	1.00
Maj L-Shared Prob Q free St.	0.67	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.67	0.67
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		2243
Potential Capacity		36
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.67	
Maj. L, Min T Adj. Imp Factor.	0.74	
Cap. Adj. factor due to Impeding mvmnt	0.00	0.85
Movement Capacity		31

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.67	0.67
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		2243
Potential Capacity		36
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.67	
Maj. L, Min T Adj. Imp Factor.	0.74	
Cap. Adj. factor due to Impeding mvmnt	0.00	0.85
Movement Capacity		31

Results for Two-stage process:		
a		
y		
C t		31

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				144		800
Movement Capacity (vph)				31		308
Shared Lane Capacity (vph)					130	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				31		308
Volume				144		800
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					130	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT					LR	
v (vph)		77					944	
C(m) (vph)		518					130	
v/c		0.15					7.26	
95% queue length		0.52					410.45	
Control Delay		13.2					11335	
LOS		B					F	
Approach Delay							11335	
Approach LOS							F	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.85
v(il), Volume for stream 2 or 5		933
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.67
d(M,LT), Delay for stream 1 or 4		13.2
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		4.3

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_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              HDR
Agency/Co.:           SDDOT
Date Performed:
Analysis Time Period: PM PEAK
Intersection:         TIMBERLINE RD.
Jurisdiction:         MINNEHAHA CO.
Units: U. S. Customary
Analysis Year:        2035
Project ID:  I-90/Timberline IMJR
East/West Street:     I-90 EB
North/South Street:   TIMBERLINE RD.
Intersection Orientation: NS               Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound            Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                             1300   360      70     580
Peak-Hour Factor, PHF              0.90   0.90     0.90   0.90
Hourly Flow Rate, HFR              1444   400      77     644
Percent Heavy Vehicles             --     --       5      --     --
Median Type/Storage         Undivided            /
RT Channelized?
Lanes                              1    0             0   1
Configuration                          TR              LT
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach       Westbound             Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                                             150           610
Peak Hour Factor, PHF                              0.90          0.90
Hourly Flow Rate, HFR                              166           677
Percent Heavy Vehicles                             1             1
Percent Grade (%)                  2                      2
Flared Approach:  Exists?/Storage               /                 No     /
Lanes                                                 0        0
Configuration                                             LR
______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach           NB     SB          Westbound             Eastbound
Movement           1      4   |  7      8      9    |  10     11     12
Lane Config               LT  |                     |         LR
______________________________________________________________________________
v (vph)                   77                                  843
C(m) (vph)                322                                 90
v/c                       0.24                                9.37
95% queue length          0.94                                379.83
Control Delay             19.7                                15150
LOS                        C                                   F
Approach Delay                                                15150
Approach LOS                                                   F
______________________________________________________________________________
```

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: HDR
Agency/Co.: SDDOT
Date Performed:
Analysis Time Period: PM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: 2035
Project ID: I-90/Timberline IMJR
East/West Street: I-90 EB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		1300	360	70	580	
Peak-Hour Factor, PHF		0.90	0.90	0.90	0.90	
Peak-15 Minute Volume		361	100	19	161	
Hourly Flow Rate, HFR		1444	400	77	644	
Percent Heavy Vehicles		--	--	5	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				150		610
Peak Hour Factor, PHF				0.90		0.90
Peak-15 Minute Volume				42		169
Hourly Flow Rate, HFR				166		677
Percent Heavy Vehicles				1		1
Percent Grade (%)		2			2	
Flared Approach: Exists?/Storage				/		No /
RT Channelized?						
Lanes				0	0	
Configuration					LR	

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		644
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1				7.1		6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			5				1		1
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				2.00	2.00	2.00	2.00	2.00	2.00
t(3,lt)			0.00				0.70		0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.2				6.8		6.4
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		5				1		1
t(f)		2.2				3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		1844				2442		644
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		644
Potential Capacity		458
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		458
Probability of Queue free St.	1.00	0.00

Step 2: LT from Major St.	4	1
Conflicting Flows	1844	
Potential Capacity	322	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	322	
Probability of Queue free St.	0.76	1.00
Maj L-Shared Prob Q free St.	0.62	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.62	0.62
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		2442
Potential Capacity		27
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.62	
Maj. L, Min T Adj. Imp Factor.	0.70	
Cap. Adj. factor due to Impeding mvmnt	0.00	0.76
Movement Capacity		21

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

```
______________________________________________________________________________
Part 2 - Second Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity
______________________________________________________________________________
Part 3 - Single Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor                     1.00             1.00
Cap. Adj. factor due to Impeding mvmnt          0.62             0.62
Movement Capacity
______________________________________________________________________________
Result for 2 stage process:
a
y
C t
Probability of Queue free St.                   1.00             1.00
______________________________________________________________________________
Step 4: LT from Minor St.                          7               10
______________________________________________________________________________
Part 1 - First Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity
______________________________________________________________________________
Part 2 - Second Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity
______________________________________________________________________________
Part 3 - Single Stage
Conflicting Flows                                                2442
Potential Capacity                                               27
Pedestrian Impedance Factor                     1.00             1.00
Maj. L, Min T Impedance factor                  0.62
Maj. L, Min T Adj. Imp Factor.                  0.70
Cap. Adj. factor due to Impeding mvmnt          0.00             0.76
Movement Capacity                                                21
______________________________________________________________________________
Results for Two-stage process:
a
y
C t                                                              21
______________________________________________________________________________

Worksheet 8-Shared Lane Calculations
______________________________________________________________________________
Movement                              7      8      9     10     11     12
                                      L      T      R      L      T      R
______________________________________________________________________________
Volume (vph)                                              166           677
Movement Capacity (vph)                                   21            458
Shared Lane Capacity (vph)                                       90
______________________________________________________________________________
```

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				21		458
Volume				166		677
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					90	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT					LR	
v (vph)		77					843	
C(m) (vph)		322					90	
v/c		0.24					9.37	
95% queue length		0.94					379.83	
Control Delay		19.7					15150	
LOS		C					F	
Approach Delay							15150	
Approach LOS							F	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.76
v(il), Volume for stream 2 or 5		644
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.62
d(M,LT), Delay for stream 1 or 4		19.7
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		7.6

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TWO-WAY STOP CONTROL SUMMARY

Analyst: HDR
Agency/Co.: SDDOT
Date Performed:
Analysis Time Period: AM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: 2035
Project ID: I-90/Timberline IMJR
East/West Street: I-90 WB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS   Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	490	540			550	150
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Hourly Flow Rate, HFR	544	600			611	166
Percent Heavy Vehicles	5	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	360		60			
Peak Hour Factor, PHF	0.90		0.90			
Hourly Flow Rate, HFR	400		66			
Percent Heavy Vehicles	11		11			
Percent Grade (%)		2			0	
Flared Approach: Exists?/Storage			Yes /50			/
Lanes	0		0			
Configuration		LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	544			466				
C(m) (vph)	826			10				
v/c	0.66			46.60				
95% queue length	5.57			231.03				
Control Delay	17.7			82811				
LOS	C			F				
Approach Delay				82811				
Approach LOS				F				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: HDR
Agency/Co.: SDDOT
Date Performed:
Analysis Time Period: AM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: 2035
Project ID: I-90/Timberline IMJR
East/West Street: I-90 WB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	490	540			550	150
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Peak-15 Minute Volume	136	150			153	42
Hourly Flow Rate, HFR	544	600			611	166
Percent Heavy Vehicles	5	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	360		60			
Peak Hour Factor, PHF	0.90		0.90			
Peak-15 Minute Volume	100		17			
Hourly Flow Rate, HFR	400		66			
Percent Heavy Vehicles	11		11			
Percent Grade (%)		2			0	
Flared Approach: Exists?/Storage			Yes	/50		/
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	600	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	5		11		11			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			2.00	2.00	2.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.2		6.9		6.5			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	5		11		11			
t(f)	2.2		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	777		2382		600			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	600	
Potential Capacity	469	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	469	
Probability of Queue free St.	0.86	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		777
Potential Capacity		826
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		826
Probability of Queue free St.	1.00	0.34
Maj L-Shared Prob Q free St.		0.00

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.00	0.00
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	2382	
Potential Capacity	27	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.00
Maj. L, Min T Adj. Imp Factor.		0.00
Cap. Adj. factor due to Impeding mvmnt	0.34	0.00
Movement Capacity	9	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.00	0.00
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity

Part 2 - Second Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity

Part 3 - Single Stage		
Conflicting Flows	2382	
Potential Capacity	27	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.00
Maj. L, Min T Adj. Imp Factor.		0.00
Cap. Adj. factor due to Impeding mvmnt	0.34	0.00
Movement Capacity	9	

Results for Two-stage process:		
a		
y		
C t	9	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	400		66			
Movement Capacity (vph)	9		469			
Shared Lane Capacity (vph)		10				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	9		469			
Volume	400		66			
Delay	79012.1			13.9		
Q sep	8779.12			0.26		
Q sep +1	8780.12			1.26		
round (Qsep +1)	8780		1			
n max		8780				
C sh		10				
SUM C sep		10				
n		50				
C act		10				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	544			466				
C(m) (vph)	826			10				
v/c	0.66			46.60				
95% queue length	5.57			231.03				
Control Delay	17.7			82811				
LOS	C			F				
Approach Delay				82811				
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.34	1.00
v(il), Volume for stream 2 or 5	600	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.00	
d(M,LT), Delay for stream 1 or 4	17.7	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	17.7	

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                 HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              HDR
Agency/Co.:           SDDOT
Date Performed:       1/2014
Analysis Time Period: PM PEAK
Intersection:         TIMBERLINE RD.
Jurisdiction:         MINNEHAHA CO.
Units: U. S. Customary
Analysis Year:        2035
Project ID:  I-90/Timberline IMJR
East/West Street:     I-90 WB
North/South Street:   TIMBERLINE RD.
Intersection Orientation: NS                Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach        Northbound               Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      650    800                    350    130
Peak-Hour Factor, PHF       0.90   0.90                   0.90   0.90
Hourly Flow Rate, HFR       722    888                    388    144
Percent Heavy Vehicles      5      --     --              --     --
Median Type/Storage         Undivided            /
RT Channelized?
Lanes                          0   1                      1    0
Configuration                   LT                            TR
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach        Westbound                Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      300           70
Peak Hour Factor, PHF       0.90          0.90
Hourly Flow Rate, HFR       333           77
Percent Heavy Vehicles      11            11
Percent Grade (%)                  2                      0
Flared Approach:  Exists?/Storage         Yes    /50                   /
Lanes                          0        0
Configuration                      LR
______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach            NB     SB         Westbound             Eastbound
Movement            1      4   |  7      8      9    |  10     11     12
Lane Config         LT         |         LR          |
______________________________________________________________________________
v (vph)             722                  410
C(m) (vph)          1020                 5
v/c                 0.71                 82.00
95% queue length    6.94                 205.49
Control Delay       16.9
LOS                  C                    F
Approach Delay
Approach LOS                              F
______________________________________________________________________________
```

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK
Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.
Units: U. S. Customary
Analysis Year: 2035
Project ID: I-90/Timberline IMJR
East/West Street: I-90 WB
North/South Street: TIMBERLINE RD.
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	650	800			350	130
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90
Peak-15 Minute Volume	181	222			97	36
Hourly Flow Rate, HFR	722	888			388	144
Percent Heavy Vehicles	5	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	300		70			
Peak Hour Factor, PHF	0.90		0.90			
Peak-15 Minute Volume	83		19			
Hourly Flow Rate, HFR	333		77			
Percent Heavy Vehicles	11		11			
Percent Grade (%)		2			0	
Flared Approach: Exists?/Storage			Yes	/50		/
RT Channelized?						
Lanes	0		0			
Configuration		LR				

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	888	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	5		11		11			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			2.00	2.00	2.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.2		6.9		6.5			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	5		11		11			
t(f)	2.2		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	532		2792		888			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	888	
Potential Capacity	314	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	314	
Probability of Queue free St.	0.75	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		532
Potential Capacity		1020
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1020
Probability of Queue free St.	1.00	0.29
Maj L-Shared Prob Q free St.		0.00

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.00	0.00
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	2792	
Potential Capacity	14	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.00
Maj. L, Min T Adj. Imp Factor.		0.00
Cap. Adj. factor due to Impeding mvmnt	0.29	0.00
Movement Capacity	4	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.00	0.00
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	2792	
Potential Capacity	14	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.00
Maj. L, Min T Adj. Imp Factor.		0.00
Cap. Adj. factor due to Impeding mvmnt	0.29	0.00
Movement Capacity	4	

Results for Two-stage process:		
a		
y		
C t	4	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	333		77			
Movement Capacity (vph)	4		314			
Shared Lane Capacity (vph)		5				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	4		314			
Volume	333		77			
Delay	149860.4			20.2		
Q sep	13862.09			0.43		
Q sep +1	13863.09			1.43		
round (Qsep +1)	13863		1			
n max		13863				
C sh		5				
SUM C sep		5				
n		50				
C act		5				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
v (vph)	722			410				
C(m) (vph)	1020			5				
v/c	0.71			82.00				
95% queue length	6.94			205.49				
Control Delay	16.9							
LOS	C			F				
Approach Delay								
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.29	1.00
v(il), Volume for stream 2 or 5	888	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.00	
d(M,LT), Delay for stream 1 or 4	16.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	16.9	

HCS 2010: Two-Lane Highways Release 6.50

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	HDR
Agency/Co.	SDDOT
Date Performed	1/2014
Analysis Time Period	AM PEAK
Highway	TIMBERLINE ROAD
From/To	NORTH OF I-90 TO SOUTH OF 60TH
Jurisdiction	MINNEHAHA CO.
Analysis Year	2035
Description	I-90/Timberline IMJR

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.88	
Shoulder width	6.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	60	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	540	veh/h
Opposing direction volume, Vo	840	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.7		1.3	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.960		0.982	
Grade adj. factor,(note-1) fg	0.97		1.00	
Directional flow rate,(note-2) vi	659	pc/h	972	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	45.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	41.8	mi/h
Adjustment for no-passing zones, fnp	0.6	mi/h
Average travel speed, ATSd	28.5	mi/h
Percent Free Flow Speed, PFFS	68.2	%

```
_________________________Percent Time-Spent-Following_________________________

Direction                                Analysis(d)        Opposing (o)
PCE for trucks, ET                           1.0                1.0
PCE for RVs, ER                              1.0                1.0
Heavy-vehicle adjustment factor, fHV         1.000              1.000
Grade adjustment factor,(note-1) fg          0.97               1.00
Directional flow rate,(note-2) vi            633    pc/h        955     pc/h
Base percent time-spent-following,(note-4) BPTSFd  63.8   %
Adjustment for no-passing zones, fnp               22.1
Percent time-spent-following, PTSFd                72.6   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.39
Peak 15-min vehicle-miles of travel, VMT15         230     veh-mi
Peak-hour vehicle-miles of travel, VMT60           810     veh-mi
Peak 15-min total travel time, TT15                8.1     veh-h
Capacity from ATS, CdATS                           1669    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               1669    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.5     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      28.5    mi/h
Percent time-spent-following, PTSFd (from above)             72.6
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	613.6
Effective width of outside lane, We	24.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	3.54
Bicycle LOS	D

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	HDR
Agency/Co.	SDDOT
Date Performed	1/2014
Analysis Time Period	PM PEAK
Highway	TIMBERLINE ROAD
From/To	NORTH OF I-90 TO SOUTH OF 60TH
Jurisdiction	MINNEHAHA CO.
Analysis Year	2035
Description	I-90/Timberline IMJR

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.88	
Shoulder width	6.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	60	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	800	veh/h
Opposing direction volume, Vo	580	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.6	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.982		0.965	
Grade adj. factor,(note-1) fg	1.00		0.98	
Directional flow rate,(note-2) vi	926	pc/h	697	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	45.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	41.8	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h
Average travel speed, ATSd	28.1	mi/h
Percent Free Flow Speed, PFFS	67.3	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		0.98	
Directional flow rate,(note-2) vi	909	pc/h	673	pc/h
Base percent time-spent-following,(note-4) BPTSFd	71.7	%		
Adjustment for no-passing zones, fnp	22.7			
Percent time-spent-following, PTSFd	84.7	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.54	
Peak 15-min vehicle-miles of travel, VMT15	341	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1200	veh-mi
Peak 15-min total travel time, TT15	12.1	veh-h
Capacity from ATS, CdATS	1608	veh/h
Capacity from PTSF, CdPTSF	1666	veh/h
Directional Capacity	1608	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	1.5	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	28.1	mi/h
Percent time-spent-following, PTSFd (from above)	84.7	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	
Percent free flow speed including passing lane, PFFSpl	0.0	%

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	E	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	909.1
Effective width of outside lane, We	24.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	3.74
Bicycle LOS	D

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	HDR
Agency/Co.	SDDOT
Date Performed	1/2014
Analysis Time Period	AM PEAK
Highway	TIMBERLINE ROAD
From/To	NORTH OF I-90 TO SOUTH OF 60TH
Jurisdiction	MINNEHAHA CO.
Analysis Year	2035
Description	I-90/Timberline IMJR

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.88	
Shoulder width	6.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	60	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	840	veh/h
Opposing direction volume, Vo	540	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.7	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.982		0.960	
Grade adj. factor,(note-1) fg	1.00		0.97	
Directional flow rate,(note-2) vi	972	pc/h	659	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	45.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	41.8	mi/h
Adjustment for no-passing zones, fnp	1.2	mi/h
Average travel speed, ATSd	27.9	mi/h
Percent Free Flow Speed, PFFS	66.9	%

```
_________________________Percent Time-Spent-Following_________________________

Direction                                  Analysis(d)        Opposing (o)
PCE for trucks, ET                             1.0                1.0
PCE for RVs, ER                                1.0                1.0
Heavy-vehicle adjustment factor, fHV           1.000              1.000
Grade adjustment factor,(note-1) fg            1.00               0.97
Directional flow rate,(note-2) vi              955    pc/h        633     pc/h
Base percent time-spent-following,(note-4) BPTSFd  73.1   %
Adjustment for no-passing zones, fnp               22.1
Percent time-spent-following, PTSFd                86.4   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.57
Peak 15-min vehicle-miles of travel, VMT15         358     veh-mi
Peak-hour vehicle-miles of travel, VMT60           1260    veh-mi
Peak 15-min total travel time, TT15                12.8    veh-h
Capacity from ATS, CdATS                           1583    veh/h
Capacity from PTSF, CdPTSF                         1666    veh/h
Directional Capacity                               1583    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.5     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      27.9    mi/h
Percent time-spent-following, PTSFd (from above)             86.4
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -
Percent free flow speed including passing lane, PFFSpl       0.0     %

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     E
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	954.5
Effective width of outside lane, We	24.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	3.77
Bicycle LOS	D

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	HDR
Agency/Co.	SDDOT
Date Performed	1/2014
Analysis Time Period	PM PEAK
Highway	TIMBERLINE ROAD
From/To	NORTH OF I-90 TO SOUTH OF 60TH
Jurisdiction	MINNEHAHA CO.
Analysis Year	2035
Description	I-90/Timberline IMJR

Input Data

Highway class	Class 3		Peak hour factor, PHF	0.88	
Shoulder width	6.0	ft	% Trucks and buses	6	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.5	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	60	%
Up/down	-	%	Access point density	13	/mi

Analysis direction volume, Vd	580	veh/h
Opposing direction volume, Vo	800	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.6		1.3	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.965		0.982	
Grade adj. factor,(note-1) fg	0.98		1.00	
Directional flow rate,(note-2) vi	697	pc/h	926	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	45.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	3.3	mi/h
Free-flow speed, FFSd	41.8	mi/h
Adjustment for no-passing zones, fnp	0.7	mi/h
Average travel speed, ATSd	28.5	mi/h
Percent Free Flow Speed, PFFS	68.2	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	0.98		1.00	
Directional flow rate,(note-2) vi	673	pc/h	909	pc/h

Base percent time-spent-following,(note-4) BPTSFd	65.1	%
Adjustment for no-passing zones, fnp	22.7	
Percent time-spent-following, PTSFd	74.8	%

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.41	
Peak 15-min vehicle-miles of travel, VMT15	247	veh-mi
Peak-hour vehicle-miles of travel, VMT60	870	veh-mi
Peak 15-min total travel time, TT15	8.7	veh-h
Capacity from ATS, CdATS	1669	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	1669	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	1.5	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	28.5	mi/h
Percent time-spent-following, PTSFd (from above)	74.8	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	
Percent free flow speed including passing lane, PFFSpl	0.0	%

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	E	
Peak 15-min total travel time, TT15	-	veh-h

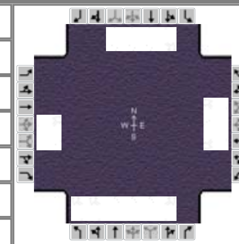
Bicycle Level of Service

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	659.1
Effective width of outside lane, We	24.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	3.58
Bicycle LOS	D

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

HCS 2010 Signalized Intersection Results Summary

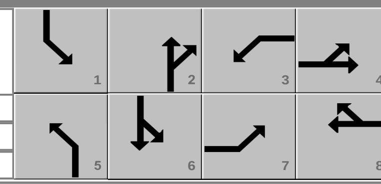
General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/20/2014	Area Type	Other
Jurisdiction	SIOUX FALLS	Time Period	AM PEAK	PHF	1.00
Intersection	60TH ST. N.	Analysis Year	2035	Analysis Period	1> 7:00
File Name	2035 AM.xus				
Project Description	CORRIDOR TRAFFIC ANALYSIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	180	40		270	60	100	400	900	160	180	930	

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	8	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	10.0	1.0	19.0	15.0	15.0	0.0
Yellow	4.0	0.0	4.0	4.0	4.0	0.0
Red	1.0	0.0	1.0	1.0	1.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8	5	2	1	6
Case Number	1.1	4.0	2.0	3.0	2.0	3.0	1.1	4.0
Phase Duration, s	20.0	20.0	20.0	20.0	16.0	25.0	15.0	24.0
Change Period, ($Y+R_c$), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.0	3.1	3.0	3.1	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s	8.0	3.5	14.4	6.7	6.8		6.7	
Green Extension Time (g_e), s	0.2	0.3	0.0	0.2	0.2	0.0	0.1	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00		1.00	
Max Out Probability	0.01	0.00	1.00	0.00	0.23		0.73	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4		3	8	18	5	2	12	1	6	
Adjusted Flow Rate (*v*), veh/h	180	40		270	60	100	202	454	81	136	704	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1681	1765		1681	1765	1496	1570	1542	1439	1617	1542	
Queue Service Time (g_s), s	6.0	1.5		12.4	2.3	4.7	4.8	6.2	3.5	4.7	11.6	
Cycle Queue Clearance Time (g_c), s	6.0	1.5		12.4	2.3	4.7	4.8	6.2	3.5	4.7	11.6	
Green Ratio (g/C)	0.38	0.19		0.19	0.19	0.19	0.14	0.25	0.25	0.36	0.24	
Capacity (*c*), veh/h	584	331		315	331	280	432	1156	360	425	1099	
Volume-to-Capacity Ratio (*X*)	0.308	0.121		0.857	0.181	0.357	0.467	0.392	0.224	0.321	0.641	
Available Capacity (c_a), veh/h	584	331		315	331	280	432	1156	360	425	1099	
Back of Queue (*Q*), veh/ln (50th percentile)	2.1	0.6		6.7	0.9	1.6	1.7	2.1	1.2	1.6	4.6	
Queue Storage Ratio (*RQ*) (50th percentile)	0.27	0.00		0.85	0.00	0.27	0.22	0.00	0.16	0.21	0.00	
Uniform Delay (d_1), s/veh	17.6	27.0		31.5	27.3	28.3	32.1	23.0	23.1	18.4	31.7	
Incremental Delay (d_2), s/veh	0.1	0.1		23.1	0.1	0.3	0.2	0.8	1.2	0.1	2.1	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh	17.7	27.1		54.6	27.4	28.6	32.3	23.8	24.3	18.5	33.8	
Level of Service (LOS)	B	C		D	C	C	C	C	C	B	C	

	EB		WB		NB		SB	
Approach Delay, s/veh / LOS	19.4	B	44.7	D	26.2	C	31.3	C
Intersection Delay, s/veh / LOS	31.0				C			

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.5	C	3.3	C	2.4	B	2.7	B
Bicycle LOS Score / LOS	0.9	A	1.2	A	1.3	A	1.1	A

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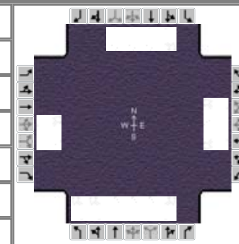
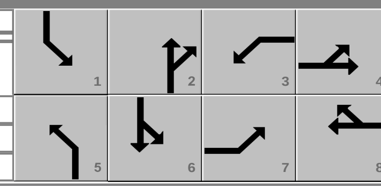
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/20/2014	Area Type	Other
Jurisdiction	SIOUX FALLS	Time Period	PM PEAK	PHF	1.00
Intersection	60TH ST. N.	Analysis Year	2035	Analysis Period	1> 7:00
File Name	2035 PM.xus				
Project Description	CORRIDOR TRAFFIC ANALYSIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	200	70		210	50	80	370	1380	220	130	830	

Signal Information									
Cycle, s	80.0	Reference Phase	2						
Offset, s	5	Reference Point	Begin	Green	7.0	0.0	22.0	10.0	1.0	15.0
Uncoordinated	No	Simult. Gap E/W	On	Yellow	4.0	4.0	4.0	4.0	0.0	4.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	1.0	1.0	0.0	1.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8	5	2	1	6
Case Number	1.1	4.0	2.0	3.0	2.0	3.0	1.1	4.0
Phase Duration, s	15.0	20.0	16.0	21.0	17.0	32.0	12.0	27.0
Change Period, ($Y+R_c$), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.0	3.1	3.0	3.1	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s	9.4	4.7	11.9	5.6	6.0		4.7	
Green Extension Time (g_e), s	0.0	0.2	0.0	0.2	0.2	0.0	0.0	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00		1.00	
Max Out Probability	1.00	0.00	1.00	0.00	0.02		1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4		3	8	18	5	2	12	1	6	
Adjusted Flow Rate (*v*), veh/h	200	70		210	50	80	179	666	106	79	501	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1681	1765		1681	1765	1496	1570	1542	1439	1617	1542	
Queue Service Time (g_s), s	7.4	2.7		9.9	1.9	3.6	4.0	8.4	4.3	2.7	7.0	
Cycle Queue Clearance Time (g_c), s	7.4	2.7		9.9	1.9	3.6	4.0	8.4	4.3	2.7	7.0	
Green Ratio (*g/C*)	0.31	0.19		0.14	0.20	0.20	0.15	0.34	0.34	0.36	0.28	
Capacity (*c*), veh/h	505	331		231	353	299	471	1561	486	384	1272	
Volume-to-Capacity Ratio (*X*)	0.396	0.212		0.909	0.142	0.267	0.379	0.427	0.219	0.204	0.394	
Available Capacity (c_a), veh/h	505	331		231	353	299	471	1561	486	384	1272	
Back of Queue (*Q*), veh/ln (50th percentile)	2.7	1.1		6.9	0.7	1.2	1.4	2.7	1.4	1.0	2.4	
Queue Storage Ratio (*RQ*) (50th percentile)	0.34	0.00		0.88	0.00	0.21	0.19	0.00	0.19	0.13	0.00	
Uniform Delay (d_1), s/veh	21.5	27.5		34.0	26.3	27.0	29.8	18.8	19.4	19.0	23.5	
Incremental Delay (d_2), s/veh	0.2	0.1		49.6	0.1	0.2	0.1	0.7	0.8	0.1	0.8	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh	21.7	27.6		83.6	26.4	27.2	29.9	19.4	20.2	19.1	24.3	
Level of Service (LOS)	C	C		F	C	C	C	B	C	B	C	
Approach Delay, s/veh / LOS	23.2	C		61.9	E		21.5	C		23.6	C	
Intersection Delay, s/veh / LOS	28.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.5	C	3.3	C	2.4	B	2.7	B
Bicycle LOS Score / LOS	0.9	A	1.0	A	1.6	A	1.0	A

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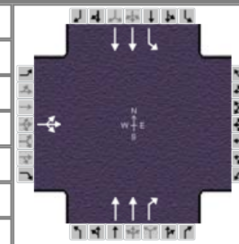
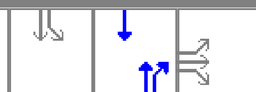
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	AM	PHF	1.00
Intersection	I-90 Eastbound	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline am 2035.xus				
Project Description	I-90/Timberline IMJR				

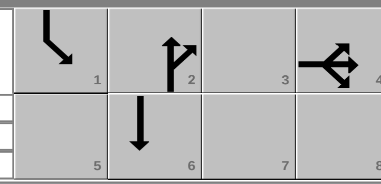


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	130	0	0					900	280	70	840	

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	9.0	39.0	17.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	1.0	1.0	0.0	0.0	0.0



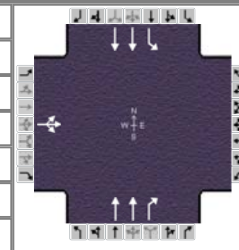
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2	1	6
Case Number		12.0				7.3	2.0	4.0
Phase Duration, s		22.0				44.0	14.0	58.0
Change Period, (*Y+R*c), s		5.0				5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.0				0.0	3.0	0.0
Queue Clearance Time (*g*s), s		7.6					5.2	
Green Extension Time (*g*e), s		0.1				0.0	0.0	0.0
Phase Call Probability		1.00					1.00	
Max Out Probability		0.00					0.30	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14					2	12	1	6	
Adjusted Flow Rate (*v*), veh/h		130						900	280	70	840	
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1600						1645	1444	1586	1640	
Queue Service Time (*g*s), s		5.6						10.3	2.8	3.2	15.1	
Cycle Queue Clearance Time (*g*c), s		5.6						10.3	2.8	3.2	15.1	
Green Ratio (*g/C*)		0.21						0.49	0.49	0.11	0.51	
Capacity (*c*), veh/h		340						1604	704	178	1683	
Volume-to-Capacity Ratio (*X*)		0.382						0.561	0.398	0.392	0.499	
Available Capacity (*c*a), veh/h		340						1604	704	178	1683	
Back of Queue (*Q*), veh/ln (50th percentile)		2.0						2.5	0.7	1.2	5.5	
Queue Storage Ratio (*RQ*) (50th percentile)		0.00						0.00	0.00	0.15	0.00	
Uniform Delay (*d*1), s/veh		27.0						7.2	2.5	31.8	12.0	
Incremental Delay (*d*2), s/veh		0.3						1.0	1.1	0.4	0.9	
Initial Queue Delay (*d*3), s/veh		0.0						0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh		27.3						8.1	3.7	32.3	12.9	
Level of Service (LOS)		C						A	A	C	B	
Approach Delay, s/veh / LOS	27.3	C		0.0			7.1	A		14.4	B	
Intersection Delay, s/veh / LOS	11.2						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.9	C	2.9	C	1.9	A	1.3	A
Bicycle LOS Score / LOS	0.7	A			1.5	A	1.2	A

HCS 2010 Signalized Intersection Results Summary

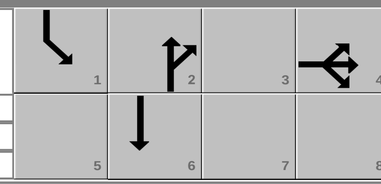
General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	PM	PHF	1.00
Intersection	I-90 Eastbound	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline pm 2035.xus				
Project Description	I-90/Timberline IMJR				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	150	0	0					1300	360	70	580	

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	6.0	44.0	15.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	1.0	1.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2	1	6
Case Number		12.0				7.3	2.0	4.0
Phase Duration, s		20.0				49.0	11.0	60.0
Change Period, ($Y+R_c$), s		5.0				5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.0				0.0	3.0	0.0
Queue Clearance Time (g_s), s		8.7					5.4	
Green Extension Time (g_e), s		0.1				0.0	0.0	0.0
Phase Call Probability		1.00					1.00	
Max Out Probability		0.02					1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14					2	12	1	6	
Adjusted Flow Rate (*v*), veh/h		150						1300	360	70	580	
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1604						1680	1456	1586	1617	
Queue Service Time (g_s), s		6.7						13.7	2.7	3.4	14.0	
Cycle Queue Clearance Time (g_c), s		6.7						13.7	2.7	3.4	14.0	
Green Ratio (g/C)		0.19						0.55	0.55	0.08	0.43	
Capacity (*c*), veh/h		301						1848	801	119	1382	
Volume-to-Capacity Ratio (*X*)		0.499						0.703	0.450	0.588	0.420	
Available Capacity (c_a), veh/h		301						1848	801	119	1382	
Back of Queue (*Q*), veh/ln (50th percentile)		2.4						2.3	0.6	1.4	6.4	
Queue Storage Ratio (*RQ*) (50th percentile)		0.00						0.00	0.00	0.17	0.00	
Uniform Delay (d_1), s/veh		29.1						4.8	1.6	35.2	18.8	
Incremental Delay (d_2), s/veh		0.5						0.8	0.6	4.6	0.8	
Initial Queue Delay (d_3), s/veh		0.0						0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh		29.6						5.6	2.2	39.8	19.6	
Level of Service (LOS)		C						A	A	D	B	
Approach Delay, s/veh / LOS	29.6	C		0.0			4.8	A		21.8	C	
Intersection Delay, s/veh / LOS	10.8						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.9	C	2.9	C	1.9	A	1.3	A
Bicycle LOS Score / LOS	0.7	A			1.9	A	1.0	A

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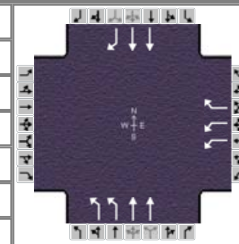
HCS 2010 Signalized Intersection Results Summary

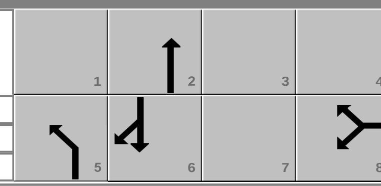
General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	AM	PHF	1.00
Intersection	I-90 Westbound	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline am 2035.xus				
Project Description	I-90/Timberline IMJR				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				360		60	490	540			550	150

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	22.0	25.0	18.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	1.0	1.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8	5	2		6
Case Number				9.0	2.0	4.0		7.3
Phase Duration, s				23.0	27.0	57.0		30.0
Change Period, ($Y+R_c$), s				5.0	5.0	5.0		5.0
Max Allow Headway (MAH), s				3.1	3.0	0.0		0.0
Queue Clearance Time (g_s), s				10.1	13.8			
Green Extension Time (g_e), s				0.6	0.8	0.0		0.0
Phase Call Probability				1.00	1.00			
Max Out Probability				0.02	0.02			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18	5	2			6	16
Adjusted Flow Rate (v), veh/h				360		60	490	540			550	150
Adjusted Saturation Flow Rate (s), veh/h/ln				1564		1439	1579	1614			1615	1425
Queue Service Time (g_s), s				8.1		2.7	11.8	5.7			11.3	6.5
Cycle Queue Clearance Time (g_c), s				8.1		2.7	11.8	5.7			11.3	6.5
Green Ratio (g/C)				0.22		0.22	0.28	0.65			0.31	0.31
Capacity (c), veh/h				704		324	868	2098			1009	445
Volume-to-Capacity Ratio (X)				0.511		0.185	0.564	0.257			0.545	0.337
Available Capacity (c_a), veh/h				704		324	868	2098			1009	445
Back of Queue (Q), veh/ln (50th percentile)				2.8		0.9	4.7	1.5			4.2	2.2
Queue Storage Ratio (RQ) (50th percentile)				0.00		0.00	0.00	0.00			0.00	0.00
Uniform Delay (d_1), s/veh				27.1		25.1	31.0	6.0			22.8	21.1
Incremental Delay (d_2), s/veh				0.3		0.1	0.4	0.2			2.1	2.1
Initial Queue Delay (d_3), s/veh				0.0		0.0	0.0	0.0			0.0	0.0
Control Delay (d), s/veh				27.4		25.2	31.5	6.3			24.9	23.2
Level of Service (LOS)				C		C	C	A			C	C

	EB		WB		NB		SB	
Approach Delay, s/veh / LOS	0.0		27.1	C	18.3	B	24.5	C
Intersection Delay, s/veh / LOS	22.0				C			

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.0	C	2.9	C	1.9	A	2.4	B
Bicycle LOS Score / LOS				F	1.3	A	1.1	A

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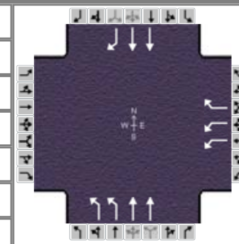
HCS 2010 Signalized Intersection Results Summary

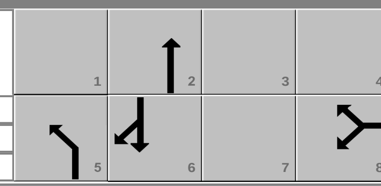
General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	PM	PHF	1.00
Intersection	I-90 Westbound	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline pm 2035.xus				
Project Description	I-90/Timberline IMJR				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				300		70	650	800			350	130

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	29.0	19.0	17.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	1.0	1.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8	5	2		6
Case Number				9.0	2.0	4.0		7.3
Phase Duration, s				22.0	34.0	58.0		24.0
Change Period, (Y+R_c), s				5.0	5.0	5.0		5.0
Max Allow Headway (*MAH*), s				3.1	3.0	0.0		0.0
Queue Clearance Time (g_s), s				8.7	16.2			
Green Extension Time (g_e), s				0.6	1.4	0.0		0.0
Phase Call Probability				1.00	1.00			
Max Out Probability				0.01	0.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18	5	2			6	16
Adjusted Flow Rate (*v*), veh/h				300		70	650	800			350	130
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1558		1433	1598	1636			1598	1422
Queue Service Time (g_s), s				6.7		3.2	14.2	9.0			7.5	6.1
Cycle Queue Clearance Time (g_c), s				6.7		3.2	14.2	9.0			7.5	6.1
Green Ratio (*g/C*)				0.21		0.21	0.36	0.66			0.24	0.24
Capacity (*c*), veh/h				662		305	1158	2168			759	338
Volume-to-Capacity Ratio (*X*)				0.453		0.230	0.561	0.369			0.461	0.385
Available Capacity (c_a), veh/h				662		305	1158	2168			759	338
Back of Queue (*Q*), veh/ln (50th percentile)				2.3		1.0	5.4	2.3			2.8	2.2
Queue Storage Ratio (*RQ*) (50th percentile)				0.00		0.00	0.00	0.00			0.00	0.00
Uniform Delay (d_1), s/veh				27.4		26.1	24.5	6.3			26.1	25.6
Incremental Delay (d_2), s/veh				0.2		0.1	0.3	0.3			2.0	3.3
Initial Queue Delay (d_3), s/veh				0.0		0.0	0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh				27.6		26.2	24.8	6.6			28.1	28.9
Level of Service (LOS)				C		C	C	A			C	C

	EB		WB		NB		SB	
Approach Delay, s/veh / LOS	0.0		27.4	C	14.8	B	28.4	C
Intersection Delay, s/veh / LOS	19.6				B			

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.0	C	2.9	C	1.9	A	2.4	B
Bicycle LOS Score / LOS				F	1.7	A	0.9	A

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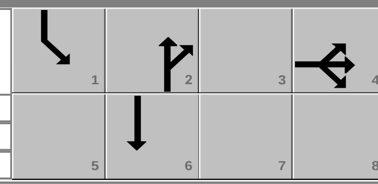
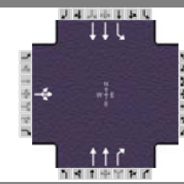
HCS 2010 Interchanges Results Summary

General Information				Interchange Information	
Agency	HDR			Interchange Type	Diamond
Analyst	RL	Analysis Date	1/3/2014	Segment Distance, ft	925
Jurisdiction	Minnehaha Co.	Duration,h	1.00	Freeway Direction	East-West
Intersection	I-90 Westbound	PHF	1.00	Arterial Direction	North-South
File Name	timberline am 2035.xus				
Project Description	I-90/Timberline IMJR				

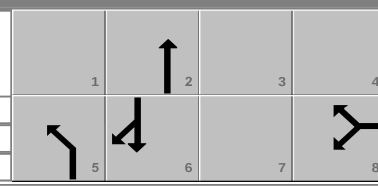
Demand	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Intersection One Demand (*v*), veh/h	130	0	0					900	280	70	840	
Intersection Two Demand (*v*), veh/h				360		60	490	540			550	150

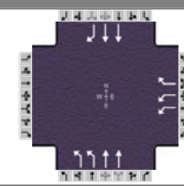
Signal One Information								
Cycle, s	80.0							
Offset, s	0	Green	9.0	39.0	17.0	0.0	0.0	0.0
Uncoordinated	No	Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Force Mode	Fixed	Red	1.0	1.0	1.0	0.0	0.0	0.0





Signal Two Information								
Cycle, s	80.0							
Offset, s	0	Green	22.0	25.0	18.0	0.0	0.0	0.0
Uncoordinated	No	Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Force Mode	Fixed	Red	1.0	1.0	1.0	0.0	0.0	0.0





Interchange Results

O-D	O-D Demand Movements	Demand (veh/h)	Delay (s)	LOS
A	WBL - WBU	360	40.3	C
B	WBR	60	25.2	B
C	EBR	0	0.0	A
D	EBL - EBU	130	33.5	C
E	NBL(INT) - EBU	490	39.6	C
F	NBR(EXT)	280	8.1	A
G	SBR(EXT)	150	23.2	B
H	SBL(INT) - WBU	70	57.2	D
I	NBT(INT) - EBL + EBU	410	6.3	A
J	SBT(INT) - WBL + WBU	480	12.9	A
K	WBT	0	-	-
L	EBT	0	-	-
M	WBU	0	-	-
N	EBU	0	-	-

Signalized Intersection One Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh		27.3						8.1	3.7	32.3	12.9	
Level of Service (LOS)		C						A	A	C	B	
Approach Delay, s/veh / LOS	27.3		C	0.0			7.1		A	14.4		B
Intersection Delay, s/veh / LOS	11.2						B					

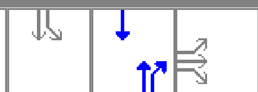
Signalized Intersection Two Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh				27.4		25.2	31.5	6.3			24.9	23.2
Level of Service (LOS)				C		C	C	A			C	C
Approach Delay, s/veh / LOS	0.0			27.1		C	18.3		B	24.5		C
Intersection Delay, s/veh / LOS	22.0						C					

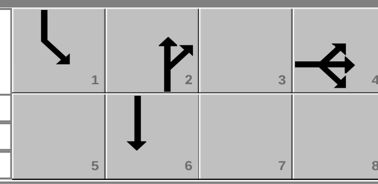
HCS 2010 Interchanges Results Summary

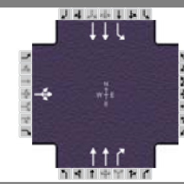
General Information				Interchange Information	
Agency	HDR			Interchange Type	Diamond
Analyst	RL	Analysis Date	1/3/2014	Segment Distance, ft	925
Jurisdiction	Minnehaha Co.	Duration,h	1.00	Freeway Direction	East-West
Intersection	I-90 Westbound	PHF	1.00	Arterial Direction	North-South
File Name	timberline pm 2035.xus				
Project Description	I-90/Timberline IMJR				

Demand	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Intersection One Demand (*v*), veh/h	150	0	0					1300	360	70	580	
Intersection Two Demand (*v*), veh/h				300		70	650	800			350	130

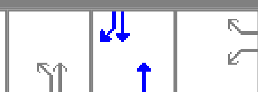
Signal One Information								
Cycle, s	80.0							
Offset, s	0	Green	6.0	44.0	15.0	0.0	0.0	0.0
Uncoordinated	No	Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Force Mode	Fixed	Red	1.0	1.0	1.0	0.0	0.0	0.0

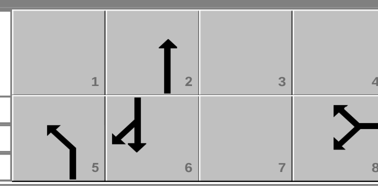


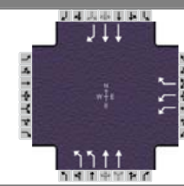




Signal Two Information								
Cycle, s	80.0							
Offset, s	0	Green	29.0	19.0	17.0	0.0	0.0	0.0
Uncoordinated	No	Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Force Mode	Fixed	Red	1.0	1.0	1.0	0.0	0.0	0.0







Interchange Results

O-D	O-D Demand Movements	Demand (veh/h)	Delay (s)	LOS
A	WBL - WBU	300	47.2	C
B	WBR	70	26.2	B
C	EBR	0	0.0	A
D	EBL - EBU	150	36.2	C
E	NBL(INT) - EBU	650	30.4	C
F	NBR(EXT)	360	5.6	A
G	SBR(EXT)	130	28.9	B
H	SBL(INT) - WBU	70	68.0	D
I	NBT(INT) - EBL + EBU	650	6.6	A
J	SBT(INT) - WBL + WBU	280	19.6	B
K	WBT	0	-	-
L	EBT	0	-	-
M	WBU	0	-	-
N	EBU	0	-	-

Signalized Intersection One Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh		29.6						5.6	2.2	39.8	19.6	
Level of Service (LOS)		C						A	A	D	B	
Approach Delay, s/veh / LOS	29.6		C	0.0			4.8		A	21.8		C
Intersection Delay, s/veh / LOS	10.8						B					

Signalized Intersection Two Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh				27.6		26.2	24.8	6.6			28.1	28.9
Level of Service (LOS)				C		C	C	A			C	C
Approach Delay, s/veh / LOS	0.0			27.4		C	14.8		B	28.4		C
Intersection Delay, s/veh / LOS	19.6						B					

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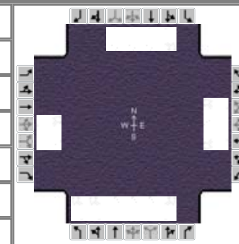
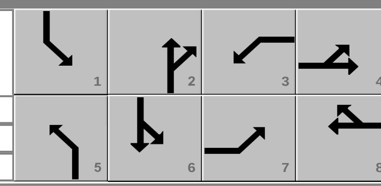
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/20/2014	Area Type	Other
Jurisdiction	SIOUX FALLS	Time Period	AM PEAK	PHF	1.00
Intersection	60TH ST. N.	Analysis Year	2035	Analysis Period	1> 7:00
File Name	2035 AM.xus				
Project Description	CORRIDOR TRAFFIC ANALYSIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	180	40		270	60	100	400	900	160	180	930	

Signal Information										
Cycle, s	80.0	Reference Phase	2							
Offset, s	8	Reference Point	Begin	Green	10.0	1.0	19.0	15.0	15.0	0.0
Uncoordinated	No	Simult. Gap E/W	On	Yellow	4.0	0.0	4.0	4.0	4.0	0.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	0.0	1.0	1.0	1.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8	5	2	1	6
Case Number	1.1	4.0	2.0	3.0	2.0	3.0	1.1	4.0
Phase Duration, s	20.0	20.0	20.0	20.0	16.0	25.0	15.0	24.0
Change Period, (Y+R_c), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (MAH), s	3.0	3.1	3.0	3.1	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s	8.0	3.5	14.4	6.7	6.8		6.7	
Green Extension Time (g_e), s	0.2	0.3	0.0	0.2	0.2	0.0	0.1	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00		1.00	
Max Out Probability	0.01	0.00	1.00	0.00	0.23		0.73	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4		3	8	18	5	2	12	1	6	
Adjusted Flow Rate (v), veh/h	180	40		270	60	100	202	454	81	136	704	
Adjusted Saturation Flow Rate (s), veh/h/ln	1681	1765		1681	1765	1496	1570	1542	1439	1617	1542	
Queue Service Time (g_s), s	6.0	1.5		12.4	2.3	4.7	4.8	6.2	3.5	4.7	11.6	
Cycle Queue Clearance Time (g_c), s	6.0	1.5		12.4	2.3	4.7	4.8	6.2	3.5	4.7	11.6	
Green Ratio (g/C)	0.38	0.19		0.19	0.19	0.19	0.14	0.25	0.25	0.36	0.24	
Capacity (c), veh/h	584	331		315	331	280	432	1156	360	425	1099	
Volume-to-Capacity Ratio (X)	0.308	0.121		0.857	0.181	0.357	0.467	0.392	0.224	0.321	0.641	
Available Capacity (c_a), veh/h	584	331		315	331	280	432	1156	360	425	1099	
Back of Queue (Q), veh/ln (50th percentile)	2.1	0.6		6.7	0.9	1.6	1.7	2.1	1.2	1.6	4.6	
Queue Storage Ratio (RQ) (50th percentile)	0.27	0.00		0.85	0.00	0.27	0.22	0.00	0.16	0.21	0.00	
Uniform Delay (d_1), s/veh	17.6	27.0		31.5	27.3	28.3	32.1	23.0	23.1	18.4	31.7	
Incremental Delay (d_2), s/veh	0.1	0.1		23.1	0.1	0.3	0.2	0.8	1.2	0.1	2.1	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay (d), s/veh	17.7	27.1		54.6	27.4	28.6	32.3	23.8	24.3	18.5	33.8	
Level of Service (LOS)	B	C		D	C	C	C	C	C	B	C	
Approach Delay, s/veh / LOS	19.4	B		44.7	D		26.2	C		31.3	C	
Intersection Delay, s/veh / LOS	31.0						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.5	C	3.3	C	2.4	B	2.7	B
Bicycle LOS Score / LOS	0.9	A	1.2	A	1.3	A	1.1	A

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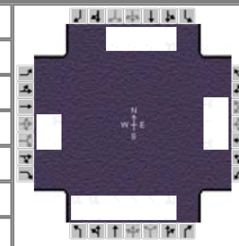
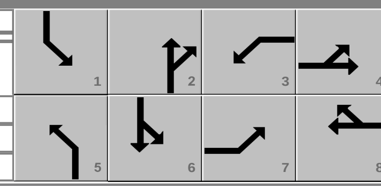
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/20/2014	Area Type	Other
Jurisdiction	SIOUX FALLS	Time Period	PM PEAK	PHF	1.00
Intersection	60TH ST. N.	Analysis Year	2035	Analysis Period	1> 7:00
File Name	2035 PM.xus				
Project Description	CORRIDOR TRAFFIC ANALYSIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	200	70		210	50	80	370	1380	220	130	830	

Signal Information											
Cycle, s	80.0	Reference Phase	2								
Offset, s	5	Reference Point	Begin	Green	7.0	0.0	22.0	10.0	1.0	15.0
Uncoordinated	No	Simult. Gap E/W	On	Yellow	4.0	4.0	4.0	4.0	0.0	4.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	1.0	1.0	0.0	1.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8	5	2	1	6
Case Number	1.1	4.0	2.0	3.0	2.0	3.0	1.1	4.0
Phase Duration, s	15.0	20.0	16.0	21.0	17.0	32.0	12.0	27.0
Change Period, ($Y+R_c$), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.0	3.1	3.0	3.1	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s	9.4	4.7	11.9	5.6	6.0		4.7	
Green Extension Time (g_e), s	0.0	0.2	0.0	0.2	0.2	0.0	0.0	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00		1.00	
Max Out Probability	1.00	0.00	1.00	0.00	0.02		1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4		3	8	18	5	2	12	1	6	
Adjusted Flow Rate (*v*), veh/h	200	70		210	50	80	179	666	106	79	501	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1681	1765		1681	1765	1496	1570	1542	1439	1617	1542	
Queue Service Time (g_s), s	7.4	2.7		9.9	1.9	3.6	4.0	8.4	4.3	2.7	7.0	
Cycle Queue Clearance Time (g_c), s	7.4	2.7		9.9	1.9	3.6	4.0	8.4	4.3	2.7	7.0	
Green Ratio (g/C)	0.31	0.19		0.14	0.20	0.20	0.15	0.34	0.34	0.36	0.28	
Capacity (*c*), veh/h	505	331		231	353	299	471	1561	486	384	1272	
Volume-to-Capacity Ratio (*X*)	0.396	0.212		0.909	0.142	0.267	0.379	0.427	0.219	0.204	0.394	
Available Capacity (c_a), veh/h	505	331		231	353	299	471	1561	486	384	1272	
Back of Queue (*Q*), veh/ln (50th percentile)	2.7	1.1		6.9	0.7	1.2	1.4	2.7	1.4	1.0	2.4	
Queue Storage Ratio (*RQ*) (50th percentile)	0.34	0.00		0.88	0.00	0.21	0.19	0.00	0.19	0.13	0.00	
Uniform Delay (d_1), s/veh	21.5	27.5		34.0	26.3	27.0	29.8	18.8	19.4	19.0	23.5	
Incremental Delay (d_2), s/veh	0.2	0.1		49.6	0.1	0.2	0.1	0.7	0.8	0.1	0.8	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh	21.7	27.6		83.6	26.4	27.2	29.9	19.4	20.2	19.1	24.3	
Level of Service (LOS)	C	C		F	C	C	C	B	C	B	C	
Approach Delay, s/veh / LOS	23.2	C		61.9	E		21.5	C		23.6	C	
Intersection Delay, s/veh / LOS	28.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.5	C	3.3	C	2.4	B	2.7	B
Bicycle LOS Score / LOS	0.9	A	1.0	A	1.6	A	1.0	A

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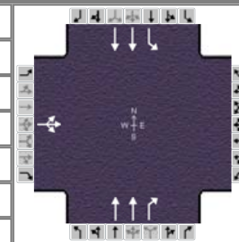
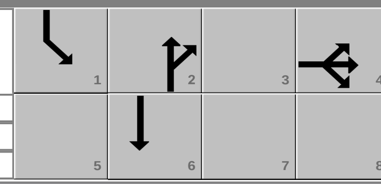
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	AM	PHF	1.00
Intersection	I-90 Eastbound	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline am 2035.xus				
Project Description	I-90/Timberline IMJR				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	130	0	0					900	280	70	840	

Signal Information										
Cycle, s	80.0	Reference Phase	2							
Offset, s	0	Reference Point	Begin	Green	9.0	39.0	17.0	0.0	0.0	0.0
Uncoordinated	No	Simult. Gap E/W	On	Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	1.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2	1	6
Case Number		12.0				7.3	2.0	4.0
Phase Duration, s		22.0				44.0	14.0	58.0
Change Period, ($Y+R_c$), s		5.0				5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.0				0.0	3.0	0.0
Queue Clearance Time (g_s), s		7.6					5.1	
Green Extension Time (g_e), s		0.1				0.0	0.0	0.0
Phase Call Probability		1.00					1.00	
Max Out Probability		0.00					0.24	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14					2	12	1	6	
Adjusted Flow Rate (*v*), veh/h		130						900	280	70	840	
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1600						1604	1444	1586	1640	
Queue Service Time (g_s), s		5.6						11.2	3.2	3.1	19.1	
Cycle Queue Clearance Time (g_c), s		5.6						11.2	3.2	3.1	19.1	
Green Ratio (g/C)		0.21						0.49	0.49	0.11	0.51	
Capacity (*c*), veh/h		340						1564	704	178	1683	
Volume-to-Capacity Ratio (*X*)		0.382						0.575	0.398	0.392	0.499	
Available Capacity (c_a), veh/h		340						1564	704	178	1683	
Back of Queue (*Q*), veh/ln (50th percentile)		2.0						2.7	0.8	1.1	8.5	
Queue Storage Ratio (*RQ*) (50th percentile)		0.00						0.00	0.00	0.14	0.00	
Uniform Delay (d_1), s/veh		27.0						7.8	3.0	29.5	20.1	
Incremental Delay (d_2), s/veh		0.3						1.0	1.1	0.4	0.9	
Initial Queue Delay (d_3), s/veh		0.0						0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh		27.3						8.8	4.1	29.9	21.0	
Level of Service (LOS)		C						A	A	C	C	
Approach Delay, s/veh / LOS	27.3		C	0.0			7.7		A	21.7		C
Intersection Delay, s/veh / LOS	14.6						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.9	C	2.9	C	1.9	A	1.3	A
Bicycle LOS Score / LOS	0.7	A			1.5	A	1.2	A

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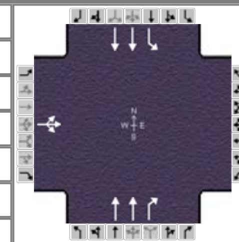
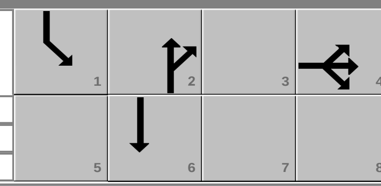
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	PM	PHF	1.00
Intersection	I-90 Eastbound	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline pm 2035.xus				
Project Description	I-90/Timberline IMJR				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	150	0	0					1300	360	70	580	

Signal Information										
Cycle, s	80.0	Reference Phase	2							
Offset, s	0	Reference Point	Begin	Green	10.0	40.0	15.0	0.0	0.0	0.0
Uncoordinated	No	Simult. Gap E/W	On	Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	1.0	0.0	0.0	0.0



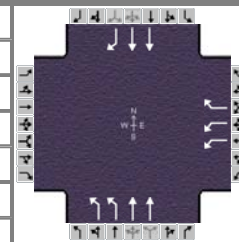
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2	1	6
Case Number		12.0				7.3	2.0	4.0
Phase Duration, s		20.0				45.0	15.0	60.0
Change Period, (Y+R_c), s		5.0				5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.0				0.0	3.0	0.0
Queue Clearance Time (g_s), s		8.7					9.4	
Green Extension Time (g_e), s		0.1				0.0	0.0	0.0
Phase Call Probability		1.00					1.00	
Max Out Probability		0.02					1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14					2	12	1	6	
Adjusted Flow Rate (*v*), veh/h		150						1300	360	70	580	
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1604						1646	1456	1586	1617	
Queue Service Time (g_s), s		6.7						20.4	5.8	3.1	13.8	
Cycle Queue Clearance Time (g_c), s		6.7						20.4	5.8	3.1	13.8	
Green Ratio (*g/C*)		0.13						0.50	0.50	0.07	0.48	
Capacity (*c*), veh/h		215						1646	728	113	1544	
Volume-to-Capacity Ratio (*X*)		0.699						0.790	0.494	0.619	0.376	
Available Capacity (c_a), veh/h		301						1646	728	113	1544	
Back of Queue (*Q*), veh/ln (50th percentile)		2.5						3.8	1.2	1.2	6.2	
Queue Storage Ratio (*RQ*) (50th percentile)		0.00						0.00	0.00	0.15	0.00	
Uniform Delay (d_1), s/veh		29.1						8.3	3.9	28.3	18.3	
Incremental Delay (d_2), s/veh		1.6						1.4	0.8	6.8	0.6	
Initial Queue Delay (d_3), s/veh		0.0						0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh		30.7						9.7	4.8	35.2	18.9	
Level of Service (LOS)		C						A	A	D	B	
Approach Delay, s/veh / LOS	30.7		C	0.0			8.7		A	20.6		C
Intersection Delay, s/veh / LOS	13.2						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.9	C	2.9	C	1.9	A	1.3	A
Bicycle LOS Score / LOS	0.7	A			1.9	A	1.0	A

HCS 2010 Signalized Intersection Results Summary

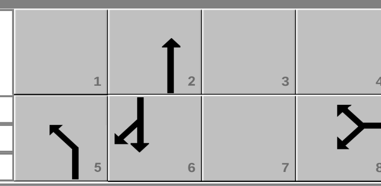
General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	AM	PHF	1.00
Intersection	I-90 Westbound	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline am 2035.xus				
Project Description	I-90/Timberline IMJR				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h				360		60	490	540			550	150

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	22.0	25.0	18.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	1.0	1.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8	5	2		6
Case Number				9.0	2.0	4.0		7.3
Phase Duration, s				23.0	27.0	57.0		30.0
Change Period, (Y+R_c), s				5.0	5.0	5.0		5.0
Max Allow Headway (MAH), s				3.1	3.0	0.0		0.0
Queue Clearance Time (g_s), s				10.1	12.9			
Green Extension Time (g_e), s				0.6	0.9	0.0		0.0
Phase Call Probability				1.00	1.00			
Max Out Probability				0.02	0.01			

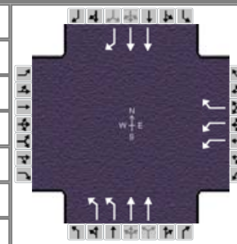
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18	5	2			6	16
Adjusted Flow Rate (v), veh/h				360		60	490	540			550	150
Adjusted Saturation Flow Rate (s), veh/h/ln				1564		1439	1579	1614			1648	1425
Queue Service Time (g_s), s				8.1		2.7	10.9	4.7			11.0	6.5
Cycle Queue Clearance Time (g_c), s				8.1		2.7	10.9	4.7			11.0	6.5
Green Ratio (g/C)				0.22		0.22	0.28	0.65			0.31	0.31
Capacity (c), veh/h				704		324	868	2098			1030	445
Volume-to-Capacity Ratio (X)				0.511		0.185	0.564	0.257			0.534	0.337
Available Capacity (c_a), veh/h				704		324	868	2098			1030	445
Back of Queue (Q), veh/ln (50th percentile)				2.8		0.9	3.9	1.2			4.1	2.2
Queue Storage Ratio (RQ) (50th percentile)				0.00		0.00	0.00	0.00			0.00	0.00
Uniform Delay (d_1), s/veh				27.1		25.1	26.1	4.7			22.7	21.1
Incremental Delay (d_2), s/veh				0.3		0.1	0.4	0.2			2.0	2.1
Initial Queue Delay (d_3), s/veh				0.0		0.0	0.0	0.0			0.0	0.0
Control Delay (d), s/veh				27.4		25.2	26.5	4.9			24.7	23.2
Level of Service (LOS)				C		C	C	A			C	C

	EB		WB		NB		SB	
Approach Delay, s/veh / LOS	0.0		27.1	C	15.2	B	24.4	C
Intersection Delay, s/veh / LOS	20.5				C			

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.0	C	2.9	C	1.9	A	2.4	B
Bicycle LOS Score / LOS				F	1.3	A	1.1	A

HCS 2010 Signalized Intersection Results Summary

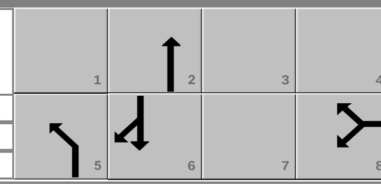
General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	PM	PHF	1.00
Intersection	I-90 Westbound	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline pm 2035.xus				
Project Description	I-90/Timberline IMJR				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				300		70	650	800			350	130

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	29.0	19.0	17.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	1.0	1.0	0.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8	5	2		6
Case Number				9.0	2.0	4.0		7.3
Phase Duration, s				22.0	34.0	58.0		24.0
Change Period, ($Y+R_c$), s				5.0	5.0	5.0		5.0
Max Allow Headway (*MAH*), s				3.1	3.0	0.0		0.0
Queue Clearance Time (g_s), s				8.7	14.5			
Green Extension Time (g_e), s				0.6	1.4	0.0		0.0
Phase Call Probability				1.00	1.00			
Max Out Probability				0.01	0.00			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3		18	5	2			6	16
Adjusted Flow Rate (*v*), veh/h				300		70	650	800			350	130
Adjusted Saturation Flow Rate (*s*), veh/h/ln				1558		1433	1598	1636			1631	1422
Queue Service Time (g_s), s				6.7		3.2	12.5	6.2			7.3	6.1
Cycle Queue Clearance Time (g_c), s				6.7		3.2	12.5	6.2			7.3	6.1
Green Ratio (*g/C*)				0.21		0.21	0.36	0.66			0.24	0.24
Capacity (*c*), veh/h				662		305	1158	2168			775	338
Volume-to-Capacity Ratio (*X*)				0.453		0.230	0.561	0.369			0.452	0.385
Available Capacity (c_a), veh/h				662		305	1158	2168			775	338
Back of Queue (*Q*), veh/ln (50th percentile)				2.3		1.0	4.0	1.3			2.8	2.2
Queue Storage Ratio (*RQ*) (50th percentile)				0.00		0.00	0.00	0.00			0.00	0.00
Uniform Delay (d_1), s/veh				27.4		26.1	18.8	3.8			26.1	25.6
Incremental Delay (d_2), s/veh				0.2		0.1	0.2	0.3			1.9	3.3
Initial Queue Delay (d_3), s/veh				0.0		0.0	0.0	0.0			0.0	0.0
Control Delay (*d*), s/veh				27.6		26.2	19.0	4.0			28.0	28.9
Level of Service (LOS)				C		C	B	A			C	C

	EB		WB		NB		SB	
Approach Delay, s/veh / LOS	0.0		27.4	C	10.8	B	28.2	C
Intersection Delay, s/veh / LOS	17.1				B			

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.0	C	2.9	C	1.9	A	2.4	B
Bicycle LOS Score / LOS				F	1.7	A	0.9	A

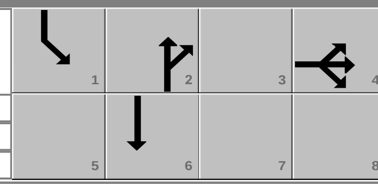
 HCS 2010™ Streets Version 6.50 Generated: 1/3/2014 1:00:42 PM

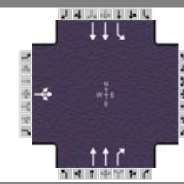
HCS 2010 Interchanges Results Summary

General Information				Interchange Information	
Agency	HDR			Interchange Type	Diamond
Analyst	RL	Analysis Date	1/3/2014	Segment Distance, ft	300
Jurisdiction	Minnehaha Co.	Duration,h	1.00	Freeway Direction	East-West
Intersection	I-90 Westbound	PHF	1.00	Arterial Direction	North-South
File Name	timberline am 2035.xus				
Project Description	I-90/Timberline IMJR				

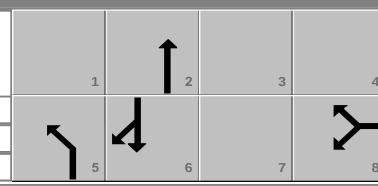
Demand	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Intersection One Demand (*v*), veh/h	130	0	0					900	280	70	840	
Intersection Two Demand (*v*), veh/h				360		60	490	540			550	150

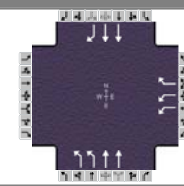
Signal One Information								
Cycle, s	80.0							
Offset, s	0	Green	9.0	39.0	17.0	0.0	0.0	0.0
Uncoordinated	No	Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Force Mode	Fixed	Red	1.0	1.0	1.0	0.0	0.0	0.0





Signal Two Information								
Cycle, s	80.0							
Offset, s	0	Green	22.0	25.0	18.0	0.0	0.0	0.0
Uncoordinated	No	Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Force Mode	Fixed	Red	1.0	1.0	1.0	0.0	0.0	0.0





Interchange Results

O-D	O-D Demand Movements	Demand (veh/h)	Delay (s)	LOS
A	WBL - WBU	360	48.4	C
B	WBR	60	25.2	B
C	EBR	0	0.0	A
D	EBL - EBU	130	32.2	C
E	NBL(INT) - EBU	490	35.3	C
F	NBR(EXT)	280	8.8	A
G	SBR(EXT)	150	23.2	B
H	SBL(INT) - WBU	70	54.6	C
I	NBT(INT) - EBL + EBU	410	4.9	A
J	SBT(INT) - WBL + WBU	480	21.0	B
K	WBT	0	-	-
L	EBT	0	-	-
M	WBU	0	-	-
N	EBU	0	-	-

Signalized Intersection One Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh		27.3						8.8	4.1	29.9	21.0	
Level of Service (LOS)		C						A	A	C	C	
Approach Delay, s/veh / LOS	27.3	C		0.0			7.7	A		21.7	C	
Intersection Delay, s/veh / LOS	14.6						B					

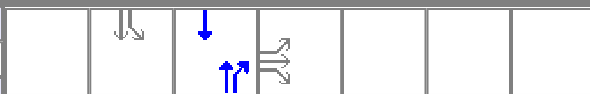
Signalized Intersection Two Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh				27.4		25.2	26.5	4.9			24.7	23.2
Level of Service (LOS)				C		C	C	A			C	C
Approach Delay, s/veh / LOS	0.0			27.1	C		15.2	B		24.4	C	
Intersection Delay, s/veh / LOS	20.5						C					

HCS 2010 Interchanges Results Summary

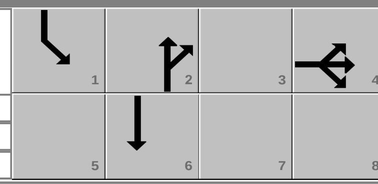
General Information				Interchange Information	
Agency	HDR			Interchange Type	Diamond
Analyst	RL	Analysis Date	1/3/2014	Segment Distance, ft	300
Jurisdiction	Minnehaha Co.	Duration,h	1.00	Freeway Direction	East-West
Intersection	I-90 Westbound	PHF	1.00	Arterial Direction	North-South
File Name	timberline pm 2035.xus				
Project Description	I-90/Timberline IMJR				

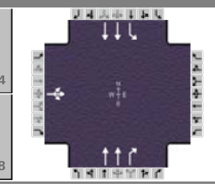
Demand	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Intersection One Demand (*v*), veh/h	150	0	0					1300	360	70	580	
Intersection Two Demand (*v*), veh/h				300		70	650	800			350	130

Signal One Information	
Cycle, s	80.0
Offset, s	0
Uncoordinated	No
Force Mode	Fixed

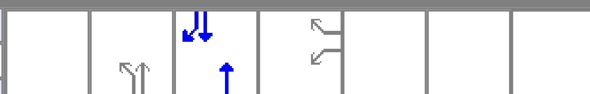


Green	10.0	40.0	15.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	1.0	1.0	0.0	0.0	0.0

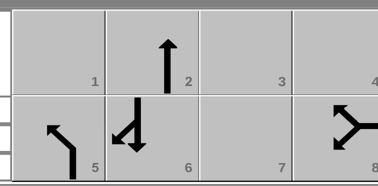


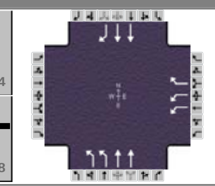


Signal Two Information	
Cycle, s	80.0
Offset, s	0
Uncoordinated	No
Force Mode	Fixed



Green	29.0	19.0	17.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	1.0	1.0	0.0	0.0	0.0





Interchange Results

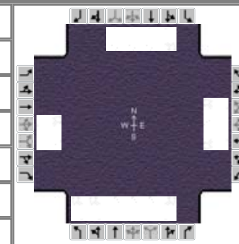
O-D	O-D Demand Movements	Demand (veh/h)	Delay (s)	LOS
A	WBL - WBU	300	46.5	C
B	WBR	70	26.2	B
C	EBR	0	0.0	A
D	EBL - EBU	150	34.7	C
E	NBL(INT) - EBU	650	28.8	B
F	NBR(EXT)	360	9.7	A
G	SBR(EXT)	130	28.9	B
H	SBL(INT) - WBU	70	63.1	D
I	NBT(INT) - EBL + EBU	650	4.0	A
J	SBT(INT) - WBL + WBU	280	18.9	B
K	WBT	0	-	-
L	EBT	0	-	-
M	WBU	0	-	-
N	EBU	0	-	-

Signalized Intersection One Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh		30.7						9.7	4.8	35.2	18.9	
Level of Service (LOS)		C						A	A	D	B	
Approach Delay, s/veh / LOS	30.7		C	0.0			8.7		A	20.6		C
Intersection Delay, s/veh / LOS	13.2						B					

Signalized Intersection Two Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh				27.6		26.2	19.0	4.0			28.0	28.9
Level of Service (LOS)				C		C	B	A			C	C
Approach Delay, s/veh / LOS	0.0			27.4		C	10.8		B	28.2		C
Intersection Delay, s/veh / LOS	17.1						B					

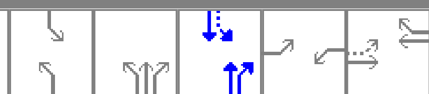
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/20/2014	Area Type	Other
Jurisdiction	SIOUX FALLS	Time Period	AM PEAK	PHF	1.00
Intersection	60TH ST. N.	Analysis Year	2035	Analysis Period	1> 7:00
File Name	2035 AM.xus				
Project Description	CORRIDOR TRAFFIC ANALYSIS				

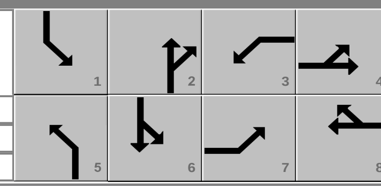


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	180	40		270	60	100	400	900	160	180	930	

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	8	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	10.0	1.0	19.0	15.0	15.0	0.0
Yellow	4.0	0.0	4.0	4.0	4.0	0.0
Red	1.0	0.0	1.0	1.0	1.0	0.0



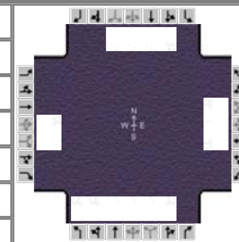
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8	5	2	1	6
Case Number	1.1	4.0	2.0	3.0	2.0	3.0	1.1	4.0
Phase Duration, s	20.0	20.0	20.0	20.0	16.0	25.0	15.0	24.0
Change Period, (Y+R_c), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.0	3.1	3.0	3.1	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s	8.0	3.5	14.4	6.7	6.8		6.7	
Green Extension Time (g_e), s	0.2	0.3	0.0	0.2	0.2	0.0	0.1	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00		1.00	
Max Out Probability	0.01	0.00	1.00	0.00	0.23		0.73	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4		3	8	18	5	2	12	1	6	
Adjusted Flow Rate (*v*), veh/h	180	40		270	60	100	202	454	81	136	704	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1681	1765		1681	1765	1496	1570	1542	1439	1617	1542	
Queue Service Time (g_s), s	6.0	1.5		12.4	2.3	4.7	4.8	6.2	3.5	4.7	11.6	
Cycle Queue Clearance Time (g_c), s	6.0	1.5		12.4	2.3	4.7	4.8	6.2	3.5	4.7	11.6	
Green Ratio (*g/C*)	0.38	0.19		0.19	0.19	0.19	0.14	0.25	0.25	0.36	0.24	
Capacity (*c*), veh/h	584	331		315	331	280	432	1156	360	425	1099	
Volume-to-Capacity Ratio (*X*)	0.308	0.121		0.857	0.181	0.357	0.467	0.392	0.224	0.321	0.641	
Available Capacity (c_a), veh/h	584	331		315	331	280	432	1156	360	425	1099	
Back of Queue (*Q*), veh/ln (50th percentile)	2.1	0.6		6.7	0.9	1.6	1.7	2.1	1.2	1.6	4.6	
Queue Storage Ratio (*RQ*) (50th percentile)	0.27	0.00		0.85	0.00	0.27	0.22	0.00	0.16	0.21	0.00	
Uniform Delay (d_1), s/veh	17.6	27.0		31.5	27.3	28.3	32.1	23.0	23.1	18.4	31.7	
Incremental Delay (d_2), s/veh	0.1	0.1		23.1	0.1	0.3	0.2	0.8	1.2	0.1	2.1	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh	17.7	27.1		54.6	27.4	28.6	32.3	23.8	24.3	18.5	33.8	
Level of Service (LOS)	B	C		D	C	C	C	C	C	B	C	
Approach Delay, s/veh / LOS	19.4	B		44.7	D		26.2	C		31.3	C	
Intersection Delay, s/veh / LOS	31.0						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.5	C	3.3	C	2.4	B	2.7	B
Bicycle LOS Score / LOS	0.9	A	1.2	A	1.3	A	1.1	A

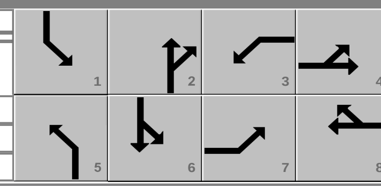
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/20/2014	Area Type	Other
Jurisdiction	SIOUX FALLS	Time Period	PM PEAK	PHF	1.00
Intersection	60TH ST. N.	Analysis Year	2035	Analysis Period	1> 7:00
File Name	2035 PM.xus				
Project Description	CORRIDOR TRAFFIC ANALYSIS				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	200	70		210	50	80	370	1380	220	130	830	

Signal Information										
Cycle, s	80.0	Reference Phase	2							
Offset, s	5	Reference Point	Begin	Green	7.0	0.0	22.0	10.0	1.0	15.0
Uncoordinated	No	Simult. Gap E/W	On	Yellow	4.0	4.0	4.0	4.0	0.0	4.0
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	1.0	1.0	0.0	1.0



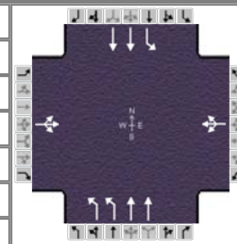
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8	5	2	1	6
Case Number	1.1	4.0	2.0	3.0	2.0	3.0	1.1	4.0
Phase Duration, s	15.0	20.0	16.0	21.0	17.0	32.0	12.0	27.0
Change Period, ($Y+R_c$), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.0	3.1	3.0	3.1	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s	9.4	4.7	11.9	5.6	6.0		4.7	
Green Extension Time (g_e), s	0.0	0.2	0.0	0.2	0.2	0.0	0.0	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00		1.00	
Max Out Probability	1.00	0.00	1.00	0.00	0.02		1.00	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4		3	8	18	5	2	12	1	6	
Adjusted Flow Rate (*v*), veh/h	200	70		210	50	80	179	666	106	79	501	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1681	1765		1681	1765	1496	1570	1542	1439	1617	1542	
Queue Service Time (g_s), s	7.4	2.7		9.9	1.9	3.6	4.0	8.4	4.3	2.7	7.0	
Cycle Queue Clearance Time (g_c), s	7.4	2.7		9.9	1.9	3.6	4.0	8.4	4.3	2.7	7.0	
Green Ratio (*g/C*)	0.31	0.19		0.14	0.20	0.20	0.15	0.34	0.34	0.36	0.28	
Capacity (*c*), veh/h	505	331		231	353	299	471	1561	486	384	1272	
Volume-to-Capacity Ratio (*X*)	0.396	0.212		0.909	0.142	0.267	0.379	0.427	0.219	0.204	0.394	
Available Capacity (c_a), veh/h	505	331		231	353	299	471	1561	486	384	1272	
Back of Queue (*Q*), veh/ln (50th percentile)	2.7	1.1		6.9	0.7	1.2	1.4	2.7	1.4	1.0	2.4	
Queue Storage Ratio (*RQ*) (50th percentile)	0.34	0.00		0.88	0.00	0.21	0.19	0.00	0.19	0.13	0.00	
Uniform Delay (d_1), s/veh	21.5	27.5		34.0	26.3	27.0	29.8	18.8	19.4	19.0	23.5	
Incremental Delay (d_2), s/veh	0.2	0.1		49.6	0.1	0.2	0.1	0.7	0.8	0.1	0.8	
Initial Queue Delay (d_3), s/veh	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Control Delay (*d*), s/veh	21.7	27.6		83.6	26.4	27.2	29.9	19.4	20.2	19.1	24.3	
Level of Service (LOS)	C	C		F	C	C	C	B	C	B	C	
Approach Delay, s/veh / LOS	23.2	C		61.9	E		21.5	C		23.6	C	
Intersection Delay, s/veh / LOS	28.7						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	3.5	C	3.3	C	2.4	B	2.7	B
Bicycle LOS Score / LOS	0.9	A	1.0	A	1.6	A	1.0	A

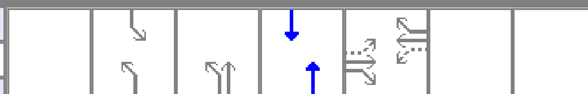
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	AM	PHF	1.00
Intersection	I-90 Eastbound	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline am 2035.xus				
Project Description	I-90/Timberline IMJR				

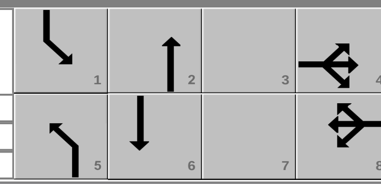


Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	130	0	0	360	0	0	490	410		70	480	

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	9.0	5.0	19.0	27.0	0.0	0.0
Yellow	4.0	4.0	4.0	4.0	0.0	0.0
Red	1.0	1.0	1.0	1.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4		8	5	2	1	6
Case Number		8.0		8.0	2.0	4.0	2.0	4.0
Phase Duration, s		32.0		32.0	24.0	34.0	14.0	24.0
Change Period, ($Y+R_c$), s		5.0		5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.0		3.0	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s		6.4		19.0	18.0		5.3	
Green Extension Time (g_e), s		0.8		0.6	0.2	0.0	0.0	0.0
Phase Call Probability		1.00		1.00	1.00		1.00	
Max Out Probability		0.00		0.04	1.00		0.34	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2		1	6	
Adjusted Flow Rate (*v*), veh/h		130			360		642	538		70	480	
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1505			1442		1597	1614		1586	1609	
Queue Service Time (g_s), s		0.0			12.9		16.0	10.5		3.3	10.7	
Cycle Queue Clearance Time (g_c), s		4.4			17.0		16.0	10.5		3.3	10.7	
Green Ratio (*g/C*)		0.34			0.34		0.24	0.36		0.11	0.24	
Capacity (*c*), veh/h		598			577		758	1170		178	764	
Volume-to-Capacity Ratio (*X*)		0.217			0.624		0.847	0.459		0.392	0.628	
Available Capacity (c_a), veh/h		598			577		758	1170		178	764	
Back of Queue (*Q*), veh/ln (50th percentile)		1.6			5.5		7.5	3.7		1.2	4.2	
Queue Storage Ratio (*RQ*) (50th percentile)		0.00			0.00		0.00	0.00		0.15	0.00	
Uniform Delay (d_1), s/veh		19.0			22.9		36.4	20.6		33.0	27.3	
Incremental Delay (d_2), s/veh		0.1			1.6		6.2	0.9		0.5	4.0	
Initial Queue Delay (d_3), s/veh		0.0			0.0		0.0	0.0		0.0	0.0	
Control Delay (*d*), s/veh		19.1			24.5		42.6	21.4		33.5	31.3	
Level of Service (LOS)		B			C		D	C		C	C	
Approach Delay, s/veh / LOS	19.1		B	24.5		C	32.9		C	31.6		C
Intersection Delay, s/veh / LOS	30.4						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.9	C	2.8	C	2.1	B	2.6	B
Bicycle LOS Score / LOS	0.7	A	1.1	A	1.2	A	0.9	A

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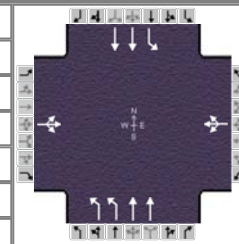
HCS 2010 Signalized Intersection Results Summary

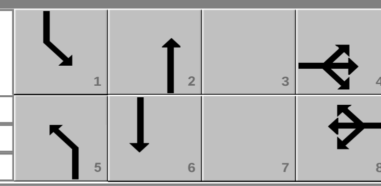
General Information				Intersection Information	
Agency	HDR			Duration, h	1.00
Analyst	RL	Analysis Date	1/3/2014	Area Type	Other
Jurisdiction	Minnehaha Co.	Time Period	PM	PHF	1.00
Intersection	I-90	Analysis Year	2035	Analysis Period	1> 7:00
File Name	timberline pm 2035.xus				
Project Description	I-90/Timberline IMJR				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	150	0	0	300	0	0	650	650		70	280	

Signal Information			
Cycle, s	80.0	Reference Phase	2
Offset, s	0	Reference Point	Begin
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	9.0	10.0	17.0	24.0	0.0	0.0
Yellow	4.0	4.0	4.0	4.0	0.0	0.0
Red	1.0	1.0	1.0	1.0	0.0	0.0



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4		8	5	2	1	6
Case Number		8.0		8.0	2.0	4.0	2.0	4.0
Phase Duration, s		29.0		29.0	29.0	37.0	14.0	22.0
Change Period, ($Y+R_c$), s		5.0		5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s		3.0		3.0	3.0	0.0	3.0	0.0
Queue Clearance Time (g_s), s		7.5		15.8	22.4		5.3	
Green Extension Time (g_e), s		0.7		0.6	0.5	0.0	0.0	0.0
Phase Call Probability		1.00		1.00	1.00		1.00	
Max Out Probability		0.00		0.03	1.00		0.34	

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2		1	6	
Adjusted Flow Rate (*v*), veh/h		150			300		830	830		70	280	
Adjusted Saturation Flow Rate (*s*), veh/h/ln		1498			1446		1619	1639		1586	1593	
Queue Service Time (g_s), s		0.0			8.6		20.4	17.3		3.3	6.1	
Cycle Queue Clearance Time (g_c), s		5.5			13.8		20.4	17.3		3.3	6.1	
Green Ratio (*g/C*)		0.30			0.30		0.30	0.40		0.11	0.21	
Capacity (*c*), veh/h		539			524		971	1311		178	677	
Volume-to-Capacity Ratio (*X*)		0.278			0.573		0.855	0.633		0.392	0.414	
Available Capacity (c_a), veh/h		539			524		971	1311		178	677	
Back of Queue (*Q*), veh/ln (50th percentile)		2.0			4.6		9.3	6.5		1.2	2.3	
Queue Storage Ratio (*RQ*) (50th percentile)		0.00			0.00		0.00	0.00		0.15	0.00	
Uniform Delay (d_1), s/veh		21.5			24.2		36.8	22.3		33.0	27.2	
Incremental Delay (d_2), s/veh		0.1			1.0		2.7	0.8		0.5	1.9	
Initial Queue Delay (d_3), s/veh		0.0			0.0		0.0	0.0		0.0	0.0	
Control Delay (*d*), s/veh		21.6			25.2		39.5	23.1		33.5	29.1	
Level of Service (LOS)		C			C		D	C		C	C	
Approach Delay, s/veh / LOS	21.6		C	25.2		C	31.3		C	30.0		C
Intersection Delay, s/veh / LOS	29.8						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.9	C	2.8	C	2.1	B	2.6	B
Bicycle LOS Score / LOS	0.7	A	1.0	A	1.6	A	0.8	A

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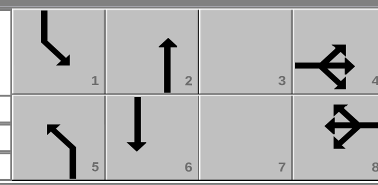
HCS 2010 Interchanges Results Summary

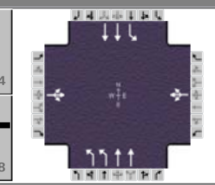
General Information				Interchange Information	
Agency	HDR			Interchange Type	SPUI
Analyst	RL	Analysis Date	1/3/2014	Segment Distance, ft	
Jurisdiction	Minnehaha Co.	Duration,h	1.00	Freeway Direction	East-West
Intersection	I-90 Eastbound	PHF	1.00	Arterial Direction	North-South
File Name	timberline am 2035.xus				
Project Description	I-90/Timberline IMJR				

Demand	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Intersection Demand (v), veh/h	130	0	0	360	0	0	490	410		70	480	

Signal Information	
Cycle, s	80.0
Offset, s	0
Uncoordinated	No
Force Mode	Fixed

Green	9.0	5.0	19.0	27.0	0.0	0.0
Yellow	4.0	4.0	4.0	4.0	0.0	0.0
Red	1.0	1.0	1.0	1.0	0.0	0.0





Interchange Results

O-D	O-D Demand Movements	Demand (veh/h)	Delay (s)	LOS
A	WBL	360	0.0	A
B	WBR	0	0.0	A
C	EBR	0	0.0	A
D	EBL	130	0.0	A
E	NBL	642	42.6	C
F	NBR	0	0.0	A
G	SBR	0	0.0	A
H	SBL	70	33.5	C
I	NBT	538	21.4	B
J	SBT	480	31.3	C
K	WBT	0	-	-
L	EBT	0	-	-
M		0	-	-
N		0	-	-

Signalized Intersection Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh		19.1			24.5		42.6	21.4		33.5	31.3	
Level of Service (LOS)		B			C		D	C		C	C	
Approach Delay, s/veh / LOS	19.1	B		24.5	C		32.9	C		31.6	C	
Intersection Delay, s/veh / LOS	30.4						C					

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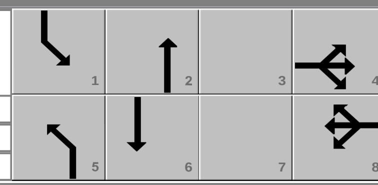
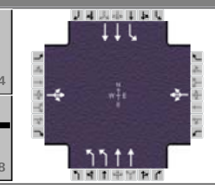
HCS 2010 Interchanges Results Summary

General Information				Interchange Information	
Agency	HDR			Interchange Type	SPUI
Analyst	RL	Analysis Date	1/3/2014	Segment Distance, ft	
Jurisdiction	Minnehaha Co.	Duration,h	1.00	Freeway Direction	East-West
Intersection	I-90	PHF	1.00	Arterial Direction	North-South
File Name	timberline pm 2035.xus				
Project Description	I-90/Timberline IMJR				

Demand	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Intersection Demand (v), veh/h	150	0	0	300	0	0	650	650		70	280	

Signal Information								
Cycle, s	80.0							
Offset, s	0	Green	9.0	10.0	17.0	24.0	0.0	0.0
Uncoordinated	No	Yellow	4.0	4.0	4.0	4.0	0.0	0.0
Force Mode	Fixed	Red	1.0	1.0	1.0	1.0	0.0	0.0





Interchange Results

O-D	O-D Demand Movements	Demand (veh/h)	Delay (s)	LOS
A	WBL	300	0.0	A
B	WBR	0	0.0	A
C	EBR	0	0.0	A
D	EBL	150	0.0	A
E	NBL	830	39.5	C
F	NBR	0	0.0	A
G	SBR	0	0.0	A
H	SBL	70	33.5	C
I	NBT	830	23.1	B
J	SBT	280	29.1	B
K	WBT	0	-	-
L	EBT	0	-	-
M		0	-	-
N		0	-	-

Signalized Intersection Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Control Delay (*d*) , s/veh		21.6			25.2		39.5	23.1		33.5	29.1	
Level of Service (LOS)		C			C		D	C		C	C	
Approach Delay, s/veh / LOS	21.6	C		25.2	C		31.3	C		30.0	C	
Intersection Delay, s/veh / LOS	29.8						C					

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Appendix Part 5—Crash Forecasts

I-90/Timberline Road Interchange

Interchange Safety Analysis Tool

General Output Data

General Interchange Information

Project description:	STD. DIAMOND			
Analyst:	HDR			
Date:	9/4/2012			
Area type:	Rural			
Beginning year of analysis period:	2012			
Ending year of analysis period:	2035			
	Mainline freeway segments	Ramps	Crossroad ramp terminals and intersections	Crossroad segments
Crash data available:	Y	Y	Y	Y
Beginning year of crash data:	2007	2007	2007	2007
Ending year of crash data:	2009	2009	2009	2009

Number of Predicted Crashes for Entire Interchange Area

Number of predicted crashes during analysis period			Average number of predicted crashes per year during analysis period		
Total	FI	PDO	Total	FI	PDO
894.6	249.3	645.2	37.3	10.4	26.9

Number of Predicted Crashes by Interchange Element Type

Interchange element type	Number of sites	Number of predicted crashes during analysis period			MVMT	MEV	Crash rate
		Total	FI	PDO			(per MVMT or MEV)
Mainline freeway segments	10	827.3	232.9	594.3	1,101.840		0.751
Ramps	4	6.1	1.1	5.0	7.398		0.826
Crossroad ramp terminals & ints	2	4.9	2.2	2.7		20.590	0.237
Crossroad segments	6	56.3	13.1	43.2	9.300		6.054
Total	22	894.6	249.3	645.2	1,118.538		0.800

Number of Predicted Crashes by Year

	Total	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Crashes	894.6	41.2	41.6	42.0	42.3	42.7	43.0	43.4	43.8	44.1	44.5
FI Crashes	249.3	11.4	11.5	11.6	11.7	11.9	12.0	12.1	12.2	12.3	12.4
PDO Crashes	645.2	29.8	30.1	30.3	30.6	30.8	31.1	31.3	31.6	31.8	32.1

Number of Predicted Crashes by Collision Type

Collision type	Number and percentage of predicted crashes by collision type					
	Total		FI		PDO	
	No.	%	No.	%	No.	%
All collision types	**894.6**	**100.0%**	**249.3**	**100.0%**	**645.2**	**100.0%**
Single vehicle	*631.6*	*70.6%*	*174.5*	*70.0%*	*457.1*	*70.8%*
Fixed object	187.8	21.0%	52.3	21.0%	135.6	21.0%
Animal	145.0	16.2%	38.9	15.6%	106.1	16.4%
Pedestrian	0.7	0.1%	0.2	0.1%	0.5	0.1%
Bicyclist	0.0	0.0%	0.0	0.0%	0.0	0.0%
Parked car	7.6	0.8%	2.1	0.8%	5.5	0.9%
Noncollision	199.8	22.3%	55.3	22.2%	144.5	22.4%
Other single-vehicle	90.7	10.1%	25.7	10.3%	65.0	10.1%
Multiple vehicle	*263.0*	*29.4%*	*74.9*	*30.0%*	*188.1*	*29.2%*
Rear-end	131.0	14.6%	37.1	14.9%	94.0	14.6%
Head-on	6.2	0.7%	1.7	0.7%	4.5	0.7%
Angle	15.6	1.7%	4.7	1.9%	10.8	1.7%
Sideswipe, same direction	59.6	6.7%	17.0	6.8%	42.6	6.6%

Sideswipe, opposite direction	4.8	0.5%	1.3	0.5%	3.5	0.5%
Other multiple-vehicle	45.7	5.1%	13.0	5.2%	32.7	5.1%

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
44.9	45.3	45.7	46.0	46.4	46.8	47.2	47.6	48.0	48.5	11.4	11.5	11.7
12.5	12.7	12.8	12.9	13.0	13.1	13.3	13.4	13.5	13.6	29.7	30.0	30.2
32.4	32.6	32.9	33.2	33.4	33.7	34.0	34.3	34.5	34.8	895.4	250.2	645.2

Interchange Safety Analysis Tool

General Output Data

General Interchange Information

Project description:	TIGHT DIAMOND			
Analyst:	HDR			
Date:	9/4/2012			
Area type:	Rural			
Beginning year of analysis period:	2012			
Ending year of analysis period:	2035			
	Mainline freeway segments	Ramps	Crossroad ramp terminals and intersections	Crossroad segments
Crash data available:	Y	Y	Y	Y
Beginning year of crash data:	2007	2007	2007	2007
Ending year of crash data:	2009	2009	2009	2009

Number of Predicted Crashes for Entire Interchange Area

Number of predicted crashes during analysis period			Average number of predicted crashes per year during analysis period		
Total	FI	PDO	Total	FI	PDO
848.0	234.5	613.5	35.3	9.8	25.6

Number of Predicted Crashes by Interchange Element Type

Interchange element type	Number of sites	Number of predicted crashes during analysis period			MVMT	MEV	Crash rate
		Total	FI	PDO			(per MVMT or MEV)
Mainline freeway segments	10	780.7	218.0	562.7	978.600		0.798
Ramps	4	5.3	1.0	4.2	5.773		0.911
Crossroad ramp terminals & ints	2	4.9	2.2	2.7		20.590	0.237
Crossroad segments	6	57.2	13.3	44.0	9.350		6.120
Total	22	848.0	234.5	613.5	993.723		0.853

Number of Predicted Crashes by Year

	Total	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Crashes	848.0	39.2	39.5	39.8	40.1	40.5	40.8	41.2	41.5	41.9	42.2
FI Crashes	234.5	10.7	10.8	10.9	11.0	11.2	11.3	11.4	11.5	11.6	11.7
PDO Crashes	613.5	28.4	28.6	28.9	29.1	29.3	29.6	29.8	30.0	30.3	30.5

Number of Predicted Crashes by Collision Type

Collision type	Number and percentage of predicted crashes by collision type					
	Total		FI		PDO	
	No.	%	No.	%	No.	%
All collision types	**848.0**	**100.0%**	**234.5**	**100.0%**	**613.5**	**100.0%**
Single vehicle	*613.1*	*72.3%*	*168.2*	*71.7%*	*444.9*	*72.5%*
Fixed object	173.1	20.4%	47.7	20.3%	125.4	20.4%
Animal	149.7	17.7%	40.2	17.1%	109.6	17.9%
Pedestrian	0.7	0.1%	0.2	0.1%	0.5	0.1%
Bicyclist	0.0	0.0%	0.0	0.0%	0.0	0.0%
Parked car	7.9	0.9%	2.2	0.9%	5.8	0.9%
Noncollision	199.8	23.6%	55.1	23.5%	144.7	23.6%
Other single-vehicle	81.9	9.7%	23.0	9.8%	58.9	9.6%
Multiple vehicle	*234.9*	*27.7%*	*66.3*	*28.3%*	*168.7*	*27.5%*
Rear-end	117.4	13.8%	32.9	14.0%	84.5	13.8%
Head-on	5.9	0.7%	1.6	0.7%	4.3	0.7%
Angle	14.4	1.7%	4.4	1.9%	10.0	1.6%
Sideswipe, same direction	52.6	6.2%	14.9	6.3%	37.7	6.2%

Sideswipe, opposite direction	4.7	0.6%	1.2	0.5%	3.4	0.6%
Other multiple-vehicle	39.9	4.7%	11.2	4.8%	28.6	4.7%

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
42.6	42.9	43.3	43.6	44.0	44.4	44.7	45.1	45.5	45.9	10.8	10.9	11.0
11.8	11.9	12.0	12.1	12.2	12.4	12.5	12.6	12.7	12.8	28.3	28.5	28.7
30.8	31.0	31.3	31.5	31.8	32.0	32.3	32.5	32.8	33.1	849.0	235.5	613.5

Interchange Safety Analysis Tool

General Output Data

General Interchange Information

Project description:	SINGLE POINT			
Analyst:	HDR			
Date:	9/4/2012			
Area type:	Rural			
Beginning year of analysis period:	2012			
Ending year of analysis period:	2035			
	Mainline freeway segments	Ramps	Crossroad ramp terminals and intersections	Crossroad segments
Crash data available:	Y	Y	Y	Y
Beginning year of crash data:	2007	2007	2007	2007
Ending year of crash data:	2009	2009	2009	2009

Number of Predicted Crashes for Entire Interchange Area

Number of predicted crashes during analysis period			Average number of predicted crashes per year during analysis period		
Total	FI	PDO	Total	FI	PDO
844.6	233.3	611.4	35.2	9.7	25.5

Number of Predicted Crashes by Interchange Element Type

Interchange element type	Number of sites	Number of predicted crashes during analysis period			MVMT	MEV	Crash rate
		Total	FI	PDO			(per MVMT or MEV)
Mainline freeway segments	10	775.1	216.3	558.8	957.525		0.810
Ramps	4	5.5	1.1	4.5	6.296		0.880
Crossroad ramp terminals & ints	2	4.9	2.2	2.7		20.590	0.237
Crossroad segments	6	59.1	13.7	45.4	9.785		6.037
Total	22	844.6	233.3	611.4	973.605		0.868

Number of Predicted Crashes by Year

	Total	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Crashes	844.6	39.0	39.3	39.7	40.0	40.3	40.7	41.0	41.3	41.7	42.0
FI Crashes	233.3	10.7	10.8	10.9	11.0	11.1	11.2	11.3	11.4	11.5	11.6
PDO Crashes	611.4	28.3	28.5	28.8	29.0	29.2	29.5	29.7	29.9	30.2	30.4

Number of Predicted Crashes by Collision Type

Collision type	Number and percentage of predicted crashes by collision type					
	Total		FI		PDO	
	No.	%	No.	%	No.	%
All collision types	**844.6**	**100.0%**	**233.3**	**100.0%**	**611.4**	**100.0%**
Single vehicle	*611.4*	*72.4%*	*167.6*	*71.8%*	*443.9*	*72.6%*
Fixed object	172.5	20.4%	47.4	20.3%	125.1	20.5%
Animal	150.1	17.8%	40.2	17.2%	109.9	18.0%
Pedestrian	0.7	0.1%	0.2	0.1%	0.5	0.1%
Bicyclist	0.0	0.0%	0.0	0.0%	0.0	0.0%
Parked car	7.9	0.9%	2.2	0.9%	5.7	0.9%
Noncollision	199.0	23.6%	54.8	23.5%	144.2	23.6%
Other single-vehicle	81.2	9.6%	22.8	9.8%	58.4	9.6%
Multiple vehicle	*233.2*	*27.6%*	*65.7*	*28.2%*	*167.5*	*27.4%*
Rear-end	116.5	13.8%	32.6	14.0%	83.9	13.7%
Head-on	6.0	0.7%	1.6	0.7%	4.3	0.7%
Angle	14.3	1.7%	4.4	1.9%	10.0	1.6%
Sideswipe, same direction	52.1	6.2%	14.7	6.3%	37.4	6.1%

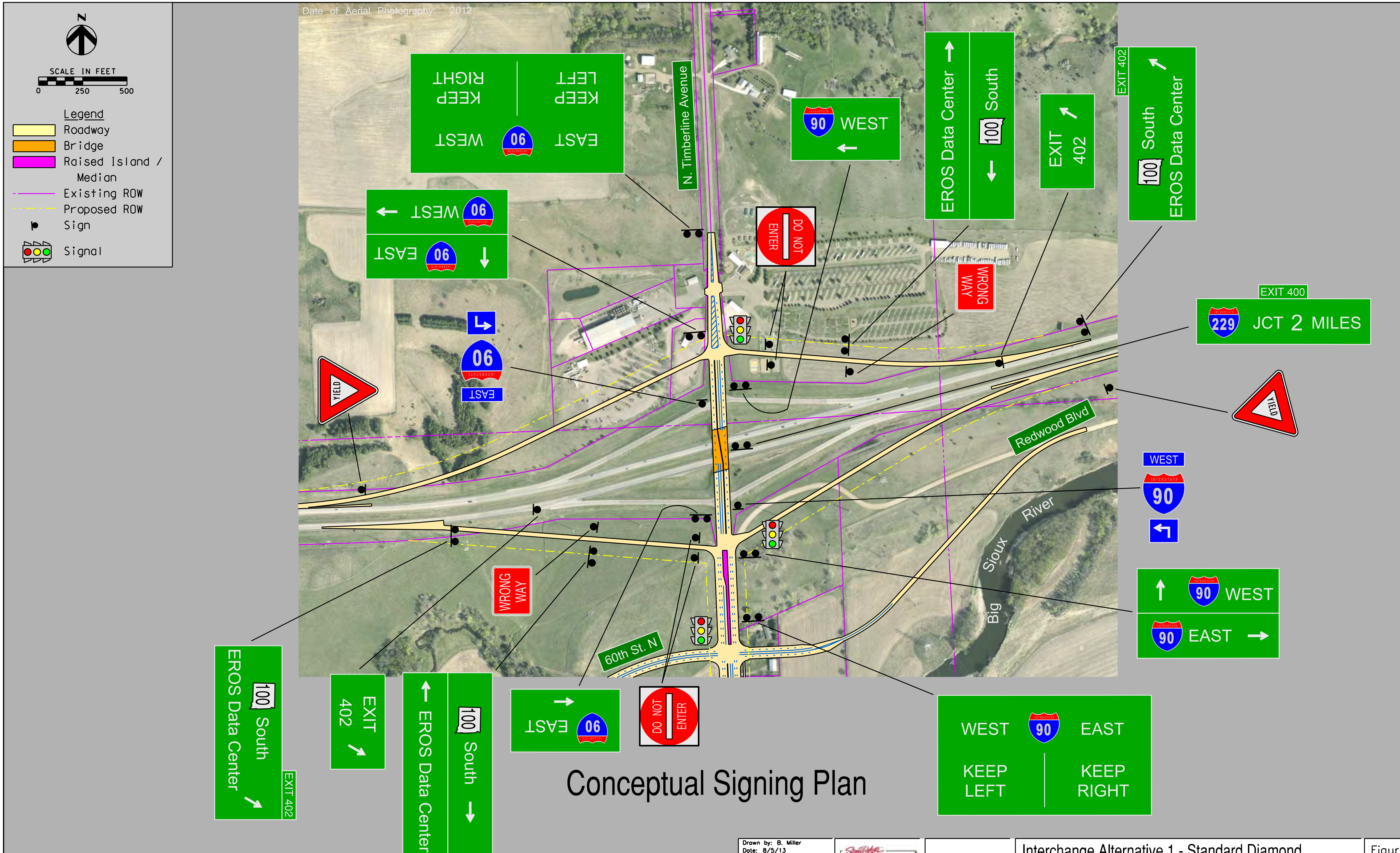
Sideswipe, opposite direction	4.7	0.6%	1.3	0.5%	3.5	0.6%
Other multiple-vehicle	39.5	4.7%	11.1	4.8%	28.4	4.6%

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
42.4	42.7	43.1	43.5	43.8	44.2	44.6	44.9	45.3	45.7	10.7	10.8	10.9
11.7	11.8	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.8	28.2	28.5	28.7
30.7	30.9	31.2	31.4	31.7	31.9	32.2	32.4	32.7	32.9	845.3	233.9	611.4

Appendix Part 6—Signing Plans

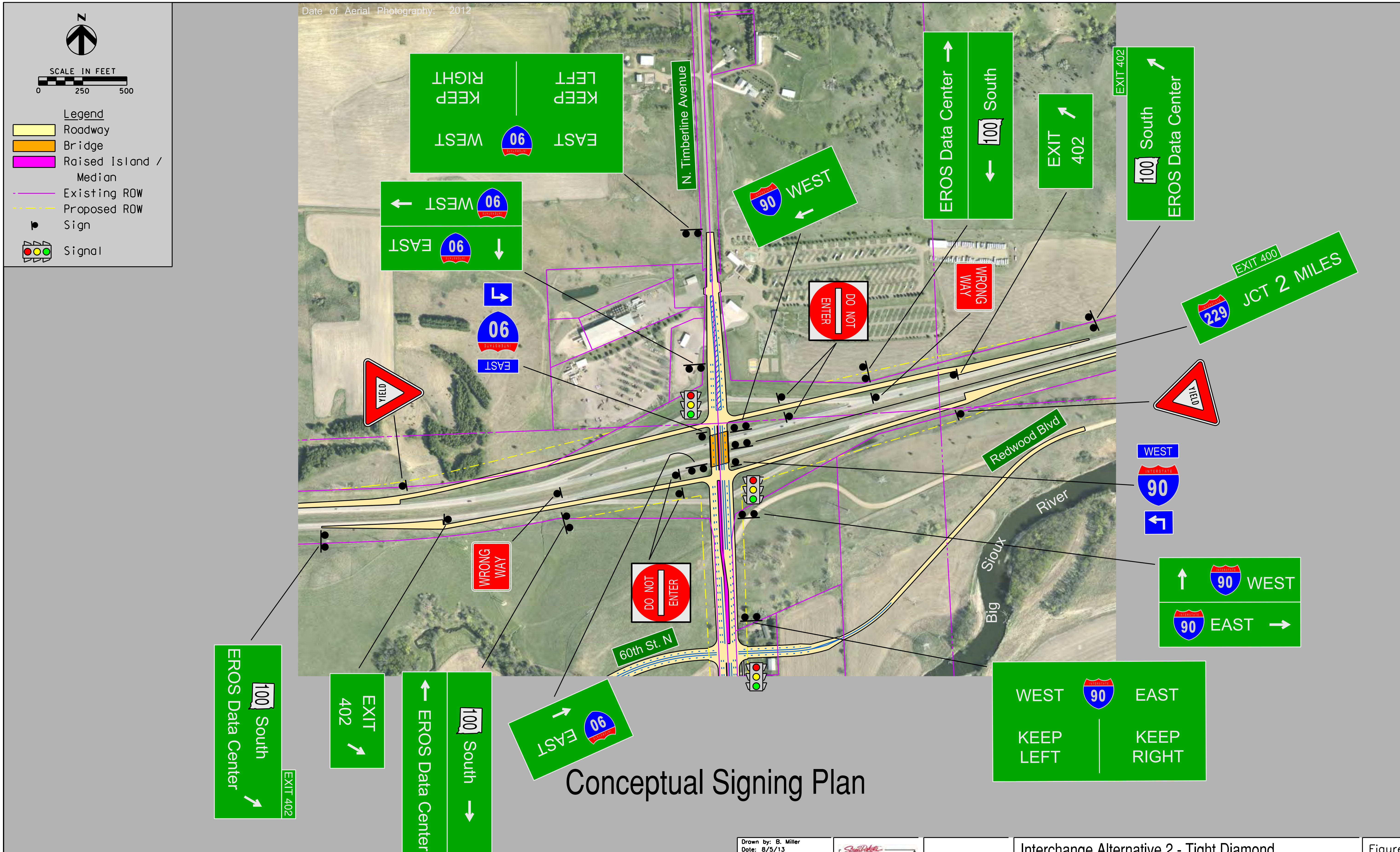
I-90/Timberline Road Interchange

HDR



Conceptual Signing Plan

Drawn by: B. Miller Date: 8/5/13 Checked by: R. Loughlin Date: 8/5/13 Revision Date:	South Dakota DOT Connecting South Dakota and the Nation	HDR	Interchange Alternative 1 - Standard Diamond SD100 / I-90 Interchange Minnehaha County, SD P0100(101)405 PCN 00T7 Interchange Justification Report	Figure A6-1



Conceptual Signing Plan

Drawn by: B. Miller
Date: 8/5/13
Checked by: R. Loughlin
Date: 8/5/13
Revision Date:

South Dakota DOT — Connecting South Dakota and the Nation

HDR

Interchange Alternative 2 - Tight Diamond
SD100 / I-90 Interchange — Minnehaha County, SD
P0100(101)405 PCN 00T7 — Interchange Justification Report

Figure A6-2

Appendix Part 7—Interchange Area Air Photos

I-90/Timberline Road Interchange

HDR

EXIT 400 – Interstate 90/Interstate 229


EXIT 402 – Interstate 90/Timberline Road
N
INTERSTATE 90
TIMBERLINE ROAD

EXIT 406 – Interstate 90/SD Highway 11
N
INTERSTATE 90
SD HIGHWAY 11