I-80 / Middle Road Interchange

Bettendorf, Scott County, Iowa

Project Number
HDP-0587(626)-71-82
Interstate Project

This document has been prepared to obtain FHWA approval to modify an existing interchange on a Priority I Highway.

Interchange Justification Report

Prepared by:

HR Green, Inc.

For:

The City of Bettendorf, Iowa

And

The Iowa Department of Transportation

April 2014

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LICENSED PROFESSIONAL ENGINEER J. ANDREW SWISHER 17928 IOWA	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa. Date: 4/25/14 J. ANDREW SWISHER, P.E. License No. 17928 My renewal date is December 31, 2015 Pages or sheets covered by this seal: All

The request for reconfiguration of the *I-80/Middle Road Interchange* is acceptable for engineering and operations. Approval is contingent upon compliance with applicable Federal requirements specifically the National Environmental Policy Act (NEPA). Completion of the NEPA process is considered acceptance of the general project location and concepts described in the environmental document.

Brian Schmidt	James R. Schnoebelen
City of Bettendorf, Iowa	Iowa Department of Transportation
04.29.14	5/15/14
Date Accepted	Date - Acceptable for Engineering Operations

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1 Introduction

The objective of this report is to provide the necessary background for justifying proposed improvements to the Interstate 80 (I-80) interchange at Middle Road in Bettendorf, Iowa. The information included will help determine if the proposed interchange improvements satisfy requirements of the Federal Highway Administration (FHWA) policy concerning additional or revised access to the Eisenhower Interstate Highway System.

This FHWA policy was set forth in "Access to the Interstate System", as published in the Federal Register, Volume 74, Number 165 on August 27, 2009. The ultimate intent of the policy is to ensure that the Interstate System provides the highest levels of safety and mobility to the traveling public. Adequate control of access is critical to providing this service.

The policy itself contains eight specific requirements that new or revised access points must meet in order to be approved for further development. These requirements, or "policy statements", are presented in this report along with responses demonstrating how the proposed revisions at the I-80/Middle Road interchange satisfy each requirement.

1.1 Project Description

The City of Bettendorf is located in eastern Iowa and is part of the Davenport-Moline-Rock Island Metropolitan Statistical Area (or Quad Cities Region), which includes Scott County in Iowa and Henry, Mercer, and Rock Island counties in Illinois. The name 'Quad Cities' refers to five anchor cities, Bettendorf and Davenport in the state of Iowa and Moline, East Moline, and Rock Island in the state of Illinois. Bettendorf is located towards the north/northeast of the Iowa metropolitan area and less than 175 miles on I-80 from both Chicago, Illinois, to the east and Des Moines, Iowa, to the west.

The City of Bettendorf population was estimated at approximately 33,200 in the 2010 census data. Between 1990 and 2010, the city's population grew nearly 18 percent (or 0.83 percent annually). Within the metropolitan statistical area, the population has grown from just over 350,000 in 1990 to nearly 380,000 in 2010 (representing an 8 percent increase).

The existing development within the City of Bettendorf is primarily located to the south of I-80 and east of I-74. The city is bound by the Mississippi River to the south/southeast and the City of Davenport to the west. The City of Le Claire is located along I-80 approximately five miles east of Bettendorf and the I-80/Middle Road interchange. Two municipalities are completely surrounded by the City of Bettendorf corporate limits: Riverdale and Panorama Park. Riverdale is located along the Mississippi River in the south/southeastern Bettendorf area, straddling U.S. Highway 67. Panorama Park is located directly northeast of Riverdale. Due to natural boundaries and established corporate limits, the direction for future growth within Bettendorf is primarily to the north/northeast of the I-80 corridor.

The Quad Cities metropolitan area is encircled by a loop of Interstate freeways, with I-80 traversing the northern and eastern boundaries, I-280 the western and southern boundaries, and I-74 bisecting the region north/south with connections between I-80 and I-280 via a Mississippi River crossing. I-80 primarily runs east-west through the region, serving as an important metropolitan, regional, and interregional route. It provides one of the five Mississippi River crossings in the metropolitan area and connections to I-280, I-74, I-88, and other arterial roadways within the region. I-88 extends eastward out of the metropolitan area and parallels I-80 to the Chicago metropolitan area. I-74 also extends eastward, but heads further south with a connection to Indianapolis, Indiana.

Both I-80 and I-74 provides Interstate and local network connectivity around the City of Bettendorf. I-80 provides two systems interchanges (I-280 and I-74) and four service interchange locations to Davenport (2), Bettendorf (1), and LeClaire (1) along the northern edge of the metropolitan area. I-74 provides four service interchanges between I-80 and the Mississippi River along the Bettendorf/Davenport corporate boundary. I-74 also offers a connection to the Quad Cities International Airport located south of the I-280/I-74 systems interchange.

I-80 through the study area was originally constructed in the 1960's with Portland Cement Concrete (PCC) and still maintains two basic freeway lanes in each direction of travel through the study area. To the west of Middle Road, rest areas accommodate eastbound (1.5 miles west of Middle Road) and westbound (1 mile west of Middle Road) I-80 traffic. Each rest area consists of two access locations, an I-80 mainline off-ramp and on-ramp.

The I-80/Middle Road interchange provides the northern Interstate access location to Bettendorf, as well as Riverdale, Panorama Park and other adjacent populated areas within Pleasant Valley Township. Adjacent interchanges to I-80/Middle Road interchange include the I-80/I-74 systems interchange (approximately 3 miles to the west) and the I-80/U.S. Highway 67 service interchange (approximately 5 miles to the east in Le Claire).

The existing I-80/Middle Road interchange is a two-quadrant partial cloverleaf configuration, also known as a folded diamond, with single-lane I-80 loop entrance ramps in the northeast and southwest quadrants. Single-lane diagonal I-80 exit ramps accommodate eastbound and westbound exiting traffic to Middle Road. All movements to and from I-80 and Middle Road are accommodated by the existing configuration. The ramp terminal intersections are stop-controlled from the ramp approach. Roadway lighting is currently provided at the ramp terminal intersections.

The I-80/I-74 systems interchange consists of a trumpet-type interchange, as I-74 only extends south of I-80. The A loop ramp is present in the northwest quadrant for westbound I-80 to southbound I-74 movements. The I-80/U.S. Highway 67 interchange consists of a partial cloverleaf with the directional and loop ramps in the northeastern and northwestern quadrants. The Mississippi River is directly south of U.S. Highway 67, thus naturally constrains the interchange ramps to the current quadrants.

Middle Road is currently classified as an Urban Minor Arterial through the study area and serves as a primary north/south route through the City of Bettendorf. It is designated as a principal arterial within the City's Comprehensive Plan and includes interchange access with both I-80 and I-74. Middle Road currently consists of a rural two-lane cross-section with aggregate surface shoulders through the I-80 interchange. Adjacent at-grade roadway intersections include Indiana Avenue to the north (approximately 2000 feet north of the westbound I-80 ramp terminal intersection) and Forest Grove Drive to the south (approximately 1,700 feet south of the eastbound I-80 ramp terminal intersection). Local access (individual parcel/field) to Middle Road is accommodated on these two segments.

The annual average daily traffic (AADT) volumes on I-80 were 27,600 and 27,500 to the east and west of Middle Road, respectively. These traffic volumes equate to a 3.2 percent and 3.0 percent annual growth when compared to 1998 AADT volumes. Middle Road was estimated to carry approximately 5,000 vehicles per day south of I-80 and 2,250 north of I-80 based on the latest 2006 traffic counts.

The Quad Cities metropolitan area is represented by the Bi-State Regional Commission, serving five counties and 44 municipalities. The commission is responsible for organizing intergovernmental cooperation and delivery of regional programs, as well as assisting local governments in planning and project development. As part of these responsibilities, the Bi-State Regional Commission is responsible for the development and maintenance of a metropolitan-wide transportation travel demand model utilized in project planning and development. This travel demand model aids in the identification, analysis, and vetting process of potential projects, ultimately establishing the Quad Cities Long Range Transportation Plan. The latest version of this plan, entitled the Quad Cities Long Range Transportation Plan (LRTP) was adopted on June 22, 2011.

The 2040 Quad Cities LRTP lists the reconstruction of the I-80/I-74 systems interchange as a project requiring additional study. This study could potentially include a concept that provides access to the north, which would impact travel patterns along I-80 as it collects and distributes traffic to/from areas north of I-80.

The 2040 Quad Cities LRTP also lists a potential interchange along I-80 in the vicinity of 257th Avenue, at the western limits of LeClaire, as a candidate project requiring additional study. This project has neither been scheduled nor funded for an IJR at this time, but the potential interchange does represent a possible adjacent interchange that could affect traffic operations along I-80.

Specific to this interchange justification report, the 2040 Quad Cities LRTP financially constrained list of projects includes improvements to the I-80/Middle Road interchange. Improvements have also been approved in the Quad Cities Transportation Improvement Program for federal fiscal year 2019.

This project has been classified by the FHWA as a Categorical Exclusion under the National environmental Policy Act (NEPA of 1969, as amended in accordance with the definition provided in 23 CFR 771.117(a). The environmental impact analysis and documentation activities are ongoing and expected to be complete by the end of May 2014.

1.2 Project Location

The project study area along I-80 encompasses the I-80/Middle Road interchange, and next adjacent interchanges: I-80/I-74 systems interchange to the west and I-80/U.S. Highway 67 service interchange to the east. The study area also extends north and south along Middle Road to include local intersections influenced by the I-80/Middle Road interchange. The general project study area limits are defined as:

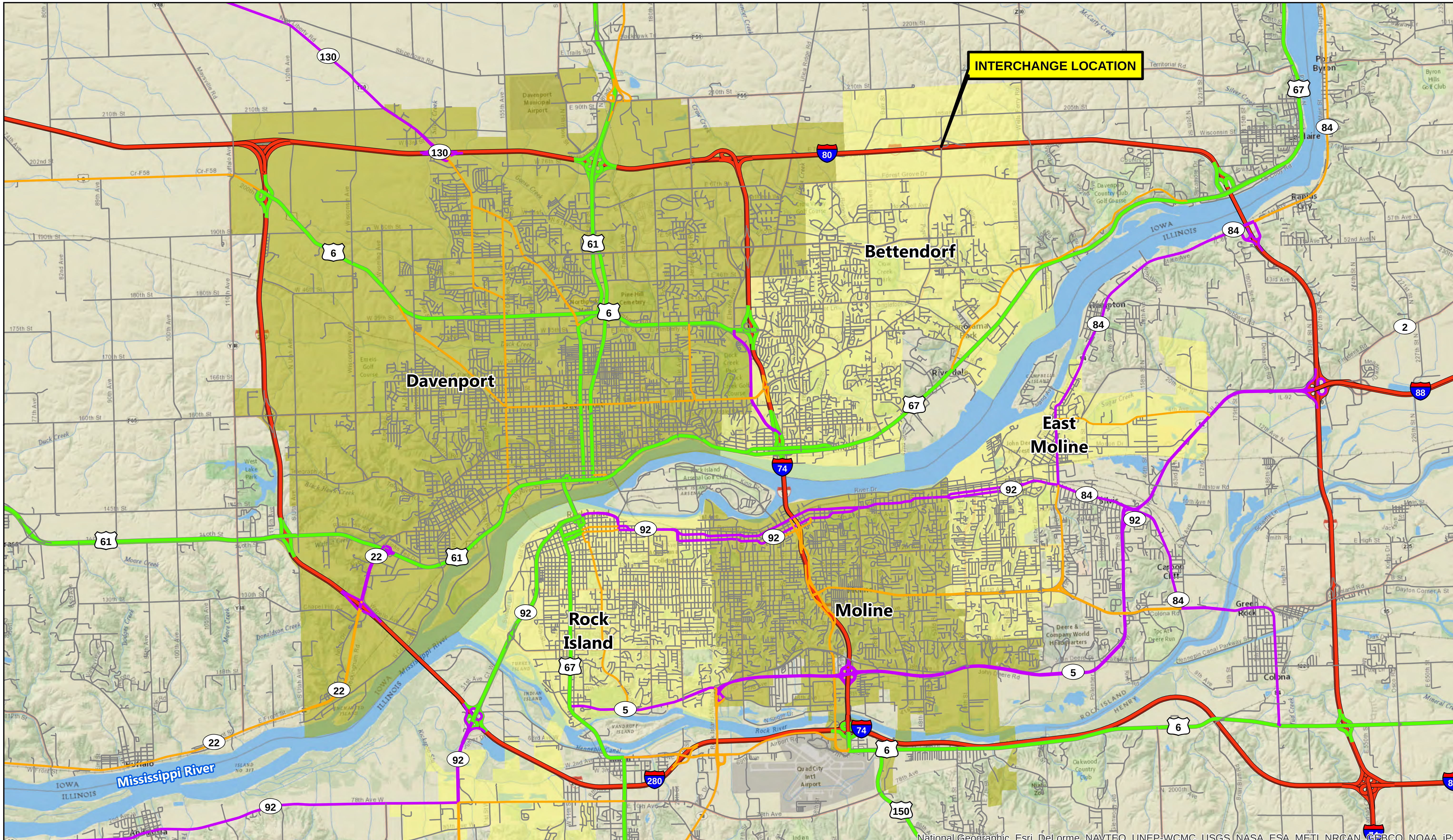
West limits:	The eastern merge/diverge points of the I-80/I-74 systems interchange (approximately 3 miles west of Middle Road)
East limits:	The western merge/diverge points of the I-80/U.S. Highway 67 service interchange (approximately 5 miles east/southeast of Middle Road)
North limits:	The Middle Road intersection with Indiana Avenue
South limits:	The Middle Road intersection with Forest Grove Drive

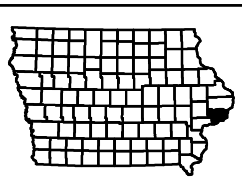
Current land use surrounding the I-80/Middle Road interchange includes rural agricultural/farming and urban fringe development, which is typically residential development along Forest Grove Drive. A privately owned and operated golf course is located approximately a half mile west of Middle Road (north of I-80) with access from Indiana Avenue.

Prominent features in the study corridor that could influence potential interchange improvements and conceptual Build alternatives include:

- Spencer Creek along the north side of I-80 through the existing interchange area; creek crosses under I-80 east of existing WB off-ramp diverge location
  - Wetland impacts
  - Floodplain impacts
- Homestead located in northwest quadrant, directly west of existing WB I-80 ramp terminal intersection
- Proximity of adjacent I-80 crossings: Utica Ridge Road (2.5 miles west of interchange) and Wells Ferry Road/240th Avenue (1.5 miles east of interchange)
- Proximity of EB and WB I-80 rest areas, both located west of the interchange

Figures 1.2-1 and **1.2-2** display the general project location, in relation to the Quad Cities metropolitan area, and study area of the proposed I-80/Middle Road interchange improvements.





LEGEND

- Interstate
- US Primary Road
- State Road
- Local Connecting Road
- Local Road
- Corporate Boundaries

HRGreen

Bettendorf

IOWA DOT

I-80 & MIDDLE RD IJR
PROJECT LOCATION

0 — 8,000 Feet

1 inch = 8,000 feet

NORTH

JAN 2014

FIG. 1.2-1

PAGE - 5

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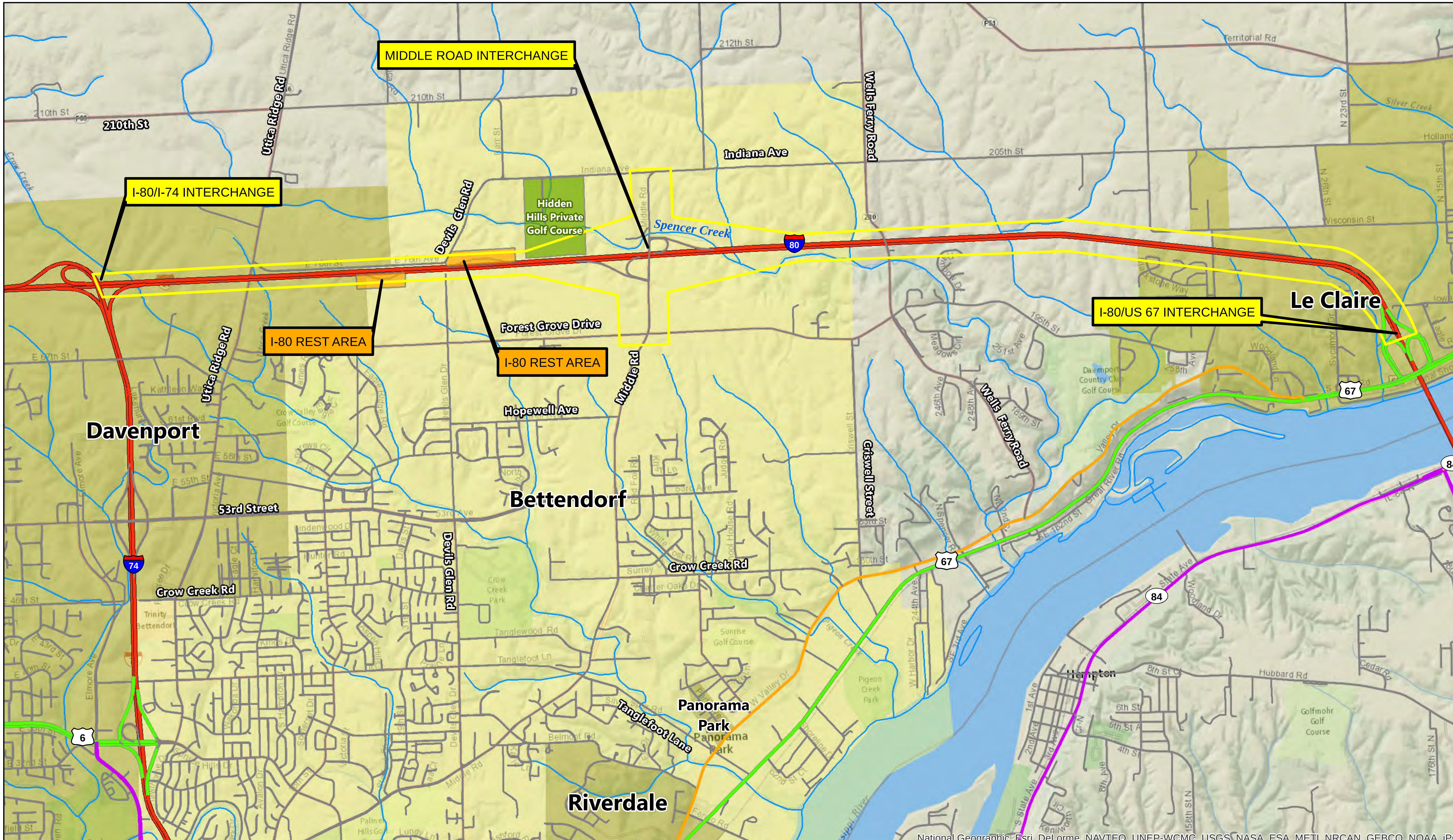

LEGEND

- Rivers & Streams
- Interstate
- US Primary Road
- State Road
- Local Connecting Road
- Local Road
- Project Study Area
- Rest Areas
- Golf Courses
- Corporate Boundaries

HRGreen | Bettendorf | IOWA DOT

I-80 & MIDDLE RD IJR INTERCHANGE AREA

0 — 3,000 Feet

1 inch = 3,000 feet

NORTH

MAR 2014

FIG. 1.2-2

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1.3 Project Purpose and Need

The purpose of this project is to improve the existing interchange to accommodate planned expansion of the local roadway network and provide adequate traffic operating capacity for the growing traffic demands at the I-80/Middle Road service interchange, providing safe access to and from the Interstate system in the Bettendorf, Iowa area. To achieve these goals, the proposed action would be expected to:

- Update interchange geometry to current design standards,
- Improve capacity within and through the interchange,
- Maintain or improve freeway travel performance,
- Improve freeway access to/from existing and planned development for regional and local travel, and
- Provide for the planned expansion of the local arterial street system.

The City of Bettendorf has experienced steady growth over the previous two decades, growing nearly 18 percent to 33,317 in 2010. The City of Bettendorf Comprehensive Plan area covers approximately 13,500 acres, of which only 8,000 are currently developed. A majority of the remaining 5,500 undeveloped acres are located along the northern boundary of the plan area, typically along the I-80 corridor where the existing Middle Road interchange provides the only direct Interstate access to the developing area. For comprehensive planning purposes, the City uses a 2020 population of 45,000 persons.

I-80 through the metropolitan area is an integral component of the national Interstate Highway System, connecting the east and west coasts, with more regional direct connections to the Chicago metropolitan area and other prominent Midwestern cities in Illinois, Iowa, and Nebraska. The combination of traffic growth through the region on I-80 and the localized development in Bettendorf along the I-80 corridor will continue to increase traffic volumes through the study area. The existing and forecasted traffic using I-80 and Middle Road within the project study area is described in **Table 1.3-1**.

Table 1.3-1: Traffic Volume Projections

Roadway Segment	**Existing Traffic 2010* AADT** *Vehicles Per Day (vpd)*	**Projected Traffic 2040** AADT** *Vehicles Per Day (vpd)*
I-80 West of Middle Road	27,500	43,500
I-80 East of Middle Road	27,600	40,800
Middle Road North of I-80	2,250#	11,800
Middle Road South of I-80	4,860#	15,800

* Source: Iowa Department of Transportation; I-80: 2010 AADT counts; Middle Road: 2006 AADT counts (#)
** Source: Bi-State Regional Commission, 2040 Travel Demand Model

Traffic is expected to increase by approximately 1.2 to 1.3 percent per year on I-80 over the next 30 years, equating to an increase of approximately 16,000 and 13,200 vehicles per day (vpd) to the west and east of Middle Road respectively. The traffic on Middle Road is expected to increase by approximately 10,000 vpd over the next 30 years.

The transportation industry defines the quality of service offered by highway facilities under specific traffic demands by using a level of service (LOS) rating. LOS is measured on a scale of A through F, representing the operating conditions of the roadway facility based on speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience measures. LOS A represents traffic that is free flowing on an uncongested roadway while LOS F represents traffic that is creeping or stopped due to a severely congested roadway. **Table 1.3-2** displays the general definitions of each LOS.

Table 1.3-2: Level of Service Definitions

Level of Service	Operating Conditions
A	Free Flow
B	Reasonably free flow
C	Stable flow
D	Approaching unstable flow
E	Unstable flow
F	Forced or breakdown flow

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

The FHWA and Iowa DOT consider LOS C to be the minimum acceptable LOS criteria for Interstates in an urban area through Iowa. The 2008 AM/PM peak hour operational LOS on I-80 with four lanes in the project study area is in a range of LOS A to B, depending on location and maneuver. The existing I-80 facility lane configuration is projected to operate at LOS B or C, depending on location and maneuver, based on projected 2040 AM/PM peak hour traffic volumes. This is documented further in the Policy Statement #1 discussion.

The existing I-80/Middle Road service interchange is a two-quadrant partial cloverleaf configuration, with entrance loop ramps in the northeast and southwest quadrants. Diagonal exit ramps from I-80 to Middle Road are also provided in the northeast and southwest quadrants. The interchange was original constructed in the 1960's, for traffic demand that was more typical of a rural setting and lower traffic volumes. With the primary population centers to the south, traffic is highly directional to and from the south of the interchange. As the City of Bettendorf, and the Quad Cities metropolitan region as a whole, continues to expand northward, the interchange traffic will continue to evolve by accommodating more metro region and localized urban trips in addition to increased interstate traffic volumes. Further, trips will be more evenly distributed to the north and south of I-80 as Bettendorf continues to grow through the I-80 corridor.

Multiple features of the interchange do not meet current design standards outlined in the American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Design Standards Interstate System, January 2005* (*AASHTO 2005*) and *A Policy on Geometric Design of Highways and Streets 5th Edition* (*AASHTO 2004*), and/or the *Iowa Department of Transportation Design Manual* (*Iowa DOT Design Manual*) recommended/suggested design minimums provided by the Iowa DOT. These features include the diagonal off-ramps (horizontal curvature, vertical curvature, and foreslope grades), loop on-ramps (merge geometry and acceleration length), and I-80 bridges (bridge width for both I-80 traffic and future Middle Road widening, and vertical clearance). Additional information regarding the design features of the existing interchange is presented in Policy Statement #1.

The Quad Cities metropolitan area population growth, land use development trends within and around the City of Bettendorf, and forecasted regional traffic flow through the I-80 corridor are all expected to contribute to the degradation of traffic operations along I-80 and within the I-80/Middle Road interchange. Geometric design features that do not meet current design standards tend to exacerbate safety and operational issues as traffic volumes increase. Operational and safety concerns stem from speed differential at I-80 and on-ramp merge locations, capacity-constrained intersections due to the existing rural interchange layout, and safety-related design features such as insufficient vertical clearance and recoverable foreslopes. As the growth of Bettendorf continues northward through the I-80 corridor, an improved interchange is necessary to integrate the planned local roadway improvements with the improvements along I-80 at the I-80/Middle Road interchange.

1.4 Design Criteria

The basic project design principles and criteria are shown in **Table 1.4-1**, on the following page, and are supported by *AASHTO 2005*, *AASHTO 2004*, and the *Iowa DOT Design Manual*.

Table 1.4-1: Roadway Design Criteria

Design Element	Design Speed	2040 LOS
Mainline Interstate	75 mph preferred 70 mph acceptable	LOS C urban LOS B rural
Directional Ramp	60 mph preferred 40 mph acceptable	LOS C
Semi-Directional Ramp	50 mph preferred 30 mph acceptable	LOS C
Loop Ramp	30 mph preferred 25 mph acceptable	LOS C
Diagonal Ramp (Entrance) – curve near free flow terminal	60 mph preferred *	LOS C
Diagonal Ramp (Entrance) – curve near at-grade terminal	40 mph preferred *	LOS C
Diagonal Ramp (Exit) – curve near free flow terminal	60 mph preferred *	LOS C
Diagonal Ramp (Exit) – curve near at-grade terminal	45 mph preferred *	LOS C
Mainline Expressway	70 mph preferred 65 mph acceptable	LOS C urban LOS B rural
Interchange Ramp Terminal and At-Grade Intersections		LOS C

** Acceptable values are 35 mph for a 70 mph mainline design speed and 40 mph for a 75 mph mainline design speed.*

The current *Iowa DOT Design Manual*, Design Criteria, Preferred Values, will be utilized for evaluation of design alternatives for the Interstate, interchange ramps and highway within the state access control limits. Where the preferred values are not feasible, Iowa DOT acceptable values or *AASHTO 2005* criteria will be identified and evaluated for acceptability. The Middle Road interchange is considered to be in an urban setting for purposes of evaluating LOS.

The projected growth in traffic volumes on I-80 and the local arterial network are expected to impact Interstate system operations through the study area. Increasing traffic volumes on I-80 and Middle Road contribute to congested operating conditions at the ramp terminal intersections and adjacent arterial intersections, which fall below acceptable LOS. This degradation in traffic operations creates additional safety impacts and potentially degrades operations on I-80 through ramp terminal queue spillback towards, or onto, the I-80 mainline. Therefore, the LOS measurement at ramp terminal intersections will be supplemented with projected queue length data as a measure of effectiveness to evaluate interchange alternatives.

The accommodation of pedestrian mobility through the interchange is currently limited to the granular shoulders, between the edge of traveled way and guardrail around the bridge piers. Pedestrian mobility needs to be accommodated along Middle Road to facilitate a crossing of I-80 through the interchange in order to prevent I-80 becoming a pedestrian barrier within the study area. This is particularly important as development occurs throughout the study area, facilitating multi-modal opportunities.

1.5 Evolution of Alternatives

The IJR process began in February 2008 with the submittal of the IJR Letter of Request (LOR) to the Iowa Department of Transportation. The LOR was refreshed in July 2013 and finalized in August 2013. Between 2008 and 2013, nine interchange build alternatives were developed and evaluated. Of the nine build alternatives, one includes the reconstruction of the existing interchange in the current geometric form, two are variations of the standard diamond, and three are variations of the partial clover leaf interchange configurations. In addition, one compressed diamond, one diverging diamond, and one single point urban interchange were developed.

Of the two standard diamond variations, one included a more typical spacing of the on and off ramps. The second variation pushed the north set of on/off ramps north to avoid impacts to Spencer Creek.

Of the three variations of the partial clover leaf interchanges, one included 25 mph loop ramps. The second partial clover leaf included 30 mph loops ramps. The third partial clover leaf included offset ramps north of I-80 to minimize impacts to the farmstead located in the NW quadrant of the interchange.

2 FHWA Policy

As previously noted, the FHWA has developed and issued a policy regarding requests for additional or revised access to the Eisenhower Interstate Highway System. The policy includes guidance for the justification and documentation needed for such requests. The policy's intent is to ensure that the Interstate System provides the highest levels of safety and mobility to the traveling public. Adequate control of access is critical to providing this service. This policy was originally issued in the Federal Register on October 22, 1990, was revised as published in the Federal Register on February 11, 1998, and updated further by Federal Register, Volume 74, Number 165 on August 27, 2009. The policy contains eight specific requirements that new or revised access points must meet in order to be approved for further development. These eight requirements or "policy statements" are:

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 (23 CFR 625.2(a)).***

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 without the proposed change(s) in access (23 CFR 625.2(a)).***

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 (23 CFR 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection 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 (23 CFR 625.2(a) and 655.603(d)). 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 (23 CFR 625.2(a) and 655.603(d)). Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).***

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 (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)).***

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 in 23 CFR part 450, and the transportation conformity requirements of 40 CFR parts 51 and 93.***

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 (23 U.S.C. 109(d), 23 CFR 625.2(a), 655.603(d), and 771.111).***

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 (23 CFR 625.2(a) and 655.603(d)). 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 (23 CFR 625.2(a) and 655.603(d)).***

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 the environmental processing (23 CFR 771.111).***

The following sections address each policy statement individually and demonstrate how the proposed revisions at the I-80/Middle Road interchange satisfy each requirement. Together, these responses provide the necessary background for justifying the proposed improvements.

2.1 FHWA Policy Statement # 1

FHWA policy statement # 1 states:

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 (23 CFR 625.2(a)).

This policy statement asks whether the existing roadway system can meet, or be improved to meet, existing and forecasted traffic demand without modifying access to the Interstate system. This project proposes to make capacity, safety, and geometric design improvements to the existing I-80 and Middle Road interchange. The proposed interchange reconstruction is expected to alleviate near-term and long-term travel demand pressures on the interchange ramps and connection points to the arterial network that cannot be resolved by making incremental capacity improvements to the local system. As demonstrated by traffic forecast and level-of-service analysis completed as part of this IJR, improvements to the local street network alone are not adequate to protect the operations of the Interstate system. The proposed interchange geometric and capacity improvements will provide the best possible improvement for future Interstate operations.

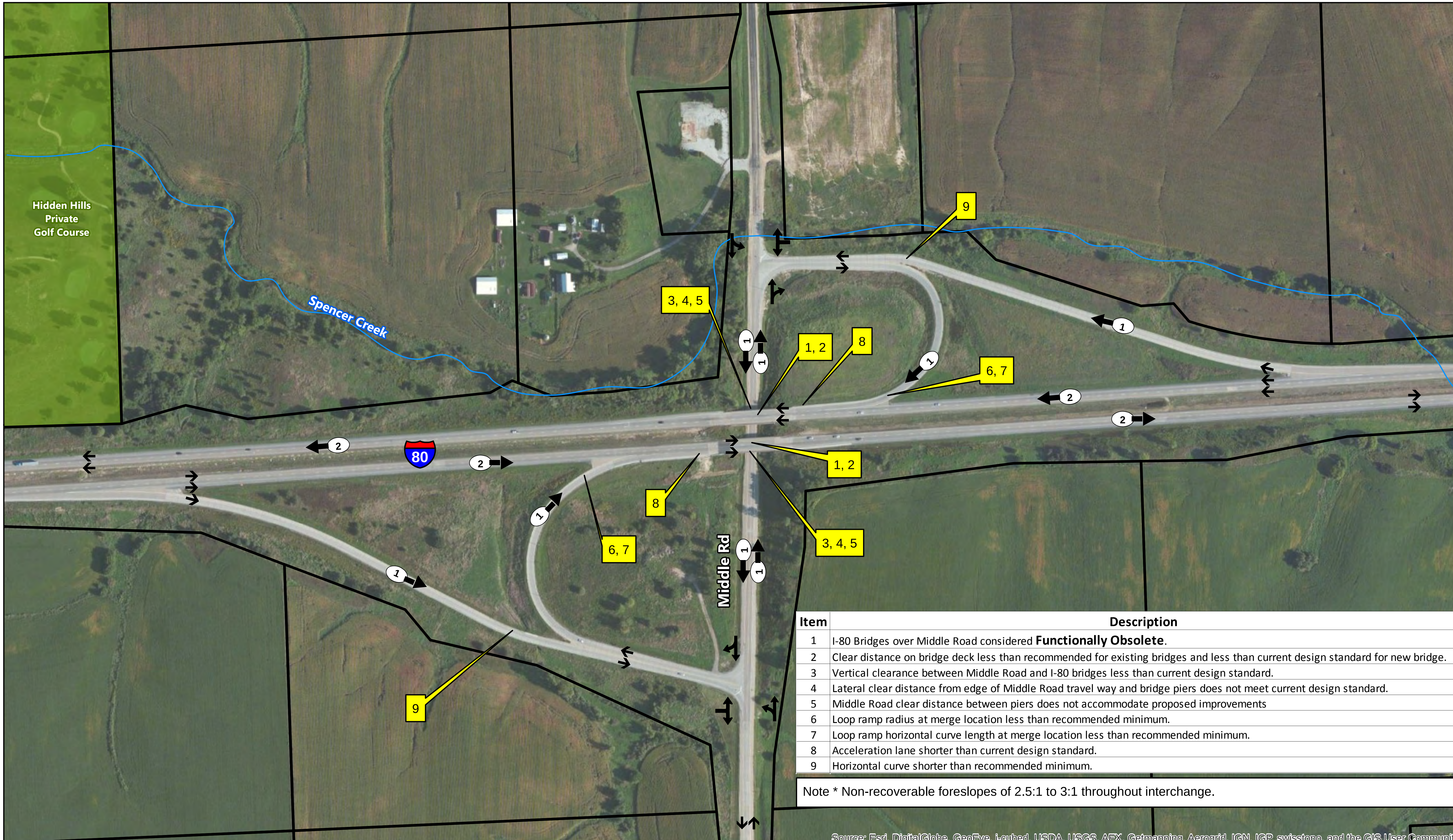
2.1.1 Existing Conditions

Interstate 80

Figure 2.1-1 shows the existing geometric conditions within the corridor. According to the record drawings, I-80 through the study area consists of two 12-foot basic freeway lanes in each direction, with a 6-foot inside (median side) shoulder and 10-foot outside shoulder. The original pavement included a 1.5 percent cross-slope outward from the roadway crown (centerline for travel-way in the respective eastbound or westbound direction) between the two travel lanes. The shoulders included a 4.0 percent outward cross-slope. Eastbound travel-way centerline to westbound travel-way centerline is approximately 84 feet, which equates to a 60-foot median from travel-way edge line to travel-way edge line.

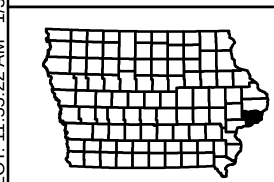
A Pavement Condition Index (PCI) is used by the Iowa DOT to measure pavement condition. A 0-100 rating represents the current pavement condition, with 0 being the worst and 100 the best. The 2011 PCI rating of the I-80 mainline pavement was 65.

The 1964 design plans also included consideration for an additional basic freeway lane in each direction to be placed on the inside (median side) of the two built travel lanes. This 'Future Addition' included a 12-foot basic freeway lane and 6-foot shoulder. An ultimate 6-lane build-out on I-80 would include a 36' median between travel-way edge lines. The bulk of improvements to this section of I-80 have included routine maintenance and roadside safety improvements.



Item	Description
1	I-80 Bridges over Middle Road considered **Functionally Obsolete**.
2	Clear distance on bridge deck less than recommended for existing bridges and less than current design standard for new bridge.
3	Vertical clearance between Middle Road and I-80 bridges less than current design standard.
4	Lateral clear distance from edge of Middle Road travel way and bridge piers does not meet current design standard.
5	Middle Road clear distance between piers does not accommodate proposed improvements
6	Loop ramp radius at merge location less than recommended minimum.
7	Loop ramp horizontal curve length at merge location less than recommended minimum.
8	Acceleration lane shorter than current design standard.
9	Horizontal curve shorter than recommended minimum.

Note * Non-recoverable foreslopes of 2.5:1 to 3:1 throughout interchange.



LEGEND

Spencer Creek

Golf Courses

X Number Of Lanes

Parcels

I-80 & MIDDLE RD IJR
EXISTING CONDITIONS

0 300
Feet
1 inch = 300 feet

NORTH

JAN 2014

FIG. 2.1-1

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PLOT: 11:55:22 AM 1/31/2014 FILE: \\hrgcrnasdata\185390J\GIS\MXD\1-30-2014\Fig-2.1-1 Existing Conditions.mxd

I-80 over Middle Road consists of dual 142.5 x 43 foot three-span pretensioned prestressed concrete beam bridges, one for eastbound traffic and one for westbound traffic. The record plans indicate a 43-foot clear area between safety curbs; however, inspection reports identify this clear area as 40 feet. Iowa DOT bridge width criteria to accommodate two through lanes plus an auxiliary lane indicate 42 feet for an existing bridge and 48 feet for new construction. Each bridge accommodates the acceleration lane from the loop on-ramp in addition to the two basic freeway lanes. The bridges were rehabilitated in 1984 and currently have adequate structural ratings of 79 and 80.

Vertical clearance between top of pavement on Middle Road and bottom of the I-80 bridge structure is 14 feet-10 inches, which does not meet minimum Iowa DOT design standards for a non-primary highway (15 feet). The overhead bridge structure was struck by Middle Road traffic in 1997 and 2002. Based on the proposed improvements to Middle Road and the interchange, and their importance to future regional travel, 16.5 feet vertical clearance is desirable.

Lateral clearance along Middle Road between the edge of travel way and I-80 bridge piers is also substandard at 9 feet-2 inches. Total opening width between the piers is approximately 44 feet. Guardrail has been installed between the travel way and piers on both sides of the roadway. The planned improvements to convert Middle Road to a 4-lane cross-section, with turn lanes, require a roadway width of 67 feet plus clear zone. The existing width between piers does not accommodate the planned cross-section. The widening of the Middle Road corridor to a 4-lane facility is a planned project in the 2021 to 2040 time frame according to the 2040 Quad Cities LRTP.

Based on the deficiencies of the I-80 bridges, it can be concluded that they are functionally obsolete to facilitate the proposed improvements to Middle Road (both horizontally and vertically) and meet current geometric standards for width on I-80.

The study area features rolling terrain, incorporating both uphill and downhill segments along I-80. Through the interchange, I-80 features a downhill grade from west to east, ranging from 0.370 percent to 1.77 percent. The horizontal alignment is typically straight through the interchange, with a horizontal curve (radius of 52,451.75 feet) beginning just east of the westbound off-ramp. The original 1964 design utilized a 70 mph design speed.

The 2040 Quad Cities LRTP includes an illustrative project for further study of capacity needs on I-80 in eastern Iowa. This study is identified as a need but not included as a priority project between 2011 and 2040 planning horizon. At this time, capacity improvements on I-80 through the metropolitan region are not programmed in the Quad Cities Metro Transportation Improvement Plan.

I-80/Middle Road Interchange

The I-80/Middle Road interchange was constructed as part of the original 1964 I-80 project through the study area. As previously discussed, the existing interchange accommodates movements between I-80 and Middle Road in all travel directions through two-quadrant partial cloverleaf configuration. Loop on-ramps to I-80 and diagonal exit ramps from I-80 are located in the northeast and southwest quadrants of the interchange. The loop ramp and diagonal ramp travel ways are adjacent to each other in each quadrant, split by two solid yellow lines, for approximately 450 feet extending away from the ramp terminal intersection with Middle Road

The original 1964 ramp typical section consisted of a 20-foot PCC pavement width with a 4-foot inside and 6-foot outside earth shoulder. A 1996 project resurfaced the interchange ramps with asphaltic cement concrete (ACC) and upgraded the earth shoulders to an ACC shoulder. The existing ramp typical section consists of a 20-foot travel-way, with a 4-foot inside shoulder and 6-foot outside shoulder.

The record drawings identify a typical cross-section foreslope from the earth/granular shoulder as ranging between 3:1 and 2.5:1 (Horizontal:Vertical). The 2011, fourth edition, of the AASHTO publication *Roadside Design Guide* identifies slopes steeper than 3:1 (as 1V:3H in *Roadside Design Guide*) as a critical foreslope where a vehicle has greater likelihood to overturn. A foreslope between 4:1 and 3:1 (1V:4H to 1V:3H in *Roadside Design Guide*) represents a slope that is traversable, but unlikely that a vehicle would be able to stop or return to the roadway. The typical ramp cross-section foreslopes fall within the critical and non-recoverable slope ranges.

The diagonal eastbound and westbound off-ramps are approximately 2,700 and 2,500 linear feet in length from beginning of exit taper and ramp terminal intersection at Middle Road. Both ramps consist of two horizontal curves, one within the I-80 diverge location and the second near the loop ramp and diagonal ramp pavement convergence location. The eastbound off-ramp contains a sag vertical curve approximately 500 feet west of Middle Road. The westbound off-ramp contains a crest vertical curve approximately 1,000 feet east of Middle Road. Vertical grades for both ramps are less than 4.0 percent.

The existing interchange features off-ramp geometry (diverge location along I-80) that meets current design standards. The diverge taper is approximately 20:1 from the edge of I-80 travel way. However, as the off-ramps approach the loop on-ramps, the horizontal curve is shorter than Iowa Dot design standard 'suggested minimum' of 300 feet for ramps. In the eastbound direction, this horizontal curve is approximately 193 feet in length and is 106 feet in length in the westbound direction. There are also locations where the existing K values for crest and sag vertical curves do not meet current design standards.

The two loop ramps each consist of a three-centered compound horizontal curve. For the eastbound I-80 loop on-ramp, the curve radii increase in the direction of travel from approximately 231 feet, to 311 feet to 462 feet. The westbound I-80 loop on-ramp contained tighter radii, transition from 150 feet to 231 feet to 311 feet along the direction of travel. The eastbound acceleration lane is 440 feet long and the westbound acceleration lane is 540 feet long. The typical superelevation through the loop ramp compound curve is 8.0 percent.

The Middle Road to I-80 loop on-ramp entrance sections, including acceleration lane and approach to acceleration lane, for both I-80 directions of travel do not meet current design standards. *AASHTO 2004* indicated that it is desirable to have a curve with a radius of 1,000 feet or greater and a length of at least 200 feet provided in advance of the acceleration lane for a loop ramp. The eastbound and westbound loop on-ramps exhibit entrance radii of 462 and 311 feet, respectively. The acceleration lane lengths for both on-ramps also do not meet current design standard. On flat terrain, the minimum acceleration length at entrance terminals for vehicles accelerating from a design speed of 25 mph to 70 mph is 1,420 feet. The existing acceleration lane lengths are 440 feet and 540 feet in the eastbound and westbound directions, respectively. Both acceleration lanes offer a 360-foot taper at the end of the acceleration lane, which exceeds AASHTO's recommended minimum length.

The ramp terminal intersections are stop-controlled from the I-80 off-ramp approach. A small raised island is present within the ramp terminal intersection with a stop sign. The on and off-ramps in each quadrant are adjacent to each other, creating head-to-head traffic, for approximately 450 feet, separated from a double solid yellow line. This head-to-head segment, the ramp terminal intersections, and approximately 300 feet of the loop ramps are illuminated with cobra-head roadway lighting.

Middle Road

Middle Road is currently a two-lane roadway cross-section through the interchange, consisting of two 12-foot PCC pavement travel lanes, 10-foot earth/granular surfaced shoulder, and roadside ditches. Middle Road currently lacks turn lanes at both ramp terminal intersections. The posted speed limit through the interchange is 45 mph. Three locations along Middle Road are illuminated through the study area, both ramp terminal intersections and the Forest Grove Drive intersection.

Along the Middle Road alignment, the study area terrain generally slopes downward towards Spencer Creek to the north of I-80. Traveling northbound, a downward grade of approximately 4.22 percent transitions into a sag vertical curve underneath I-80. A downhill grade continues at approximately 0.5 percent from I-80 to the northern ramp terminal intersection and Spencer Creek. To the north of Spencer Creek, Middle Road climbs at approximately 7.5 percent to the crest of the hill. Deficiencies with the existing I-80 bridges, and the subsequent impacts to Middle Road, were previously described in Existing Conditions – Interstate 80 section.

The rural cross-section extends southward to the 53rd Street intersection. 53rd Street was recently reconstructed to the west of, and including, the intersection with Middle Road. The new intersection consists of a single-lane roundabout, with the ability to accommodate two approach lanes from all four directions. South of 53rd Street, Middle Road transitions back to the rural cross-section to Crow Creek Road. The roadway has been widened to accommodate left-turn lanes through residential development intersections north of Crow Creek Road, but it still consists of a rural cross-section lacking curb and gutter.

South of the Crow Creek Road intersection, Middle Road has been improved to a three-lane cross-section with curb and gutter along the east side. The roadway accommodates two through lanes in the northbound direction and a single through lane in the southbound direction. It is anticipated that a fourth through lane will be added in the southbound direction in the future, as warranted by traffic volumes.

The Middle Road Bridge over Crow Creek has been reconstructed to accommodate two through lanes in each direction.

A 10-foot wide PCC pavement pedestrian trail has been constructed along the eastern side of Middle Road, extending south from 53rd Avenue into the more urbanized area of Bettendorf. A turf boulevard of varying width is typically provided between the edge of travel way and the trail. A similar trail also extends west from Middle Road along the northern side of 53rd Avenue. It is planned that this trail will continue northward through the I-80/Middle Road interchange in conjunction with future Middle Road improvements.

Future roadway projects identified in the 2040 Quad Cities LRTP, for priority between years 2021 and 2040 include:

- 4-lane reconstruction of Middle Road between Crow Creek Road and Forest Grove Drive
- 4-lane reconstruction of Middle Road between Forest Grove Drive and Indiana Avenue

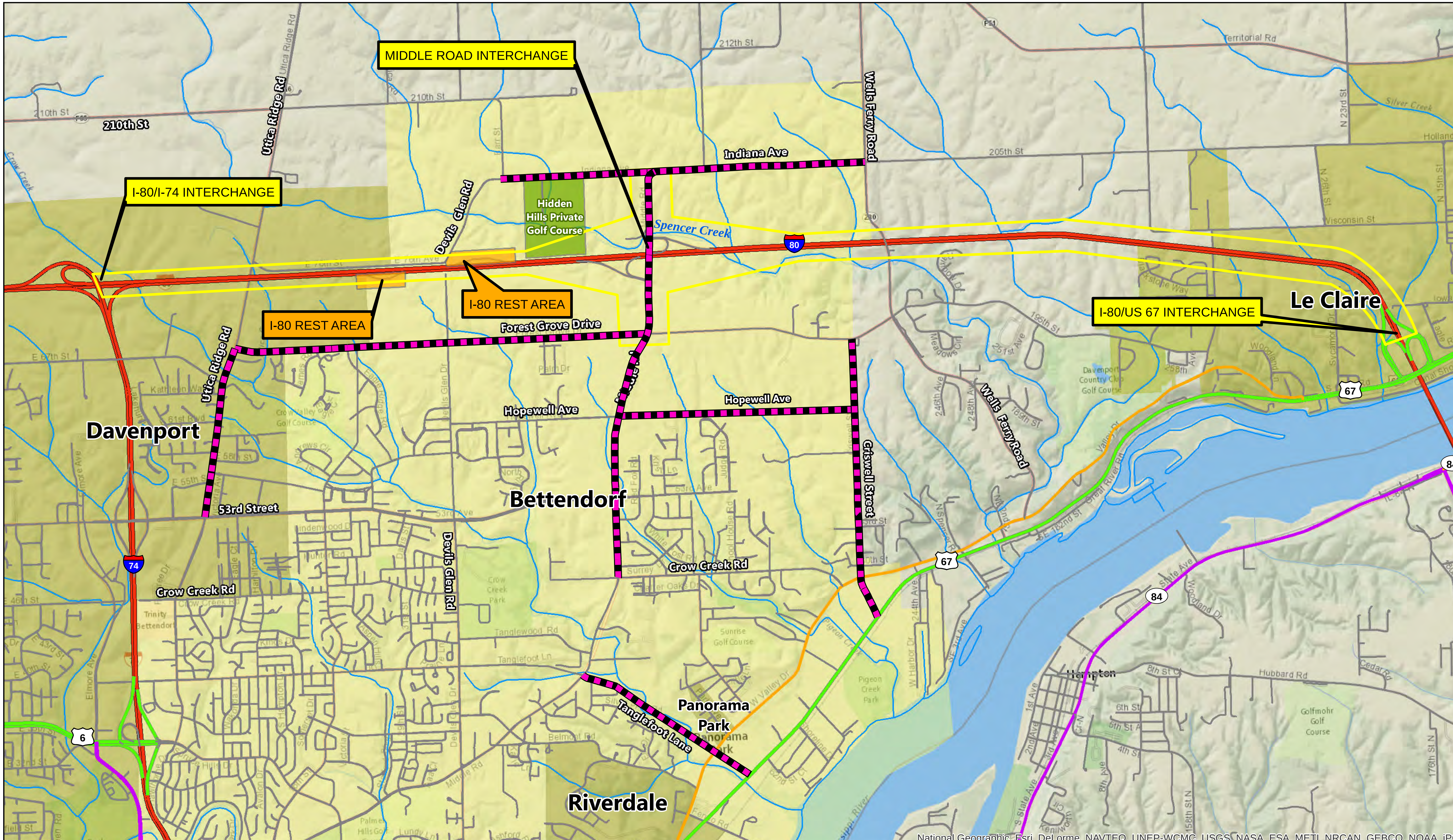
Future Land Use and Roadway Network

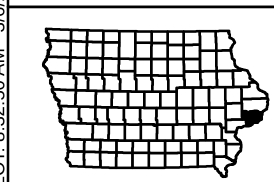
The area surrounding the I-80/Middle Road interchange is primarily rural, transitioning to a more urbanized setting south of I-80. The roadways within the study area are typically rural, 2-lane, cross-sections that may or may not have been improved to accommodate higher traffic volumes from the approaching urbanization. The primary area of traffic generation that currently impacts the interchange is located south of I-80, to both the west and east of Middle Road.

In the 2040 Quad Cities LRTP, the proposed future land use immediately surrounding the interchange entails office/business park and general commercial on both sides of the interchange along Middle Road, Indiana Avenue, and Forest Grove Drive. Extending outward, future land use includes medium/high density residential, transitioning to low density residential. The office, commercial, and high density residential land uses potentially contain high trip generation characteristics, necessitating transportation capacity improvements at adjacent facilities. An overview of the 2040 Quad Cities LRTP Future Lane Use map is provided in **Appendix A**.

The City of Bettendorf Comprehensive Plan provided the framework of the future land use data around the I-80/Middle Road interchange in the 2040 Quad Cities LRTP. The Comprehensive Plan contains discussions of an I-80/Middle Road Subarea Plan, representing 3,100 acres of land along the Middle Road and I-80 corridors. This is shown in **Appendix A**. As this location is primarily in a rural setting, it affords the opportunity to create detailed criteria for future development. The Subarea Plan outlines the purpose of the respective designation and specific development standards and recommended actions. The Subarea Plan provides detailed information regarding projected land use and its impact on the transportation network, lending itself for a more thorough analysis of projected traffic in the area.

Figure 2.1-2 shows the arterial and local street network surrounding the project area with respective Federal Functional Classification. Projects identified within the 2040 Quad Cities LRTP were overlaid into the figure and discussed further below. The topography is generally rolling and includes Spencer Creek to the north of I-80.





LEGEND

- Planned Improvements
- Rivers & Streams
- Interstate
- US Primary Road
- State Road
- Local Connecting Road
- Local Road
- Project Study Area
- Rest Areas
- Golf Courses
- Corporate Boundaries

HRGreen | Bettendorf | IOWA DOT

I-80 & MIDDLE RD IJR
2040 QUAD CITIES LRTP
PLANNED IMPROVEMENTS

0 3,000
Feet
1 inch = 3,000 feet

NORTH

MAR 2014

FIG. 2.1-2

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The roadway network is generally laid out in a grid pattern, with a well distributed network of east-west and north-south roadways. In certain locations, the rolling terrain and other topographic features have dictated routes to deviate from the typical grid pattern. U.S. Highway and State routes also tend to deviate from the prevalent grid pattern, rather following historical alignments that connected city centers. The primary roadways in and around the study area include:

East-West Corridors
(From north to south)

Indiana Avenue – Located approximately 0.5 mile north of, and parallel to, I-80. The roadway is identified as an Urban Collector east of Middle Road and local roadway to the west. The roadway currently traverses through rural terrain, providing access to Hidden Hills Golf Course, residences/farms, and agricultural land uses. The existing roadway consists of a rural cross-section with a 2-lane chip-sealed asphaltic concrete pavement. The 2040 Quad Cities LRTP identifies three projects within the 2021-2040 timeframe along Indiana Avenue:

- Roundabout at the intersection of Indiana Avenue and Middle Road
- 2-lane reconstruction of Indiana Avenue between Barr Road and Middle Road
- 2-lane reconstruction of Indiana Avenue between Middle Road and Wells Ferry Road

Forest Grove Drive – Urban Collector roadway approximately 0.5 mile south of, and parallel to I-80. The surrounding land use through the study area consists of an area transitioning from a rural to a more urbanized setting. Primary development along Forest Grove Drive has been residential development. Access locations are typically limited to existing farm residences, field access, and new residential developments. The roadway currently consists of a 2-lane rural cross-section with a chip-sealed asphaltic concrete pavement. The 2040 Quad Cities LRTP identifies a project extending west of Middle Road within the 2021-2040 timeframe along Forest Grove Drive:

- 4-lane reconstruction of Forest Grove Drive between Devils Glen Road and Middle Road

Further to the west of Devils Glen Road, a 4-lane reconstruction project is planned between 2011 and 2020 for Forest Grove Drive between Eagle Ridge Road and Devils Glen Road. These projects are part of a reconstruction and capacity improvement effort, improving local connectivity, mobility, and safety, of the southern parallel roadway to I-80 through Davenport and Bettendorf.

Hopewell Avenue – Local roadway approximately 0.5 mile south of Forest Grove Drive, or 1 mile south of I-80. To the west of Middle Road, Hopewell Avenue was recently improved to an urban, 2-lane, cross-section to Devils Glen Road. The 2040 Quad Cities LRTP identifies a project extending east of Middle Road for construction of a new urban 2-lane roadway in the 2011-2020 timeframe. This local roadway provides additional access to and from new residential development in the area, impacting Middle Road traffic operations.

53rd Avenue – Located approximately 1.5 miles south of I-80 and traverses across Davenport and Bettendorf. West of Middle Road, 53rd Avenue is identified as an Urban Minor Arterial and was recently improved to a two-lane roadway between Middle Road to Devils Glen Road. This cross-section primarily consists of a single travel lane in each direction, with potential expansion to two lanes in each direction (occurring in conjunction with new development), separated by a raised median. Access breaks have been constructed along this corridor for connections to future development. The 53rd Avenue and Middle Road intersection was also improved through the reconstruction of a roundabout. 53rd Avenue currently ends approximately 0.75 miles east of Middle Road.

Tanglefoot Lane – Minor Arterial located approximately one mile south of 53rd Street, or 2.5 miles south of I-80. Currently, the roadway terminates at Middle Road to the east and extends westward into Davenport. The segment west of Middle Road was recently improved, accommodating one lane in each direction until traffic volumes warrant expansion to the north. The Middle Road and Tanglefoot Lane intersection has been built-out to an ultimate configuration. The 2040 Quad Cities LRTP identifies two projects that extend Tanglefoot Lane eastward on new alignment to Valley Drive and U.S. Highway 67:

- 4-lane new construction of Tanglefoot Lane between Middle Road and Valley Drive (2021-2040 timeframe)
- New construction (number of lanes to be determined) of Tanglefoot Lane between Valley Drive and U.S. Highway 67 (2021-2040 timeframe)

These two projects will facilitate connectivity of the Tanglefoot Lane corridor between Middle Road and U.S. Highway 67.

North-South Corridors
(from west to east)

Interstate 74 – Interstate freeway located approximately 3 miles west of the I-80/ Middle Road interchange with connections between I-80 and I-280 within the metropolitan area. I-74 continues southward out of the Quad Cities before heading east towards Indianapolis, Indiana. Between I-80 and I-280, the typical cross-section consists of two travel lanes in each direction separated by a median. I-74 provides one of the five Mississippi River crossings within the metropolitan area.

Identified needs along I-74 have been established by both the Iowa DOT and Illinois DOT, leading to the creation of the I-74 Mississippi River Corridor Project. This major project consists of several phases that began prior to 2011. These projects, or phases, primarily consist of capacity improvements along I-74 mainline and at interchanges and cross-streets along the corridor. A significant component of the I-74 project is the construction of a new bridge across the Mississippi River.

The 2040 Quad Cities LRTP also identifies an illustrative project that entails a feasibility study for the reconstruction of the I-80/I-74 systems interchange with new access to the north of I-80.

Utica Ridge Road – Urban Minor Arterial located approximately 0.5 mile east of I-74, or 2.5 miles west of Middle Road. This roadway traverses northward through Bettendorf and Davenport, and provides the next adjacent I-80 crossing (no interchange)west of Middle Road. The roadway is identified as a Rural Major Collector north of the Quad Cities MPO boundary. The 2040 Quad Cities LRTP has identified a project for 2021-2040 that reconstructs Utica Ridge Road between 53rd Street and Forest Grove Drive to a 4-lane urban cross-section.

Devils Glen Road – Located approximately one mile west of Middle Road within the study area. South of I-80, the roadway has local termini at Forest Grove Drive to the north and just south of U.S. Highway 67 to the south. Devils Glen Road intersects Middle Road approximately 3 miles south of I-80. The roadway is classified as an Urban Collector between Forest Grove Drive and 53rd Avenue and an Urban Minor Arterial between 53rd Avenue and U.S. Highway 67.

The typical cross-section consists of a 4-lane roadway south of, and including, the intersection of 53rd Avenue. North of 53rd Avenue, Devils Glen Road consists of a two-lane section with granular shoulders.

Criswell Street – Located approximately 1 mile east of Middle Road through the study area. Criswell Street is identified as an Urban Collector with termini at Forest Grove Drive to the north and Valley Drive to the south. This segment is approximately 1 mile in length and serves as an eastern boundary of Bettendorf. The roadway currently consists of a rural two-lane cross-section with a chip-sealed asphaltic concrete roadway.

Two future projects have been identified in the 2040 Quad Cities LRTP, including:

- 4-lane reconstruction of Criswell Street between Forest Grove Drive and Valley Street (2021-2040 timeframe)
- 4-lane new construction of Criswell Street between Valley Drive and U.S. Highway 67 (2011-2020 timeframe)

Wells Ferry Road – Located between 1-1.5 miles east of Middle Road. This roadway is classified as an Urban Collector, extending northwest from Valley Drive. North of I-80, and outside of the Bettendorf corporate limits, the roadway is classified as a Rural Major Collector and is also known as 240th Street and County Highway Z30. The existing cross-section consists of a rural two-lane section with an asphaltic concrete roadway surfacing. West Ferry Road provides the next adjacent I-80 crossing (no interchange) east of Middle Road that would also carry traffic on Criswell Street north and south across I-80.

Existing Conditions Summary

The existing I-80 cross-section through the study area consists of two lanes in each direction, traversing the northern boundary of the Quad Cities metropolitan area. Adjacent interchanges are currently spaced at distances representative of a rural area at three miles to the west (I-80/I-74 systems interchange) and five miles to the east (U.S. Highway 67 service interchange). Therefore, increases in traffic demand generated by areas within and around the study area will be concentrated to accessing I-80 via the Middle Road interchange.

The local area street system consists of an integrated grid network with roadways typically traversing north-south and east-west. Topography and natural features, such as rivers and streams, tend to dictate deviation from this at locations throughout the metropolitan area.

The study area is currently located in a rural setting, transitioning to a more urbanized area as Bettendorf continues expanding northward. The road network primarily consists of two-lane rural roadways, with roadside ditches and lacking sidewalks. Recent improvements to 53rd Street, Hopewell Avenue, Tanglefoot Lane, and segments of Middle Road south of the study area have begun urban roadway expansion spurred by development in the area. Several projects are planned in the 2040 Quad Cities LRTP throughout the area, on many of the adjacent and crossing arterial and collector roadways.

As Middle Road is Bettendorf's primary northern gateway to/from I-80, it is expected to handle much of the increased traffic between the area and I-80. The city of Bettendorf and Bi-State Regional Commission are planning for this increase in development, and generated traffic, through the I-80/Middle Road interchange. This includes a proposed project to reconstruct the interchange to current design standards in order to provide the physical space and geometry needed to accommodate the planned urban arterial network, improve capacity and improve traffic operations.

This section established the need to reconstruct the existing interchange to accommodate the planned expansion of the arterial street network and provide an interchange that meets current geometric design criteria. Middle Road is the only access point directly between I-80 and the developing land north and south of I-80 within the study area. Improvements to other corridors would not alleviate the need to reconstruct the existing interchange.

2.1.2 Crash Analysis

A review of crash history data was completed for the I-80/Middle Road interchange to identify potential trends or safety concerns within the study area. Crash data was obtained from Iowa DOT's Crash Mapping Analysis Tool (CMAT) software and included data from January 1, 2008 through December 31, 2012 for a total of five (5) years of data.

A review of the crash data was completed by analyzing specific location segments within the interchange area and summarized in **Table 2.1-1**. The outer I-80 crash study limit began approximately 2000 feet upstream from the I-80 off-ramp to Middle Road, in each respective direction. This point corresponded with the opposite direction of travel's downstream study limit. The I-80/Middle Road interchange area was divided into I-80 mainline segments, diagonal ramps, loop ramps, ramp terminal intersections and the Middle Road segment between the two ramp terminal intersections. The Middle Road intersections with Indiana Avenue and Forest Grove Drive were also included. The crash data, obtained from CMAT within each respective segment for eastbound and westbound directions of travel were applicable, is provided in **Appendix B**.

One fatal crash occurred within the study area approximately 1,500 feet upstream of the eastbound I-80 to Middle Road off-ramp. This crash involved two vehicles, with one running off the road to the left. The pavement was noted as wet and under rainy conditions at the time of the crash. Two other minor injuries were noted with this crash.

The Iowa DOT maintains crash rate averages for intersections, but not for interchanges. Thus, the interchange was reviewed as an intersection and a crash rate of 0.90 crashes per million entering vehicles (MEV) was calculated. The interchange, when viewed as an intersection, exceeds the statewide average crash rate of 0.7 crashes per MEV for rural intersections with greater than 10,000 entering vehicles per day. However, the crash rate is less than the statewide crash rate at 90% confidence level of 1.3 crashes per MEV. When viewed as an urban intersection, it is less than the statewide average of 1.0 crashes per MEV with greater than 25,000 entering vehicles per day.

Table 2.1-1: 2008 – 2012 Crash Data Summary

Segment Code #	Analysis Segment Location *Length Description*	Total # Crashes	Total # Fatal Crashes	Total # Major Injury Crashes	Total # Minor Injury Crashes	Total # Possible/ Unknown
I-80 Eastbound						
1	Off-Ramp Diverge *2000' Upstream from Diverge*	2	1	0	0	0
2	Mainline Between Ramps *Off-Ramp to On-Ramp*	5	0	0	0	0
3/4	Loop On-Ramp Merge *2500' Downstream from Merge*	6	0	1	2	0
5	Mainline *2000' Downstream (from WB Off-Ramp Location)*	5	0	0	0	0
I-80 Westbound						
5	Off-Ramp Diverge *2000' Upstream from Diverge*	15	0	0	2	1
4	Mainline Between Ramps *Off-Ramp to On-Ramp*	2	0	0	1	0
3/2	Loop On-Ramp Merge *2500' Downstream from Merge*	7	0	0	1	0
1	Mainline *2000' Downstream (from EB Off-Ramp Location)*	2	0	0	0	0
Interchange Ramps						
6	I-80 EB Off-Ramp	3	0	0	0	1
6	I-80 EB Loop On-Ramp	1	0	0	0	0
7	I-80 WB Off-Ramp	0	0	0	0	0
7	I-80 WB Loop On-Ramp	2	0	0	0	1
Ramp Terminal Intersections						
8	I-80 EB	2	0	0	0	0
9	I-80 WB	1	0	0	0	0
Middle Road Corridor						
10	Middle Road/Forest Grove Drive Intersection	12	0	0	2	2
11	Middle Road/Indiana Avenue Intersection	1	0	0	0	0
12/3	Middle Road Segments* *Between Ramp Terminal Intersections*	2	0	0	0	0
	Total Interchange	**54**	**1**	**1**	**6**	**3**

Note: Forest Grove Drive and Indiana Avenue intersections excluded from Total Interchange crash totals
** 1 crash occurred under I-80 bridges, included in Total Interchange crash summary*

The following summarizes observations from the crash data for mainline merge and diverge segments, loop ramps, and ramp terminal intersections.

Mainline Diverge Segments

The eastbound and westbound I-80 diverge segments at the Middle Road off-ramps shows two crashes in the eastbound direction and fifteen crashes in the westbound direction. These I-80 segments encompass approximately 2000 feet upstream, and including, the diverge location to the off-ramp. The following provides additional detail on the crashes:

<u>Eastbound I-80 Diverge Segment</u>

- 2 Total crashes
  - 1/2 = Fatal (two minor injuries also reported with this crash)
  - Major Cause
    - 1/2 = Ran off road – left
    - 1/2 = Followed too close
  - Pavement Conditions
    - 1/2 = Wet pavement conditions
  - Manner of Crash
    - 2/2 = Rear-end

<u>Westbound I-80 Diverge Segment</u>

- 15 Total crashes
  - 2/15 = Minor injury
  - 2/15 = Possible injury
- Major Cause
  - 5/15 = Animal
  - 5/15 = Swerving/Evasive Action
  - 3/15 = Ran off road – right
  - 2/15 = Driving too fast for conditions
- Pavement Condition
  - 6/15 = Ice
  - 2/15 = Snow
- Manner of Crash
  - 9/15 = Non-collision
  - 1 Each = Head-on, broadside, sideswipe in same direction

Mainline Merge Segments

The eastbound and westbound merge segments both encompass the merge location from the loop ramp and 2500 feet downstream to account for the acceleration lane and vehicular turbulence from merging vehicles. The eastbound and westbound segments reported six and seven crashes, respectively, and are summarized as follows:

Eastbound I-80 Merge Segment

- 6 Total crashes
  - 1/6 = Major Injury
  - 2/6 = Minor Injury
- Major Cause
  - 2/6 = Ran off road – left
  - 1 Each = Animal, crossed centerline, swerving/evasive action, ran off road – right
- Pavement Condition
  - 2/6 = Snow
- Manner of Crash
  - 5/6 = Non-collision
  - 1/6 = Head-on
- Other
  - 1/6 = under influence of alcohol/drugs/medication
  - 1 Each = Struck bridge/bridge rail/overpass, guardrail

Westbound I-80 Merge Segment

- 7 Total crashes
  - 1/7 = Minor injury
- Major Cause
  - 3/7 = Animal
  - 1 Each = driving too fast for conditions, swerving/evasive action, ran off road – right, lost control
- Pavement Condition
  - 2/7 = snow
- Manner of Crash
  - 3/7 = Non-collision
  - 2/7 = sideswipe, same direction
  - 1/7 = Rear-end

Ramp Segments

The ramp segments encompass the entire ramp segments not included within the I-80 merge/diverge segment and ramp terminal intersection. Each of the ramps had no more than three crashes over the five-year period, with zero for the westbound off-ramp.

Eastbound Diagonal Off-Ramp

- 3 Total crashes
  - 1/3 = Possible injury
- Major Cause
  - 1 Each = Animal, driving too fast for conditions, ran off road – right
- Pavement Condition
  - 1 Each = Dry, wet, snow
- Manner of Crash
  - 3/3 = Non-collision

- Other
    - 1/3 = Under influence of alcohol/drugs/medication
    - 1 Each = Struck tree, sign post

Eastbound Loop On-Ramp

- 1 Total crash
- Major Cause
    - 1/1 = Over-correcting/over-steering
- Pavement Condition
    - 1/1 = Wet
- Manner of Crash
    - 1/1 = Sideswipe, same direction
- Other
    - 1/1 = Alcohol (statutory)

Westbound Diagonal Off-Ramp

- 0 Crashes

Westbound Loop On-Ramp

- 2 Total crashes
    - 1/2 = Possible injury
- Major Cause
    - 1 Each = driving too fast for conditions, downhill runaway
- Pavement Condition
    - 1 Each = Dry, wet
- Manner of Crash
    - 2/2 = Non-collision
- Other
    - 1/2 = Struck ditch/embankment

Ramp Terminal Intersections

The two ramp terminal intersections are both stop-controlled from the I-80 off-ramp approach. Within the five-year study period, two crashes were recorded for the eastbound ramp terminal intersection and a single crash at the westbound ramp terminal intersection. The following summarizes those crashes:

Eastbound Ramp Terminal Intersection

- 2 Total crashes
- Major Cause
    - 1 Each = Lost control, other: other improper action
- Pavement Condition
    - 2/2 = Dry
- Manner of Crash
    - 2/2 = Rear-end

Westbound Ramp Terminal Intersection

- 1 Total crash
- Major Cause
  - 1/1 = Failure to yield ROW: from stop sign
- Pavement Condition
  - 1/1 = Dry
- Manner of Crash
  - 1/1 = Broadside

Crash History Conclusion

The interchange crash rate between 2008 and 2012, when calculated as an intersection of I-80 and Middle Road, is less than the statewide average for urban intersections with greater than 25,000 entering vehicles. When comparing it to a rural intersection, the crash rage exceeds the statewide average, but is less than the crash rate at a 90 percent confidence level.

One fatal crash has been recorded within the crash analysis study area and within the five-year period of queried data, approximately 1,500 feet upstream of the interchange in the eastbound direction. Overall, 54 crashes were recorded within the analysis period, with one fatal crash, one major injury crash, six minor injury crashes, and three possible/unknown injury crashes. The fatal crash occurred approximately 1,500 feet upstream of the off-ramp in the eastbound direction. Animal crashes and inclement weather-related road conditions were notable factors in the recorded crashes.

Thirty (30) of the 54 total crashes were identified within the merge and diverge segments within the analysis. Another seven crashes were identified in the segment between the off-ramp and loop on-ramp in each direction. The turbulence in traffic flow introduced from merging, diverging, and lane change maneuvers is evident by the number of crashes, and crash types, at these locations. Overall within these six analysis segments, eight (8) of the 37 crashes involved swerving/evasive action as the major cause and five (5) involved run off road to the right. Eight (8) of the 37 involved vehicle-animal crashes.

Overall, there are indications that the number of crashes within the interchange study area approach statewide averages. There are correctable geometrics that do not meet current design standards within the interchange that would be expected to improve traffic operations and safety along I-80 and within the I-80/Middle Road interchange. Further, major cause summaries of the crashes within segments affected by merging and diverging traffic exhibit characteristics of impacts of access-related turbulence. The development and evaluation of Build alternatives within this IJR will further address safety and geometric concerns.

2.1.3 Traffic Forecasts

Traffic forecasts for the 2040 planning year were obtained from the adopted 2040 Bi-State Regional Commission travel demand model used in the development of their 2040 Quad Cities LRTP. Through the model development process, the City of Bettendorf worked with the Bi-State Regional Commission in updating projected land use in and around the study area in northern Bettendorf to account for planned development.

The Bi-State Regional Commission completed the travel demand model post-processing procedures, providing traffic volume data from which peak hour volumes were derived. Peak hour traffic volumes were developed, consistent with NCHRP Report 255 procedures, for Interstate and arterial mainline segments and turning movements for the 2040 Planning Year AM and PM peak hours.

As previously discussed, the City of Bettendorf identified the I-80/Middle Road interchange area as a specific sub-area within their latest Comprehensive Plan. The sub-area plan provided additional detail, identifying development goals, objectives, planned land use, and transportation needs/improvements within area. Because the Bi-State Regional Commission travel demand model is limited to the control totals in population and employment, it does not represent full build-out potential. Therefore, a Sub-Area Scenario was developed to consider additional build-out of the developable lands around the interchange and assess the interchange alternatives' ability to accommodate additional traffic volumes. Estimates for increased socioeconomic factors used in the travel demand modeling process, including number of residential dwellings, retail employment, and general employment, were provided to Bi-State Regional Commission for incorporation into the region's travel demand model for a special scenario. The traffic volumes were derived from information outlined within the I-80/Middle Road Sub-Area Plan and the aforementioned collaboration between the City of Bettendorf and the Bi-State Regional Commission in the development of the 2040 travel demand model.

This Sub-Area scenario assisted in assessing the ability of each Build alternative to accommodate future growth and projected operating conditions under a full build-out sub-area. It should be noted, however, that this volume scenario is not representative of the adopted travel demand model used in the creation of the 2040 Quad Cities LRTP.

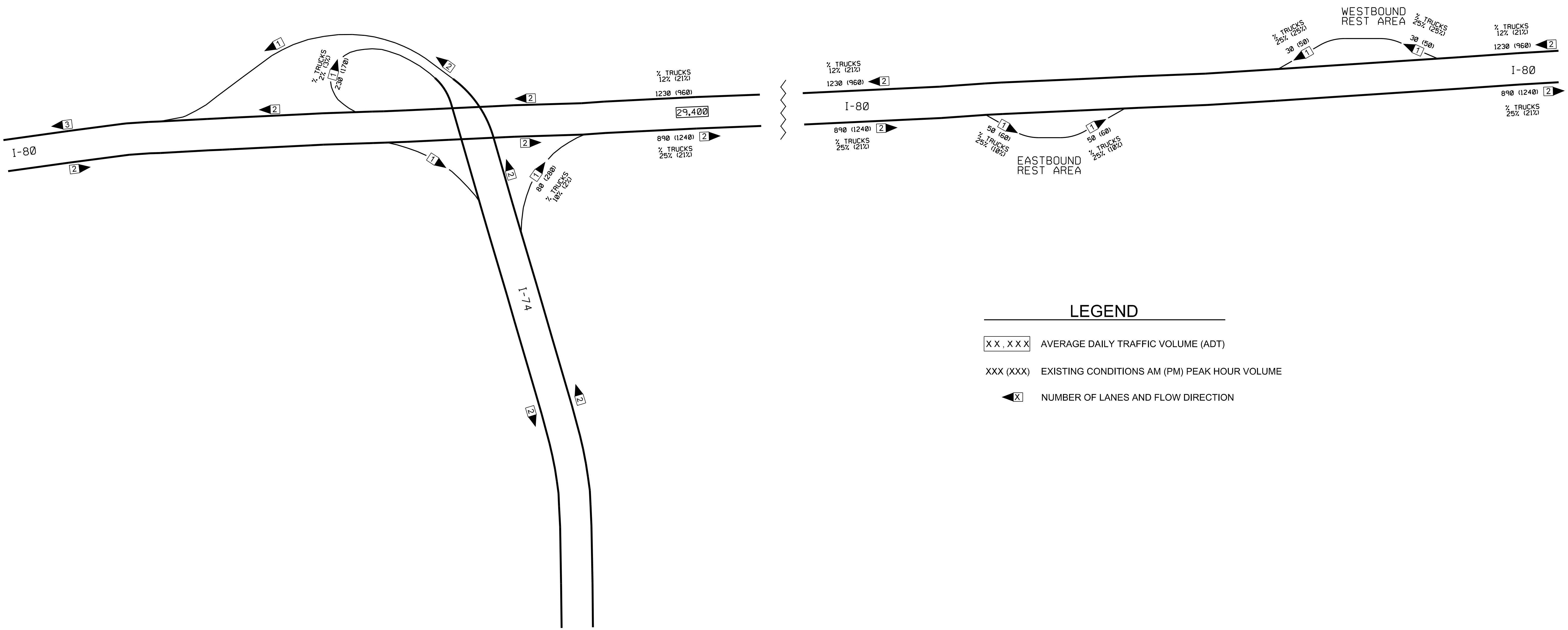
Documentation on the development of forecasted traffic volumes used in the 2040 planning year and 2040 Sub-Area (full build-out) analyses is provided in **Appendix C**.

Figure 2.1-3 depicts the 2008 Existing Year AM and PM peak hour and average daily traffic volumes in the study area.

Figure 2.1-4 depicts the projected 2040 Planning Year AM and PM peak hour and average daily traffic volumes in the study area.

Figure 2.1-5 displays the developed 2040 Sub-Area Scenario AM and PM peak hour volumes and average daily traffic volumes in the study area.

It is not anticipated that the proposed improvements to the I-80/Middle Road interchange will dictate a change in traffic patterns within the travel demand model. The existing interchange accommodates all movements and provides adequate traffic operations, based on 2008 traffic volumes discussed in the following section. Adjacent crossings of I-80 are accommodated at Utica Ridge Road to the west and Wells Ferry Road to the east and will continue to accommodate traffic traversing to/from the either side of I-80. Further, the existing network provides connections between these three roads, both north and south of I-80. For this reason, the no-build and build alternative traffic projections are the same.



LEGEND

XX,XXX	AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	EXISTING CONDITIONS AM (PM) PEAK HOUR VOLUME
◄X	NUMBER OF LANES AND FLOW DIRECTION

NORTH

NOT TO SCALE

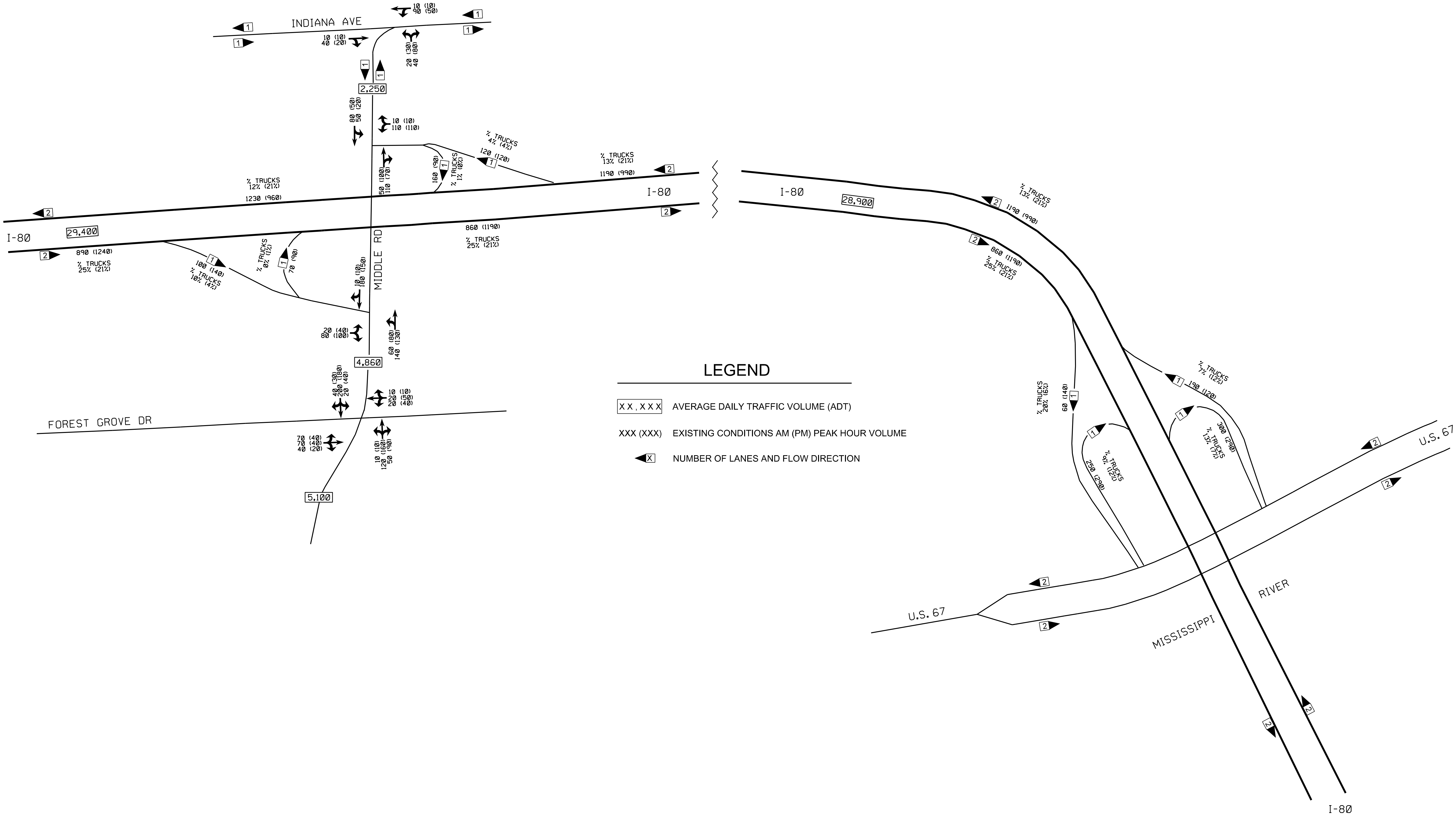
Bettendorf IOWA

IOWADOT

2008 EXISTING STUDY AREA
AM/PM PEAK HOUR TRAFFIC VOLUMES
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

FIGURE 2.1-3 (A)



LEGEND

XX,XXX	AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	EXISTING CONDITIONS AM (PM) PEAK HOUR VOLUME
X	NUMBER OF LANES AND FLOW DIRECTION

NORTH

NOT TO SCALE

Bettendorf IOWA

IOWADOT

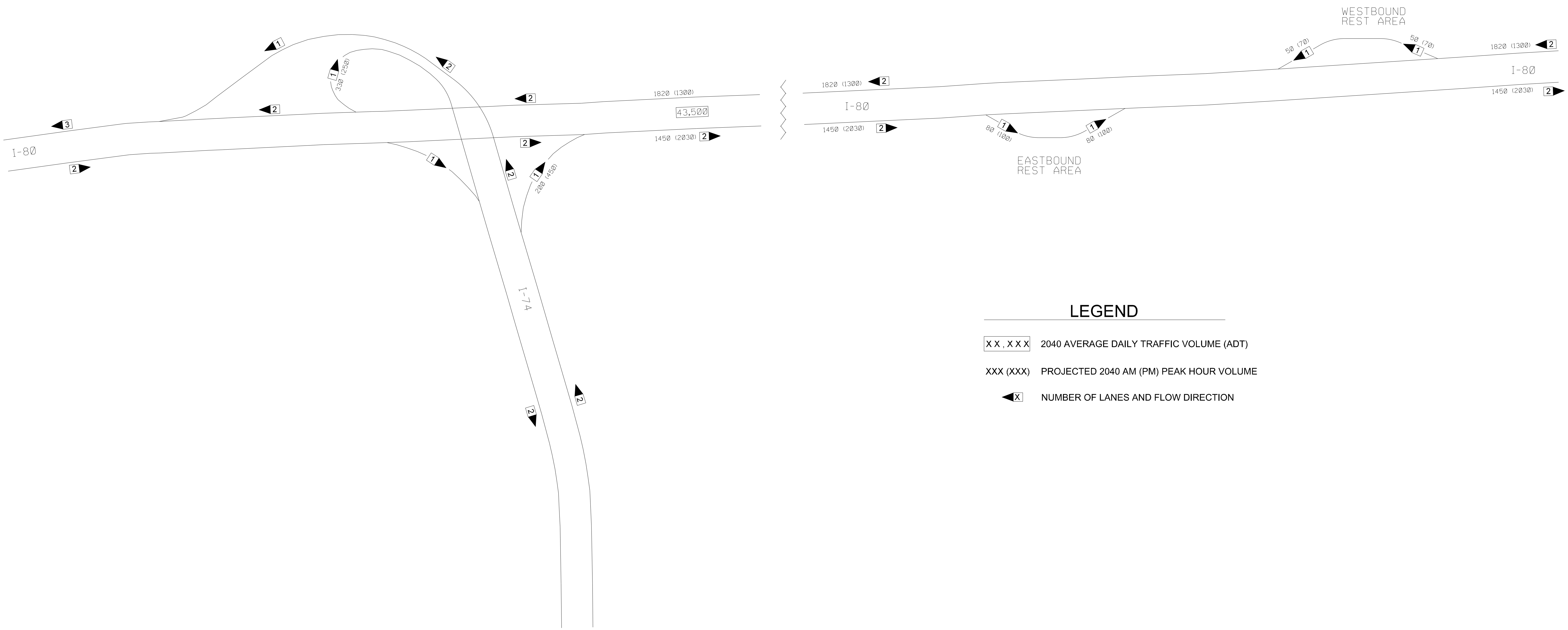
2008 EXISTING STUDY AREA AM/PM PEAK HOUR TRAFFIC VOLUMES

I-80 AND MIDDLE ROAD

BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

FIGURE 2.1-3 (B)



LEGEND

XX,XXX	2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
X	NUMBER OF LANES AND FLOW DIRECTION

NORTH

NOT TO SCALE

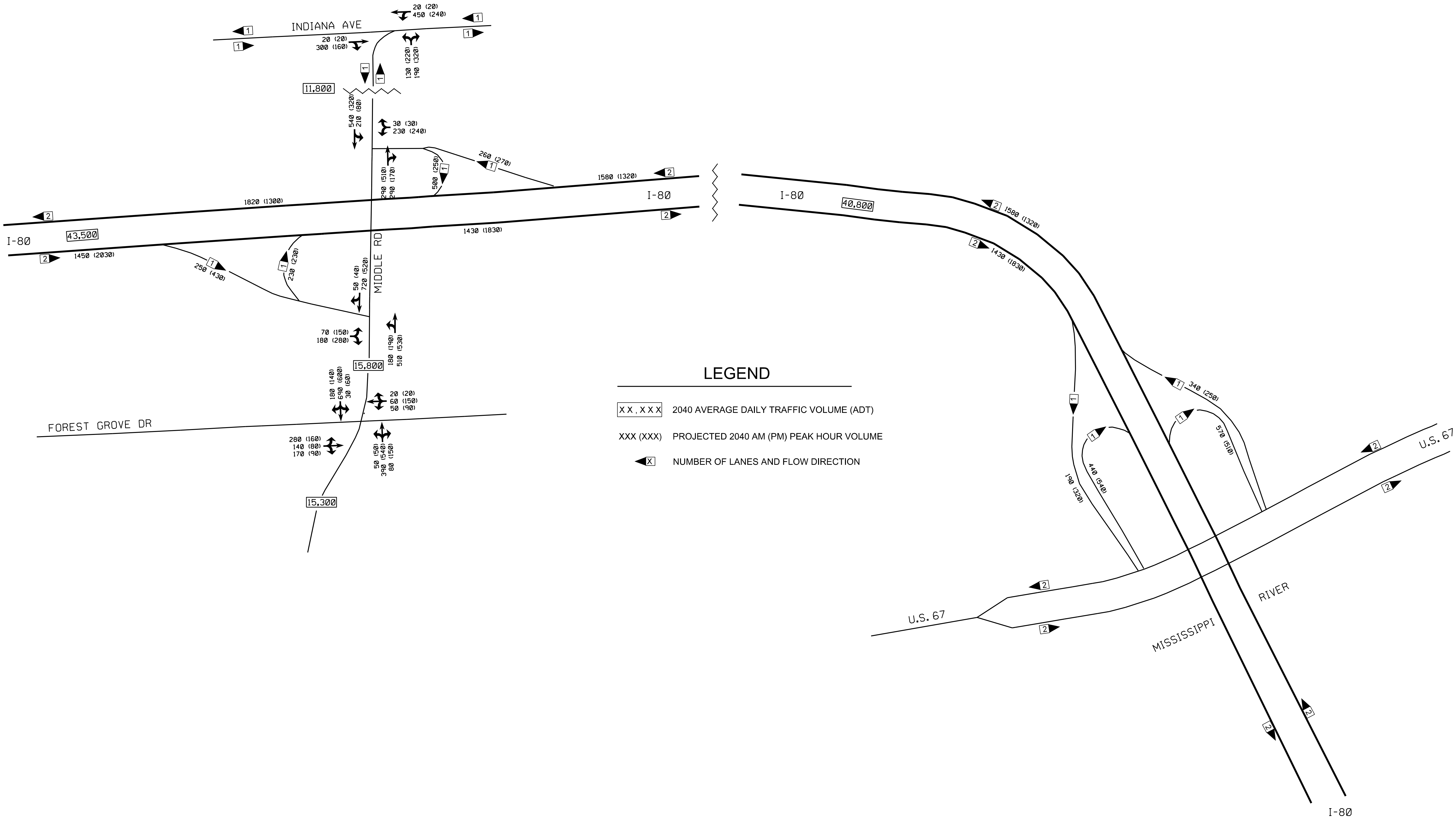
Bettendorf IOWA

IOWADOT

2040 PLANNING YEAR STUDY AREA
AM/PM PEAK HOUR TRAFFIC VOLUMES
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

FIGURE 2.1-4 (A)



NORTH
NOT TO SCALE

Bettendorf IOWA

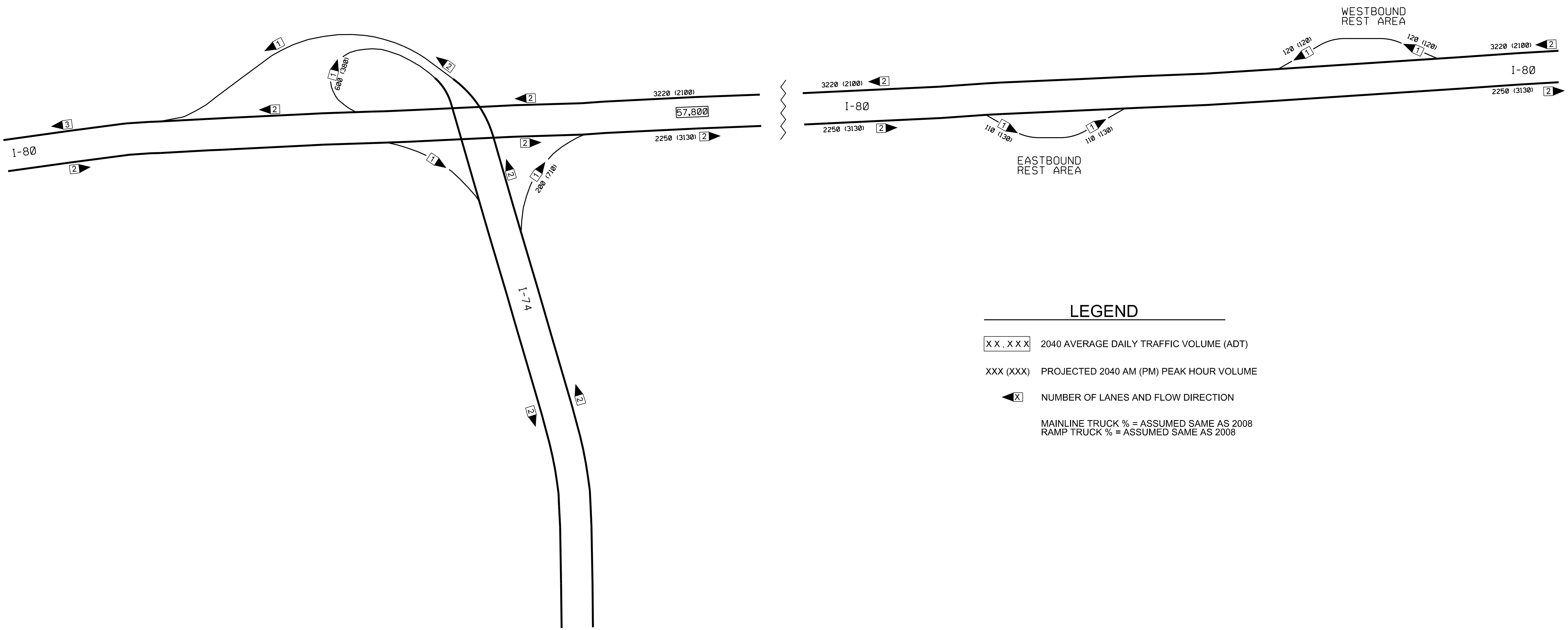
IOWADOT

2040 PLANNING YEAR STUDY AREA AM/PM PEAK HOUR TRAFFIC VOLUMES

I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

FIGURE 2.1-4 (B)



LEGEND

XX,XXX	2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
◄X	NUMBER OF LANES AND FLOW DIRECTION

MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008

NORTH

NOT TO SCALE

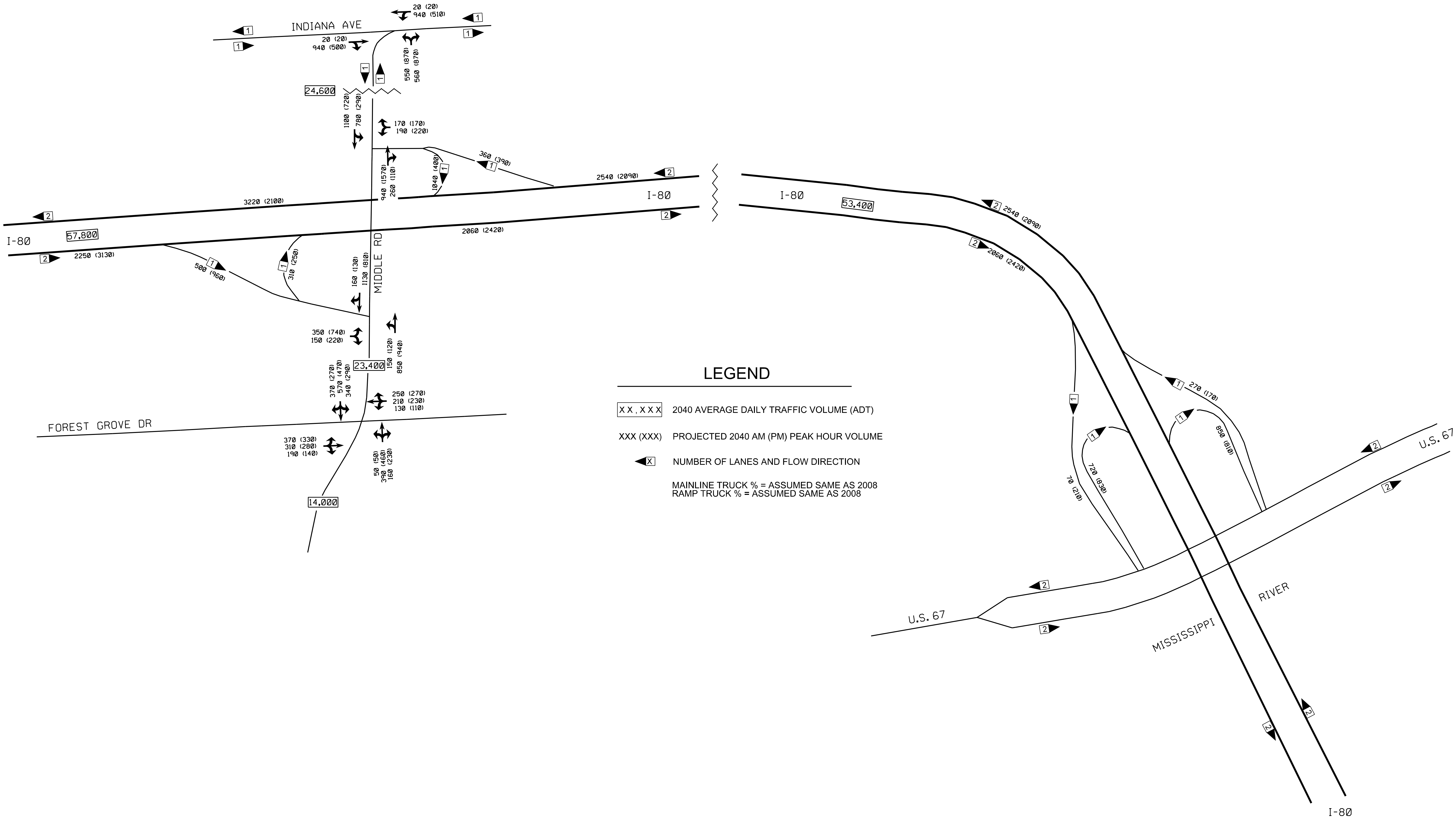
Bettendorf IOWA

IOWA DOT

2040 SUB-AREA SCENARIO
AM/PM PEAK HOUR TRAFFIC VOLUMES
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

FIGURE 2.1-5 (A)



NORTH

NOT TO SCALE

Bettendorf IOWA

IOWA DOT

2040 SUB-AREA SCENARIO
AM/PM PEAK HOUR TRAFFIC VOLUMES
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

FIGURE 2.1-5 (B)

2.1.4 System Analysis

The traffic operations analysis for the study area was completed using Highway Capacity Software (HCS) to analyze Interstate operations along basic freeway segments, merge, diverge, and possible weaving segments. HCS was also used to analyze the stop-controlled and roundabout intersections along Middle Road in the No-Build conditions analyses. Synchro/SimTraffic software was used to analyze the Middle Road corridor in the Build alternatives analyses, including the I-80 ramp terminal intersections, to account for traffic signal coordination. The corridor model was created using Synchro with results being reported from SimTraffic microsimulation measures. Each SimTraffic simulation was run five times and the measures of effectiveness were averaged across the five runs to develop the results

The primary measure of effectiveness compared throughout the analysis for both the Interstate and Middle Road corridors is LOS. For Interstate operations, LOS is a function of vehicle density measured in terms of passenger cars per mile per lane (pc/mi/ln). For intersections, LOS is a function of the average delay incurred per vehicle measured in seconds.

Measures of density and delay are assigned a letter grade between A and F, much like an academic report card, based on a designated LOS range. For freeway facilities, LOS A represents free-flow operations, with operational characteristics of little delay and low vehicle density. LOS E describes freeway traffic operations at capacity and LOS F represents unstable flow, or a breakdown in traffic flow, indicative of heavy delay or high vehicle density. Intersection LOS represents average delay per vehicle, with LOS A representing little delay and LOS F representing high delay. The LOS delay ranges differ between signalized intersections and stop-controlled/roundabout intersections. The density and delay thresholds for the various LOS conditions are shown in **Tables 2.1-2** and **2.1-3**.

Section 1.4 (Design Criteria) explains the LOS design criteria for this project. As the project study area is in an urban area, LOS C is typically the chosen design criteria for all freeway movements including ramp terminal intersections. LOS D is chosen as the design criteria for the adjacent intersections on Middle Road (Indiana Avenue and Forest Grove Drive).

In addition to LOS, SimTraffic was used to estimate the 95th percent queue lengths for the Middle Road intersections. SimTraffic records the maximum back of queue for every two minute period. The average queue is then calculated by averaging the maximum queue recorded for each two minute period. The 95th percent queue is the average queue plus 1.65 standard deviations. These queue lengths were recorded for each of the analysis scenarios and were used to determine potential situations where ramp queues might interfere with freeway traffic operations.

Table 2.1-2: Freeway Operations Level of Service Thresholds

LOS	Basic Freeway Segment	Merge and Diverge Segments	Weaving Segments
	Density Range (pc/mi/ln)	Density Range (pc/mi/ln)	Density Range (pc/mi/ln)
A	0 – 11	0 – 10	0 – 10
B	> 11 – 18	> 10 – 20	> 10 – 20
C	> 18 – 26	> 20 – 28	> 20 – 28
D	> 26 – 35	> 28 – 35	> 28 – 35
E	> 35 – 45	> 35	> 35
F	> 45	Demand Exceeds Capacity	Demand Exceeds Capacity

Table 2.1-3: Intersection Operations Level of Service Thresholds

LOS	Signalized Intersections	Two-Way Stop Control, All-Way Stop Control, and Roundabouts
	Delay / Vehicle (s)	Delay / Vehicle (s)
A	0 – 10	0 – 10
B	> 10 – 20	> 10 – 15
C	> 20 – 35	> 15 – 25
D	> 35 – 55	> 25 – 35
E	> 55 – 80	> 35 – 50
F	> 80	> 50

2.1.5 Traffic Operations Analysis – 2008 and 2040 No-Build Conditions

This section contains an analysis of I-80 and Middle Road through the study area based on current roadway conditions, utilizing existing (2008) and planning year (2040) traffic volumes. This analysis represents a "No-Build" condition where no improvements are made to the existing I-80/Middle Road interchange. The 2040 planning year volumes apply to both the No-Build conditions and Build alternatives analyses.

The No-Build analysis within this section is split into two sub-sections, the I-80 freeway operations analysis and Middle Road intersections analysis. The 2040 No-Build scenario further demonstrates LOS issues specific to the I-80/Middle Road interchange and adjacent roadways.

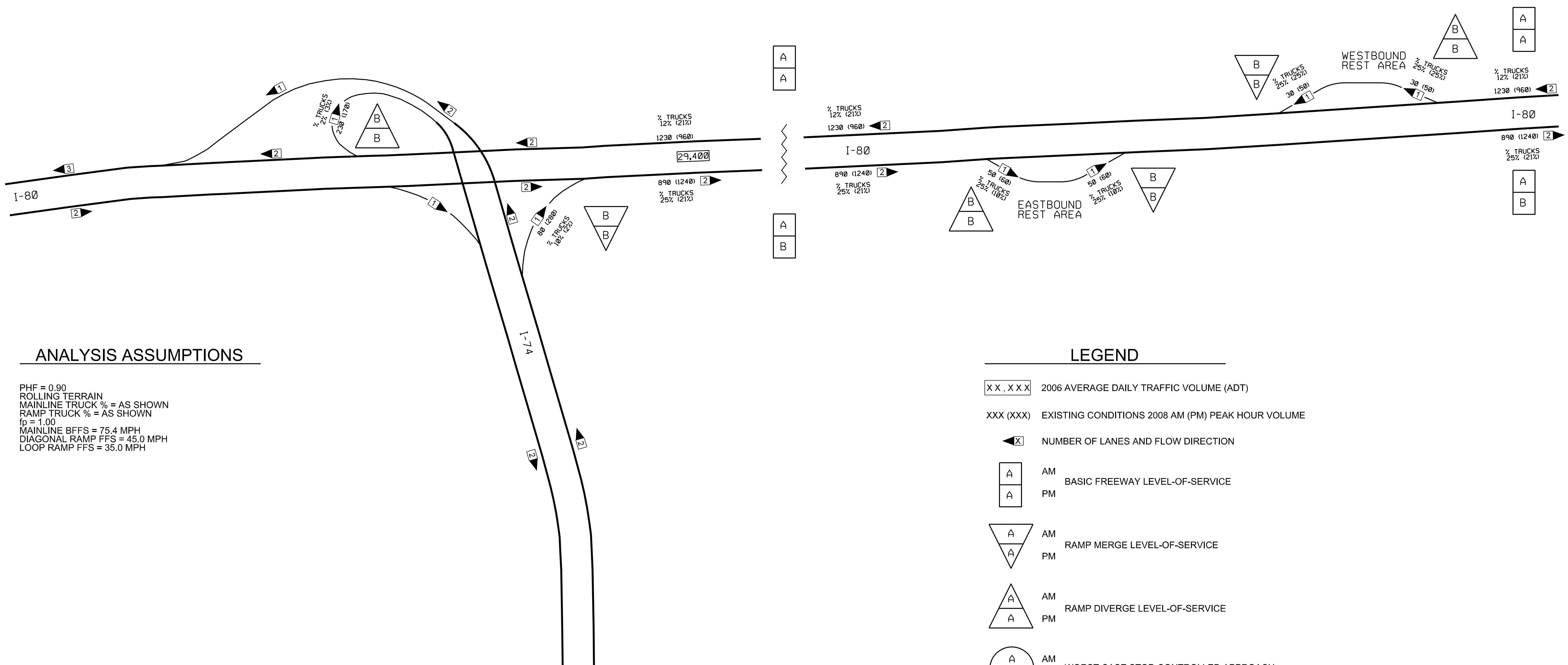
I-80 Freeway Operational Analysis

The traffic operations analysis of the No-Build conditions with existing 2008 and forecasted 2040 AM/PM peak hour traffic volumes is provided in **Figure 2.1-6** and **Figure 2.1-7**, respectively.

The analysis of 2008 existing year traffic conditions shows that all I-80 movements, including basic freeway and ramp merge and diverge segments, operate at LOS B or better in both the AM and PM peak hours.

The analysis of the 2040 planning year No-Build traffic conditions shows that all freeway movements are projected to operate at LOS C or better in the AM and PM peak hour. In general, traffic operations representing LOS C are more prevalent in the westbound direction in the AM peak hour and eastbound in the PM peak hour. This aligns with the directional nature of traffic flow during the AM and PM commute periods.

This analysis shows that based on the forecasted traffic volumes developed for this study, I-80 freeway segment operations are expected to operate at LOS C or better in both the AM and PM peak periods. It should be noted, however, that these results do not take into account operations at the ramp terminal intersections and subsequent impacts upstream to the I-80 mainline freeway segments and these results are discussed in the following section.



ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = AS SHOWN
RAMP TRUCK % = AS SHOWN
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH

LEGEND

XX,XXX 2006 AVERAGE DAILY TRAFFIC VOLUME (ADT)

XXX (XXX) EXISTING CONDITIONS 2008 AM (PM) PEAK HOUR VOLUME

X NUMBER OF LANES AND FLOW DIRECTION

A AM / A PM BASIC FREEWAY LEVEL-OF-SERVICE

A AM / A PM RAMP MERGE LEVEL-OF-SERVICE

A AM / A PM RAMP DIVERGE LEVEL-OF-SERVICE

A AM / A PM WORST CASE STOP-CONTROLLED APPROACH LEVEL-OF-SERVICE

NORTH
NOT TO SCALE

Bettendorf IOWA

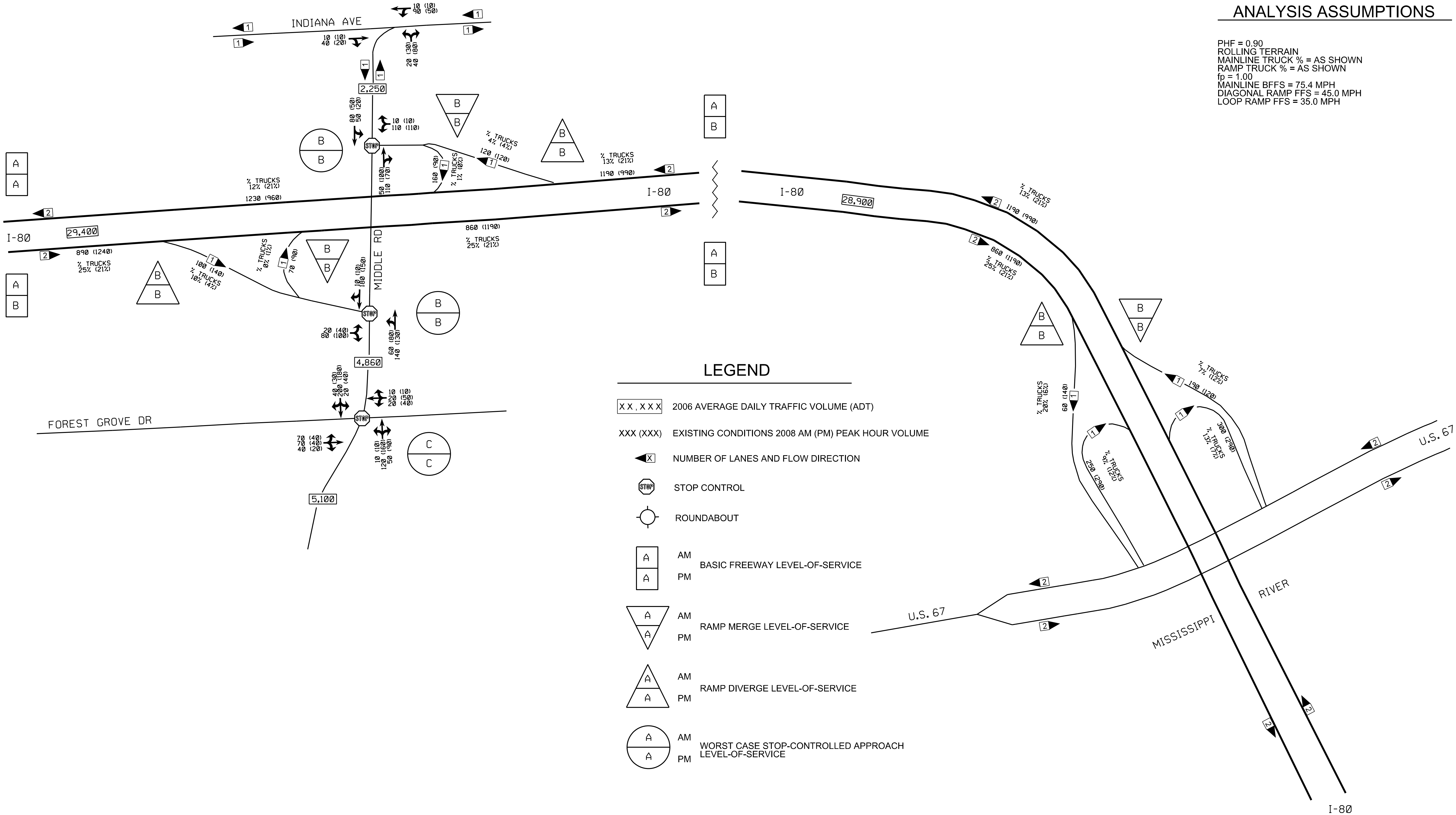
IOWA DOT

TRAFFIC OPERATIONS ANALYSIS
2008 NO-BUILD CONDITIONS
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

FIGURE 2.1-6 (A)

PLOT: 1:26:27 PM 1/31/2014 FILE: \\hrgcrnas\data\185390\UR\Updated_Traffic_03092012_TCW\2014_IJR_MostCurrent\2.1-6_2008 EXISTING OPS.dgn



NORTH
NOT TO SCALE

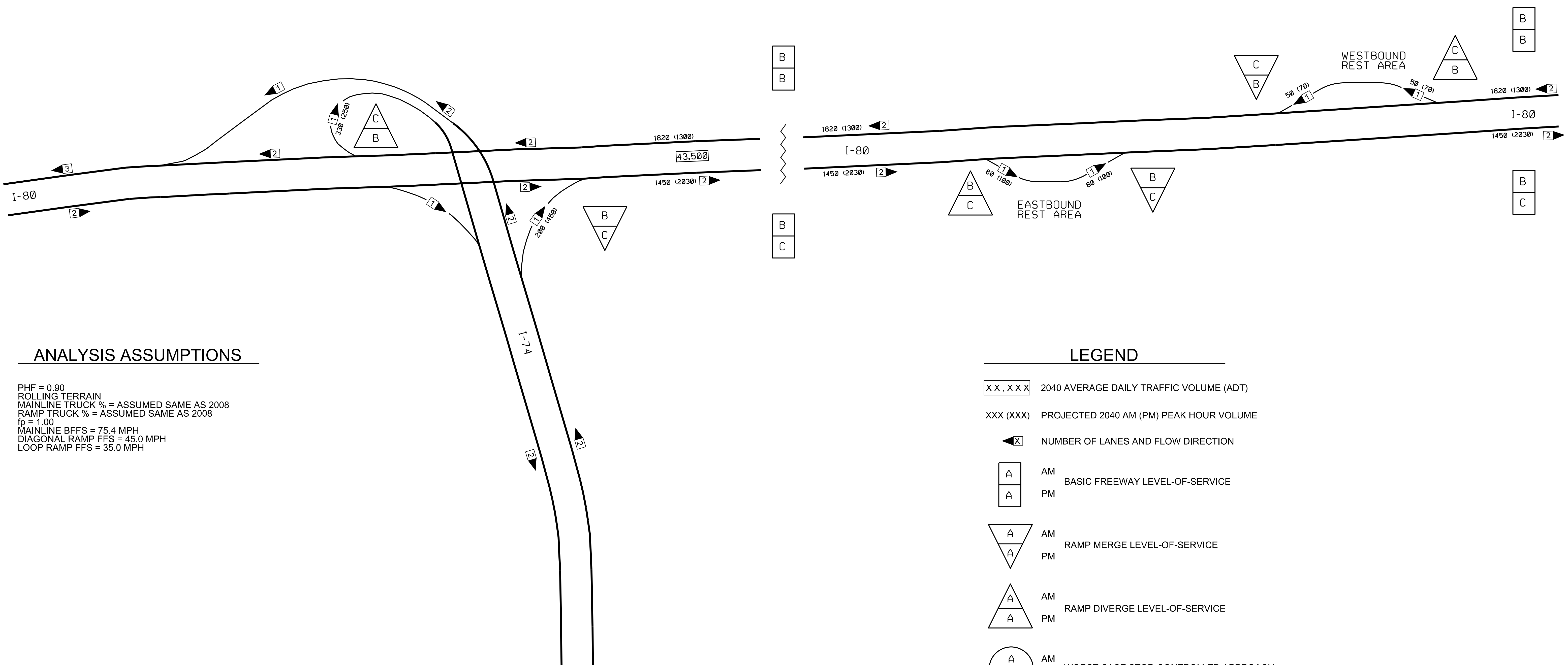
Bettendorf IOWA

IOWA DOT

TRAFFIC OPERATIONS ANALYSIS
2008 NO-BUILD CONDITIONS
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

FIGURE 2.1-6 (B)



ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH

LEGEND

XX,XXX	2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
X	NUMBER OF LANES AND FLOW DIRECTION
A / A (AM / PM)	BASIC FREEWAY LEVEL-OF-SERVICE
A / A (AM / PM)	RAMP MERGE LEVEL-OF-SERVICE
A / A (AM / PM)	RAMP DIVERGE LEVEL-OF-SERVICE
A / A (AM / PM)	WORST CASE STOP-CONTROLLED APPROACH LEVEL-OF-SERVICE

NORTH
NOT TO SCALE

Bettendorf IOWA

IOWADOT

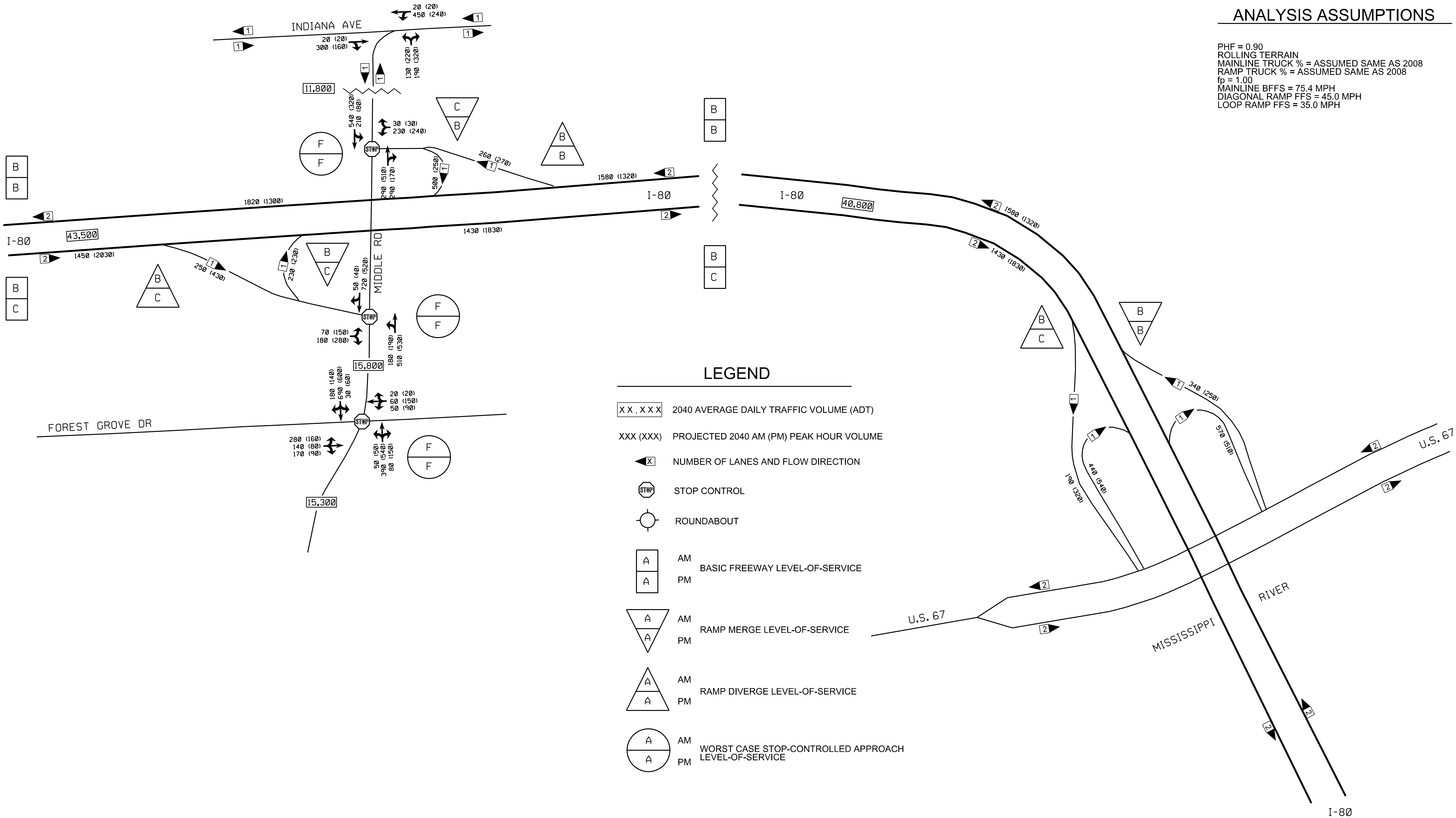
TRAFFIC OPERATIONS ANALYSIS
2040 NO-BUILD CONDITIONS
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

FIGURE 2.1-7 (A)

ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH



LEGEND

XX,XXX 2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX) PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
NUMBER OF LANES AND FLOW DIRECTION
STOP CONTROL
ROUNDABOUT
AM / PM BASIC FREEWAY LEVEL-OF-SERVICE
AM / PM RAMP MERGE LEVEL-OF-SERVICE
AM / PM RAMP DIVERGE LEVEL-OF-SERVICE
AM / PM WORST CASE STOP-CONTROLLED APPROACH LEVEL-OF-SERVICE

NORTH
NOT TO SCALE

Bettendorf IOWA
IOWADOT

TRAFFIC OPERATIONS ANALYSIS
2040 NO-BUILD CONDITIONS
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014
FIGURE 2.1-7 (B)

PLOT: 1:28:31 PM 1/31/2014 FILE: \\hrgcrnas\data\185390\IJR\Updated_Traffic_03092012_TCW\2014_IJR_MostCurrent\2.1-7_2040 NO-BUILD OPS.dgn

Middle Road Intersection Operational Analysis

The analysis of Middle Road at-grade intersections within the study area was completed using Synchro/SimTraffic software. The following intersections were analyzed:

- I-80/Middle Road Ramp Terminal Intersections
  - Stop-controlled from eastbound I-80 off-ramp approach
  - Stop-controlled from westbound I-80 off-ramp approach
- Middle Road/Forest Grove Intersection
  - Stop-controlled from Forest Grove Drive approaches
- Middle Road/Indiana Avenue Intersection
  - Stop-controlled from the western Indiana Avenue approaches (roadway splits to southbound approach and eastbound approach)

Control delay was measured at Middle Road stop-controlled intersections with HCS 2010 software in the No-Build conditions analysis. **Figure 2.1-6** and **Figure 2.1-7** graphically depict intersection traffic operations, represented by worst case stop-controlled approach LOS, for 2008 existing conditions and 2040 forecasted traffic volumes respectively. The measured control delay, and respective LOS, of the worst-case stop-controlled approaches is provided in **Table 2.1-4**.

Table 2.1-4: Middle Road Intersections Traffic Operations Analysis – 2008 and 2040 No-Build Conditions (HCS 2010)

Intersection Stop-Controlled Approach	**2008 No-Build** *LOS/Delay (sec/veh)*		**2040 No-Build** *LOS/Delay (sec/veh)*	
	AM	**PM**	**AM**	**PM**
I-80/Middle Road Ramp Terminal Intersections				
EB I-80 Off-Ramp	B/10.9	B/11.6	F/423.7	F/758.8
WB I-80 Off-Ramp	B/11.7	B/11.0	F/899.4	F/301.2
Forest Grove Drive/Middle Road				
EB Forest Grove Drive	C/24.4	C/17.5	F/22128	F/-
WB Forest Grove Drive	C/16.3	C/18.0	F/-	F/-

In 2008 No-Build conditions, the two ramp terminal intersections were measured to operate at LOS B from the stop-controlled approach in both the AM and PM peak hours. The Forest Grove Drive approaches with Middle Road were measured at LOS C in both the AM and PM peak hours.

In 2040 No-Build conditions, all analyzed stop-controlled approaches operated at LOS F. At Forest Grove Drive, both approaches in the PM and the westbound approach in the AM exhibited a volume to capacity ratio (v/c ratio) greater than 1.0, which defaults to a LOS F in HCM methodology and does not provide control delay or 95% queue length measures. In AM peak hour eastbound direction, the calculated 22,128 seconds of average delay per vehicle is indicative of 2040 traffic approach demand exceeding operational capacity of a two-way stop-controlled intersection. It should be noted that if these intersections are not improved, the resulting delay would likely divert traffic to other intersections and parallel routes; impacting traffic operations at those locations.

With regards to queue length, HCM methodology reports 95th percentile queue length in number of vehicles. It also estimates queue length differently than SimTraffic measures, therefore the following 2040 No-Build conditions queue lengths should not be used as a like comparison of queue lengths with the Build alternatives 95th percentile queue measured in SimTraffic.:

- Eastbound AM: 20.25 vehicles
- Westbound AM: 27.11 vehicles
- Eastbound PM: 40.76 vehicles
- Westbound PM: 18.73 vehicles

Based on the Middle Road at-grade intersection analysis, it can be concluded that the No-Build condition does not accommodate projected 2040 traffic volumes.

2.1.6 Local System Improvements

A review of the surrounding local roadway system was completed and found that improvements to the local roadway system beyond the Middle Road corridor would not significantly reduce traffic demand at the I-80/Middle Road interchange area. Further, I-80 has available capacity to accommodate greater travel demand than shown in the 2040 No-Build traffic operations analysis before congestion encourages motorists to select alternative routes on the local network. The 2040 basic freeway segments all operate at LOS C or better in the AM and PM peak hours.

The I-80 corridor affects continuity in the local roadway network, as it is more costly to construct roadway structures over or under I-80. Therefore, only select roadways typically of higher functional classification span north-south over I-80. Within and adjacent to the study area, this currently consists of Utica Ridge Road, Middle Road, and Wells Ferry Road. The 2040 Quad Cities LRTP does not identify any additional crossings within this area.

Development in the area will spur increased travel demand on the local roadway network, reflected in the 2040 travel demand model and 2040 Quad Cities LRTP projects. It should be noted that these identified improvements to the local system accommodate projected travel demand with roadway volume to capacity ratios of less than 1.0, indicating there is available roadway capacity to accommodate additional traffic volumes.

Middle Road provides the only access to I-80 of the three crossings previously identified. Middle Road also provides the most direct route between I-80, the planned future development north and south of I-80, and the Bettendorf city center. Therefore, it can be concluded that the attractiveness of the Middle Road corridor, proximity to development, and access to local destinations will maintain a level of travel demand that other local system roadways will not be able to accommodate (due to location, connectivity, orientation, etc.).

The planned development around the I-80/Middle Road interchange of office and commercial land use lends itself to potentially be a significant traffic generator. It is anticipated that a significant number of trips will arrive from the south, the urban core of Bettendorf, as well as from throughout the metropolitan area via I-80. The location of adjacent I-80 crossings, other perpendicular and parallel corridors, and the fact that Middle Road is a Minor Arterial extending out of the more densely urbanized area is expected to funnel traffic to Middle Road segments within the study area.

It is anticipated that improvements will be needed to Middle Road intersections within the study area to accommodate increased traffic demand. Potential improvements include, but are not limited to: signalization or other traffic control, turn lanes, and/or other improvements to improve intersection capacity. Further discussion of proposed improvements to the local roadways, as needed to address criteria outlined within this IJR, is included in Policy Statement #3.

2.1.7 Need Summary

Review of the existing interchange conditions identified several roadway design geometrics that do not meet current design standards. Locations or design features that do not meet current design standards include:

- Horizontal curve radii along off-ramps
- Horizontal curve radii along loop on-ramps
- K values along off-ramps for crest and sage vertical curves
- Non-recoverable foreslopes of 2.5:1 to 3:1
- Acceleration lane lengths for both loop on-ramps

The two I-80 bridges over Middle Road also do not meet current design standards and are considered functionally obsolete. Locations or design features of the two bridges that do not meet current design standards include:

- Vertical clearance of 14 feet - 10 inches, less than non-primary minimum criteria of 15 feet and desirable clearance based on proposed Middle Road improvements of 16 feet - 6 inches
- Lateral clearance along Middle road is 9 feet - 2 inches from edge of travel way to bridge piers
- Proposed improvements to Middle Road requires an opening of 67 feet plus clear zone under I-80; existing opening is 44 feet
- Lateral clear width on bridge decks was measured at 40 feet, which is less than 42 feet for existing bridges with auxiliary lane and 48 feet for new construction

A review of the crash data between 2008 and 2012 at the I-80/Middle Road interchange indicates that the interchange crash rate approaches that of statewide rates for similar facilities. One fatality was recorded over the study period, as was one major injury crash, six minor injury crashes, and three possible/unknown injury crashes. While a notable number of crashes were due to vehicle-animal conflicts, there were crashes that included correctable characteristics by geometric improvements to meet current design standards.

The I-80 freeway traffic operations analysis for the 2040 No-Build conditions shows adequate traffic operations for basic freeway segments and interchange merge and diverge locations throughout the study area. Traffic operations at the ramp terminal intersections, however, are projected at LOS F in both the AM and PM peak periods.

Planned future development throughout and around the study area was previously discussed in this section, consistent with land use plans presented in the City of Bettendorf Comprehensive Plan and 2040 Quad Cities LRTP. The 2040 Quad Cities LRTP outlines improvement projects to the local roadway network to address this development. These projects are included in the 2040 Bi-State Regional Commission Travel demand model, from which the 2040 traffic volumes for this study were developed.

Improvements to Middle Road are included within the area-wide capacity improvements in northern Bettendorf. These improvements include continued roadway upgrades to urban 4-lane sections northward to and through the I-80 interchange. However, existing constraints are imposed on roadway widening improvements at the I-80 bridges over Middle Road. The current bridges are functionally obsolete, providing inadequate vertical and horizontal clearance on Middle Road. These limitations restrict the ability to add sufficient capacity to accommodate future traffic volumes, with improvements consistent with the 2040 Quad Cities LRTP.

The proposed improvements contained within this IJR are expected to address operational and geometric deficiencies within the interchange to improve traffic mobility and safety along both the I-80 and Middle Road corridors. As the northern gateway between I-80 and Bettendorf Iowa, Middle Road improvements are a critical piece of the overall mobility improvements in the region. This interchange justification report looked into improvement strategies which address needs for the I-80/Middle Road interchange.

2.1.8 Policy Statement # 1 Summary

This policy statement asks whether the existing roadway system can meet, or be improved to meet, existing and forecasted traffic demand without modifying access to the Interstate system. A thorough review and analysis of the existing geometric, crash history, traffic forecast, capacity analysis, and local roadway system showed the following:

- Existing geometrics do not meet current standards or design practice
- Safety concerns based on geometric design that does not meet current design standards
- Traffic forecast indicates traffic demand will cause operational issues along Middle Road based on planning year No-Build conditions
- Local roadway system improvements outlined in the 2040 Quad Cities LRTP are anticipated to accommodate increased travel demand within and around the I-80/Middle Road interchange

Improvements to adjacent interchanges, the local roadway network, or I-80/Middle Road interchange ramps would not completely upgrade the interchange to current design standards or meet the traffic operations and safety goals of the project. The above analysis defines the purpose and need for the project and identifies issues with the existing systems interchange.

Policy Statement #1 criteria has been satisfied.

2.2 FHWA Policy Statement # 2

FHWA policy statement # 2 states:

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 without the proposed change(s) in access (23 CFR 625.2(a)).

The second policy statement raises the question as to whether alternate interchange design, location, and modal solutions have been considered prior to deciding on the improvements proposed as part of this IJR.

2.2.1 Alternative Evaluation

The interchange concept development process identified eight Build alternates, plus a No-Build condition, to address existing geometric features that do not meet current design standards and to meet traffic operation goals. These eight alternatives were carried forward for further evaluation on the ability to improve interchange traffic operations and update geometrics to current design standards. Concept drawings for the Build alternative concept configurations are provided in **Appendix D**.

Alternative interchange locations were considered but dismissed from further consideration. Shifting the interchange east to increase the distance from the rest area ramps and mitigate stream impacts in the northwest quadrant was considered; however, the shifted interchange location impacted Spencer Creek in other locations and the existing interchange location provides adequate traffic operations between the Middle Road interchange and the rest areas. The additional cost and land impacts associated with a new Middle Road alignment were not justified.

All eight Build alternatives include an improved Middle Road corridor to accommodate future traffic volumes. This includes expanding capacity at the adjacent intersections of Indiana Avenue and forest Grove Drive, based on existing approach cross-sections and proposed improvements identified in the 2040 Quad Cities LRTP. Lane configurations at ramp terminal intersections are based on operational needs identified through the analysis and as dictated by the specific interchange alternative layout. Each alternative was initially configured with single-lane ramps (both diagonal and loops), with consideration to future expansion where possible.

The impacts from traffic operations, environmental considerations, and project costs were integrated into the development of the alternatives carried forward for further analysis.

These alternatives are described as follows, with primary design features and subsequent impacts of the alternative considered within the evaluation process:

Alternative 1 – Reconstruct Existing Interchange

Reconstructs existing interchange configuration with current geometric standards. This includes diagonal and loop ramps in the northeast and southwest quadrants

- 4 access points to I-80
- Ramp terminal intersections
  - EB and WB I-80 ramp terminal intersections located closer to I-80 than existing configuration
- Impacts
  - Least impact of all Build alternatives to floodway, floodplain, and Right-of-Way (ROW)
  - Spencer Creek
    - Extension of I-80 WB loop on-ramp acceleration lane impacts Spencer Creek

Alternative 2 – Standard Diamond Interchange

Alternative 2 constructs a standard diamond interchange with diagonal ramps in all four interchange quadrants.

- 4 access points to I-80
- Ramp terminal intersections
  - Approximately 1,100 feet spacing between ramp terminal intersections
  - WB I-80 located at similar location as existing, south of Spencer Creek
  - EB I-80 located north of existing
- Impacts
  - Requires relocation of homestead in northwest quadrant
  - ROW required for diagonal ramps in northwest and southeast quadrants
  - Spencer Creek
    - Two bridges required in northwest quadrant
    - Avoids creek in northeast quadrant

Sub-Alternative 2a – Standard Diamond with 25 mph Loops (Partial Cloverleaf)

Sub-alternative 2a constructs a standard diamond interchange, similar to Alternative 2, with I-80 loop on-ramps (25 mph design speed) in the northeast and southwest quadrants for additional traffic carrying capacity.

- 6 access points to I-80
- Ramp terminal intersections
  - Locations same as Alternative 2
  - Requires diverge location on NB and SB Middle Road for I-80 loop on-ramps
- Impacts
  - Same as Alternative 2

Alternative 3 – Standard Diamond with 30 mph Loops (Partial Cloverleaf)

Alternative 3 constructs a standard diamond interchange with I-80 loop on-ramps (30 mph design speed) in the northeast and southwest quadrants. The loop ramp curve radii are larger than those in Sub-Alternative 2a, necessitating the ramp terminal intersections be located further away from I-80 mainline.

- 6 access points to I-80
- Ramp terminal intersections
  - Approximately 1,700 feet spacing between ramp terminal intersections
  - WB I-80 located north of existing and Spencer Creek
  - EB I-80 located at similar location as existing
- Impacts
  - Requires relocation of homestead in northwest quadrant
  - ROW required for diagonal ramps in northwest, northeast, and southeast quadrants
  - Spencer Creek
    - Bridge required for diagonal ramp in northwest quadrant, diagonal ramp in northeast quadrant, and loop ramp in northeast quadrant

Alternative 4 – Homestead Avoidance Diamond Interchange with 25 mph Loops

Constructs a diamond interchange with I-80 loop on-ramps (25 mph design speed) in the northeast and southwest quadrants. This alternative differs from Alternative 2a in that the westbound I-80 diagonal ramp is separated from and located south of the westbound I-80 off-ramp terminal intersection. The 'tighter' location of the westbound on-ramp avoids impacting an existing homestead in the northwest quadrant. This alternative creates two ramp terminal T-intersections north of I-80.

- 6 access points to I-80
- Ramp terminal intersections
  - All ramp terminal intersection locations similar to Alternative 2a except diagonal ramp in northwest quadrant which is relocated to the south
- Impacts
  - ROW required in northwest and southeast quadrants for diagonal ramps
  - Spencer Creek
    - Similar impacts to Alternative 2 in northeast, southeast, and southwest quadrants
    - Diagonal ramp requires bridge to span multiple crossing locations of Spencer Creek in northwest quadrant

Alternative 5 – Creek Avoidance Diamond Interchange with Loop Ramps

Alternative 5 constructs a diamond interchange with I-80 loop on-ramps in the northeast and southwest quadrants. The westbound I-80 ramp terminal intersection is located north of Spencer Creek in order to minimize creek impacts in both the northwest and northeast quadrants. The loop ramp in the northeast quadrant incorporates a 25 mph design speed, similar to Alternative 2a, to also minimize impacts to Spencer Creek. The southwest and southeast quadrants are similar to the design in Alternative 3, with diagonal ramps in both quadrants and a 30 mph design speed loop ramp in the southeast quadrant.

- 6 access points to I-80
- Ramp terminal intersections
    - Approximately 1,800 feet spacing between ramp terminal intersections
    - WB I-80 located north of Spencer Creek
    - EB I-80 located at similar location as existing to accommodate a 30 mph design speed loop in southwest quadrant
- Impacts
    - Requires relocation of homestead in northwest quadrant
    - ROW required in northwest, northeast and southeast quadrants for diagonal ramps
    - Spencer Creek
        - Alternative designed to minimize impacts to Spencer Creek.
        - Bridges required for crossing in northwest quadrant

Alternative 6 – Compressed Diamond Interchange

Constructs a compressed diamond interchange where the ramp terminal intersections are located closer to the I-80 mainline, compared to the Alternative 2 Standard Diamond Interchange configuration. The ramp terminal intersections are spaced approximately 750 feet apart, compared to 1,100 feet for the Standard Diamond, in order to minimize impacts to Spencer Creek and the homestead in the northwest quadrant. This alternative does not provide I-80 loop on-ramps, nor is the configuration expandable to accommodate loop ramps in the future.

- 4 access points to I-80
- Ramp terminal intersections
    - Approximately 750 feet spacing between ramp terminal intersections
    - WB I-80 located south of Spencer Creek
    - EB I-80 located at similar offset from I-80 mainline as the WB intersection
    - Close ramp terminal intersection spacing may allow traffic signals to operate as a single intersection
- Impacts
    - ROW required in northwest and southeast quadrants, but not to the extent as the other diamond interchange alternatives
    - Spencer Creek
        - Requires bridge spanning multiple crossings of Spencer Creek in northwest quadrant
        - Avoids creek in northeast quadrant

Alternative 7 – Diverging Diamond Interchange (DDI)

Alternative 7 constructs a diverging diamond interchange with ramp terminal intersections at similar locations as the Alternative 6 Compressed Diamond Interchange. This alternative minimizes impacts to Spencer Creek and the homestead in the northeast quadrant, and requires ROW similar to the Compressed Diamond and Single Point Urban Interchanges.

- 4 access points to I-80
- Ramp terminal intersections
  - Approximately 790 feet spacing between Middle Road through-movement intersections
  - Located at similar locations as Compressed Diamond and Single Point Interchange
  - Accommodates traffic through free left and right-turns at ramp terminal intersections
  - 2-phase traffic signal operation at the Middle Road through-movement crossover intersections
- Impacts
  - ROW required in northwest and southeast quadrants, but not to the extent as the other diamond interchange alternatives
  - Spencer Creek
    - Requires bridge spanning multiple crossings of Spencer Creek in northwest quadrant
    - Avoids creek in northeast quadrant

Alternative 8 – Single Point Urban Interchange (SPUI)

Alternative 8 constructs a single point urban interchange under the I-80 mainline bridge(s), condensing two ramp terminal intersections, as provided in the other Build alternatives, to a single intersection. Similar to the Compressed Diamond and Diverging Diamond interchange alternatives, this alternative minimizes impacts to Spencer Creek and the homestead in the northeast quadrants and requires similar ROW extents.

- 4 access points to I-80
- Ramp terminal intersections
  - Single intersection located under I-80 mainline
  - All traffic movements handled from single traffic signal cycle
- Impacts
  - ROW required in northwest and southeast quadrants, but not to the extent as the other diamond interchange alternatives
  - Spencer Creek
    - Requires bridge spanning multiple crossings of Spencer Creek in northwest quadrant
    - Avoids creek in northeast quadrant

2.2.2 Evaluation Factors

Evaluation criteria were established to analyze and compare the No-Build condition and the eight proposed Build Alternatives, as summarized in the previous section. In general, the evaluation criteria encompassed the following items:

- Level of service
- I-80 Lane balance
- I-80 Lane continuity
- Flexibility to accommodate a widened I-80 through the interchange
- Guide signing
- Constructability
- Utility conflicts
- Environmental impacts
- ROW considerations

- Meet Iowa DOT and FHWA geometric design criteria
- Decision sight distance for ramp merge/diverge and ramp intersections
- Pedestrian mobility
- Construction cost

Some specific, critical evaluation factors include:

- LOS C criteria met for interchange ramp terminal intersections.
- Meet Iowa DOT and FHWA geometric design criteria.
- Middle Road operations do not create exit ramp queues that would impact I-80 operations.
- Minimize environmental impacts to Spencer Creek, the floodway and floodplain, wetlands, and adjacent properties.
- Avoid or minimize ROW impacts related to environmental factors or financial implications that could significantly delay or make the project cost prohibitive.
- Given the rolling topography constraints, develop concepts that are constructible while meeting the normal standard of care for geometric design practices.

2.2.3 Alternative Modal Solutions

Alternative modal solutions such as transit and travel demand management were considered in the analysis process. It was found that several modal solutions were conducive to the type of development proposed around the interchange area, but they did not eliminate the need to improve the interchange infrastructure to current design standards.

Ramp metering is a transportation system management strategy that is used on high-volume ramps and congested corridors to improve traffic flows and safety conditions. A goal of ramp meters is to divert short distance trips to other facilities and break up platoons of vehicles entering the freeway, thereby smoothing flows of traffic entering the high-speed freeway as well as reducing vehicle conflicts associated with merging traffic. This is accomplished through the installation of traffic signals on major entrance ramps to the freeway facility. The signals regulate the flow of traffic entering the freeway at a given point.

The existing 4-lane I-80 cross-section is expected to accommodate the projected 2040 traffic volumes including the merge and diverge operations associated with the Middle Road interchange. Therefore, based on this analysis, ramp metering improvements are not warranted within this study's planning horizon; however, allowances for future implementation of ramps meters needs to be considered in the design of the interchange.

High Occupancy Vehicle (HOV) lanes are also not currently implemented within the Quad Cities area. Future expansion of I-80 to six or more lanes would provide the opportunity to add HOV lanes. However, based on the analysis provided in **Figure 2.1-7**, the projected 2040 traffic volumes utilized in this study do not warrant expansion of I-80 beyond the exiting 4-lane section. Future consideration of HOV lanes would need to be based on an established need and integrated with other Interstate segments in the Quad Cities area.

Some specific transit and travel demand management strategies include:

1) <u>Transit Operations</u>
Three fixed-route transit systems operate within the Quad Cities, operated by the City of Bettendorf, City of Davenport, and Rock Island Metropolitan Mass Transit District (MetroLINK/Metro, representing East Moline, Moline, Rock Island, and Silvis). A coordinated effort between the three transit systems provide the Loop Riverfront Circulator, operated by the City of Bettendorf, to provide a single route that connects Davenport, Rock Island, Moline, and Bettendorf. Currently, all fixed-route systems in the Quad Cities are interconnected by the Loop Riverfront Circulator and/or fringe transfer locations between operators.

   The City of Bettendorf's fixed route transit network currently consists of a multiple-route system radiating outward from the Waterfront Convention Center along U.S. Highway 67/State Street and the Mississippi River. This location is approximately 5.5 miles from the I-80/Middle Road interchange. The system provides two connections with the City of Davenport's system along the shared corporate limits.

   In order to serve the proposed development around the I-80/Middle Road interchange, the City of Bettendorf's transit system will need to extend a route northward. The proposed interchange modifications would accommodate a future route.

2) <u>Regional Multi-Modal Connectivity</u>
The Quad Cities region has an integrated multi-modal network, with fixed route bus services providing connections to intercity/regional bus lines and passenger rail stations. Both rail and bus lines through the Quad Cities provide daily connections to other metropolitan areas such as Chicago, Indianapolis, and Denver, among others.

   MetroLINK provides fixed-route service to the Quad City International Airport in Moline.

3) <u>Future Projects</u>
The City of Bettendorf Comprehensive Plan and 2040 Quad Cities Long Range Transportation Plan outline future studies that would benefit the Quad Cities metropolitan area. Potential future projects include:
   - Light rail passenger service within the metropolitan area
   - Passenger rail service between Chicago and Iowa City (with potential connections further west)

   The 2040 Quad Cities LRTP incorporates the concept of Transit-Oriented Development, which encourages compact, mixed use-development. This development provides population densities and land use conducive to transit operations.

These strategies would be expected to improve travel operations along I-80 and Middle Road, but require infrastructure improvements as well as development to occur around the interchange in order to generate traveler demand. Further, traffic volumes along I-80 and Middle Road are not projected to be at levels high enough that creates significant congestion, encouraging a mode shift by the traveling public. Long range planning for both the Bi-State Regional Commission and the City of Bettendorf considers multi-modal transportation in both existing infrastructure and future development, thus it is expected to be extended into the future development around the I-80/Middle Road interchange. Due to the undeveloped nature of the interchange area, low surrounding population densities, and projected traffic volumes, travel demand mode-shift was not considered in development of traffic forecasts utilized within this study.

2.2.4 Pedestrian Mobility

The I-80/Middle Road interchange is currently located in an area that is transitioning from a rural to a more urbanized setting as Bettendorf continues to grow northward. The current transportation network is reflective of this rural setting with rural roadway cross-sections that lack curb and gutter and sidewalks or trails.

As the roadway network continues to be improved to an urbanized cross-section, the inclusion of pedestrian facilities is typically included. In recent projects, a trail has been constructed on the north side of 53rd Street with a connection to the Middle Road intersection. South of 53rd Street, a trail is constructed on the east side of Middle Road southward into Bettendorf's urban core.

The 2040 Quad Cities LRTP identifies the Middle Road corridor north of 53rd Street as a proposed trail route, providing an extension of the existing trail network northward of the existing terminus. The proposed multipurpose trail, identified as a Long Term (2020-2040) project, would extend north of I-80 and tie into a proposed trail and designated greenway along Spencer Creek. The Middle Road trail extension would also provide connectivity to the network in northern Bettendorf with connections to existing and proposed trails along Forest Grove Drive and Hopewell Avenue.

The undeveloped nature of the study area affords the detailed planning of an intricate pedestrian network to ensure pedestrian mobility and integration with future multi-modal connections. This proposed project will incorporate identified pedestrian improvements from the 2040 Quad Cities LRTP and City of Bettendorf Comprehensive Plan. All the alternatives include provisions for a 10-foot trail on the west side of Middle Road and a 5-foot walk on the east side of Middle Road.

2.2.5 Policy Statement #2 Summary

Eight Build alternatives were developed to improve traffic operations, safety, and geometrics of the existing I-80/Middle Road interchange. They were developed with consideration to meeting design criteria and maintaining or improving traffic operations on I-80 while minimizing environmental and other land use impacts. All Build alternatives were developed to address the geometric concerns within the interchange as well as accommodate planned future expansion of Middle Road and I-80. Alternative interchange locations were considered but dismissed.

Alternative modal solutions were reviewed, particularly transit service and pedestrian mobility through the study area, along with the ability to accommodate future travel demand management strategies such as HOV lanes or ramp metering. While these items are important considerations through the analysis of alternatives and development within the area, they do not address the geometric concerns within the interchange. It has been concluded that selecting one of the proposed Build alternatives would improve roadway geometrics through the study area to current design standards and allow for the planned capacity improvements of the local roadway network and the interchange; thereby meeting the purpose and need of the project.

Policy Statement #2 criteria has been satisfied.

2.3 FHWA Policy Statement # 3

FHWA policy statement # 3 states:

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 (23 CFR 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection 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 (23 CFR 625.2(a) and 655.603(d)). 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 (23 CFR 625.2(a) and 655.603(d)). Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).

This policy statement asks that analysis be provided that demonstrates proposed improvements will not adversely affect existing and expected future traffic on the I-80 corridor. Based on the traffic analysis conducted, the proposed interchange improvements at the I-80 Middle Road interchange will not have a significant adverse impact on the traffic operations and safety of I-80.

Specific to the actions proposed herein, improvements are needed to alleviate safety concerns and upgrade interchange geometry to current design standards at the I-80/Middle Road service interchange. The following analysis will focus on determining the most effective combination of solutions and how they impact the needs of the corridor identified in the 2040 No-Build analysis. The following alternatives analysis shows that the interchange improvements would be expected to maintain or improve I-80 operations by providing more efficient merge/diverge locations, ramp geometrics, and ramp terminal intersections.

As discussed in Policy Statement #2, eight Build alternatives were developed for the I-80/Middle Road service interchange to improve or maintain traffic operations as well as design the new interchange to current standards. Some of the alternatives were iterations of a standard interchange design, with modifications to interchange geometry to minimize cost and environmental or ROW impacts. Where these iterations had negligible impact on traffic operations, they were analyzed under a single traffic operations alternative. The following traffic operations alternatives were analyzed under Policy Statement #3:

- No-Build Condition
- Reconstruct Existing Interchange
  - Alternative 1 – Reconstruct Existing Interchange
- Diamond Interchange
  - Alternative 2 – Standard Diamond Interchange
- Partial Cloverleaf (Parclo, with loops in northeast and southwest quadrants)
  - Alternative 2a – Standard Diamond Interchange with 25 mph Loops
  - Alternative 3 – Standard Diamond Interchange with 30 mph Loops
  - Alternative 4 – Homestead Avoidance Diamond Interchange with 25 mph Loops
  - Alternative 5 – Creek Avoidance Diamond Interchange with Loop Ramps
- Compressed Diamond Interchange
  - Alternative 6 – Compressed Diamond Interchange
- Diverging Diamond Interchange (DDI)
  - Alternative 7 – Diverging Diamond Interchange
- Single Point Urban Interchange (SPUI)
  - Alternative 8 – Single Point Urban Interchange

The Build alternatives analysis also utilized similar initial design features, consistent across all Build alternatives within the respective scenario, including:

- I-80: 4-lane cross-section (two lanes in each direction)
- I-80: Provisions to widen I-80 to the outside, providing an additional lane in each direction (three lanes in each direction)
- Ramps: Single lane diagonal and loop ramps
- Design Standards: All Build alternative designs meet current design standards
- Analysis assumptions (traffic data inputs and calibration parameters)

The following presents the traffic operations analysis of the eight alternatives, with comparison to the No-Build conditions, culminating with a recommendation of a preferred interchange alternative.

2.3.1 Planning Year Build Conditions and Traffic Forecasts

The Bi-State Regional Commission travel demand model incorporates projects identified in the 2040 Quad Cities LRTP in the development of forecasted 2040 traffic distribution. A number of projects geared towards improving the local arterial/collector street network, in response to the continuing northward expansion of development in Bettendorf, have been identified in the 2040 Quad Cities LRTP, as previously discussed in **Section 2.1**.

At this time, no capacity improvement needs have been identified for I-80 through the study area within the planning horizon. The 2040 Quad Cities LRTP also does not identify any specific interchange capacity improvements, or new access locations, to adjacent interchanges within the LRTP timeframe. However, the plan does identify two illustrative projects that could impact traffic operations along I-80 in the vicinity of the I-80/Middle Road interchange: 1) Capacity improvements to the I-80/I-74 systems interchange with new access to the north and, 2) A new interchange in the vicinity of 257th Avenue/western city limits of LeClaire. As both of these projects are identified as illustrative in the LRTP, indicating they are recommended for future study, they have not been incorporated in the development of the forecasted 2040 travel demand model volumes. Therefore, they are not included within this analysis.

Discussion on the development of the 2040 AM/PM peak hour traffic volumes was presented in **Section 2.1**. 2008 and 2040 AM/PM peak hour traffic volumes utilized in this analysis are provided in **Figure 2.1-3** and **2.1-4**, respectively, as well as on the following Traffic Operations Analysis figures.

The No-Build and Build conditions traffic volumes are the same within the respective analysis periods (2008 and 2040). Traffic growth on I-80 is primarily due to the overall growth of the metropolitan area plus increased regional traffic volumes. The anticipated development of Bettendorf to the north, particularly in the vicinity of the interchange, contributes to increased traffic volumes. Because the existing interchange and proposed Build alternatives accommodate all movements, it is not anticipated that a specific interchange design attracts or deters motorists from the interchange.

Table 2.3-1, on the following page, summarizes the expected traffic growth along I-80 and Middle Road through the corridor. The Bi-State Regional Commission travel demand model utilizes Iowa DOT (collected 2006) average annual daily traffic (AADT) volumes to calibrate the 2006 Base Model. It is expected that traffic will grow by over 3 percent annually on the Middle Road segments within the study area. Traffic growth along I-80 is projected at a more modest 1.2-1.3 percent annually.

Table 2.3-1: AADT Comparison

Roadway Segment	2006 Base Model AADT	2040 Projected AADT	Average Annual % Growth
I-80 West of Middle Road	27,800	43,500	1.3%
I-80 East of Middle Road	27,600	40,800	1.2%
Middle Road North of I-80	2,300	11,800	4.9%
Middle Road, I-80 to Forest Grove Drive	5.100	15,800	3.4%
Middle Road South of Forest Grove Drive	5.400	15,300	3.1%

With regard to the Sub-Area Scenario, the following table summarizes magnitude of traffic growth based on the build-out of developable lands around the I-80/Middle Road interchange.

Table 2.3-2: Sub-Area Scenario AADT Comparison

Roadway Segment	2006 Base Model AADT	2040 Projected AADT	2040 Sub-Area AADT
I-80 West of Middle Road	27,800	43,500	57,800
I-80 East of Middle Road	27,600	40,800	53,400
Middle Road North of I-80	2,300	11,800	24,600
Middle Road, I-80 to Forest Grove Drive	5.100	15,800	23,400
Middle Road South of Forest Grove Drive	5.400	15,300	14,000

2.3.2 Traffic Operations Analysis – 2040 Planning Year Build Conditions

The following traffic operations analysis examines how the different types of service interchanges affect I-80 operations. The analysis then focuses on traffic operations along Middle Road, measuring operational LOS and queue lengths at the ramp terminal intersections to determine any potential impacts to mainline I-80 operations.

As previously mentioned, the 2040 Quad Cities LRTP identifies a future interchange near 257th Avenue as an illustrative project. The operations analysis contained within this report does not account for an interchange near 257th Avenue. A future interchange at that location, if carried forward to that point, would need to address compatibility with the existing Middle Road interchange at the time of study.

I-80 Operations

The different Build alternatives do not significantly impact I-80 traffic operations outside of the I-80/Middle Road interchange merge/diverge locations in HCM methodology calculations. The lone impact to freeway segment density calculations is the consideration to additional access locations, whether the I-80/Middle Road interchange includes four or six access points, in the calculation of estimated free-flow speed. However, this is considered negligible as all analysis scenarios utilize a 75 mph speed curve in the freeway segment density calculation.

The traffic operations LOS for the I-80 freeway segments that are applicable to the No-Build conditions and Build alternatives are provided in **Table 2.3-3** and represented graphically in **Figure 2.3-1**.

Table 2.3-3: I-80 Traffic Operations Analysis – 2040 Build Conditions (HCS 2010)

I-80 Segment	2040 Traffic Operations	I-80 Segment	2040 Traffic Operations
	AM (PM)		AM (PM)
Eastbound		**Westbound**	
Merge, I-74 to I-80	B (C)	Merge, U.S. Hwy 67 to I-80	B (B)
Mainline, East of I-74	A (C)	Mainline, East of Middle Road	B (B)
Diverge, Eastbound Rest Area	B (C)	Middle Road Interchange	*See Table 2.3-4*
Merge, Eastbound Rest Area	B (C)	Mainline, West of Middle Road	B (B)
Mainline, West of Middle Road	A (C)	Diverge, Westbound Rest Area	C (B)
Middle Road Interchange	*See Table 2.3-4*	Merge, Westbound Rest Area	C (B)
Mainline, East of Middle Road	B (C)	Mainline, East of I-74	B (B)
Diverge, I-80 to U.S. Hwy 67	B (C)	Diverge, I-80 to I-74	C (B)

I-80 traffic operations are projected to operate at LOS C or better in both the 2040 AM and PM peak periods through the corridor. This includes ramp merge and diverge locations at the adjacent interchanges and rest areas. The directional nature of peak period traffic is apparent in the results, with LOS C measures typically occurring for westbound traffic in the AM peak period and eastbound traffic in the PM peak period.

The I-80/Middle Road interchange Build alternative 2040 traffic operations are summarized in **Table 2.3-4**, on the following page, and represented graphically in **Figure 2.3-2**. These results include the merge and diverge locations to and from I-80 and Middle Road. The primary differences between the Build alternatives, with regard to I-80 operations, are the number of access locations and type of I-80 on-ramp (diagonal or loop). All ramps were analyzed with a single lane.

Table 2.3-4: I-80/Middle Road Interchange Traffic Operations Analysis – 2040 Build Alternatives (HCS 2010)

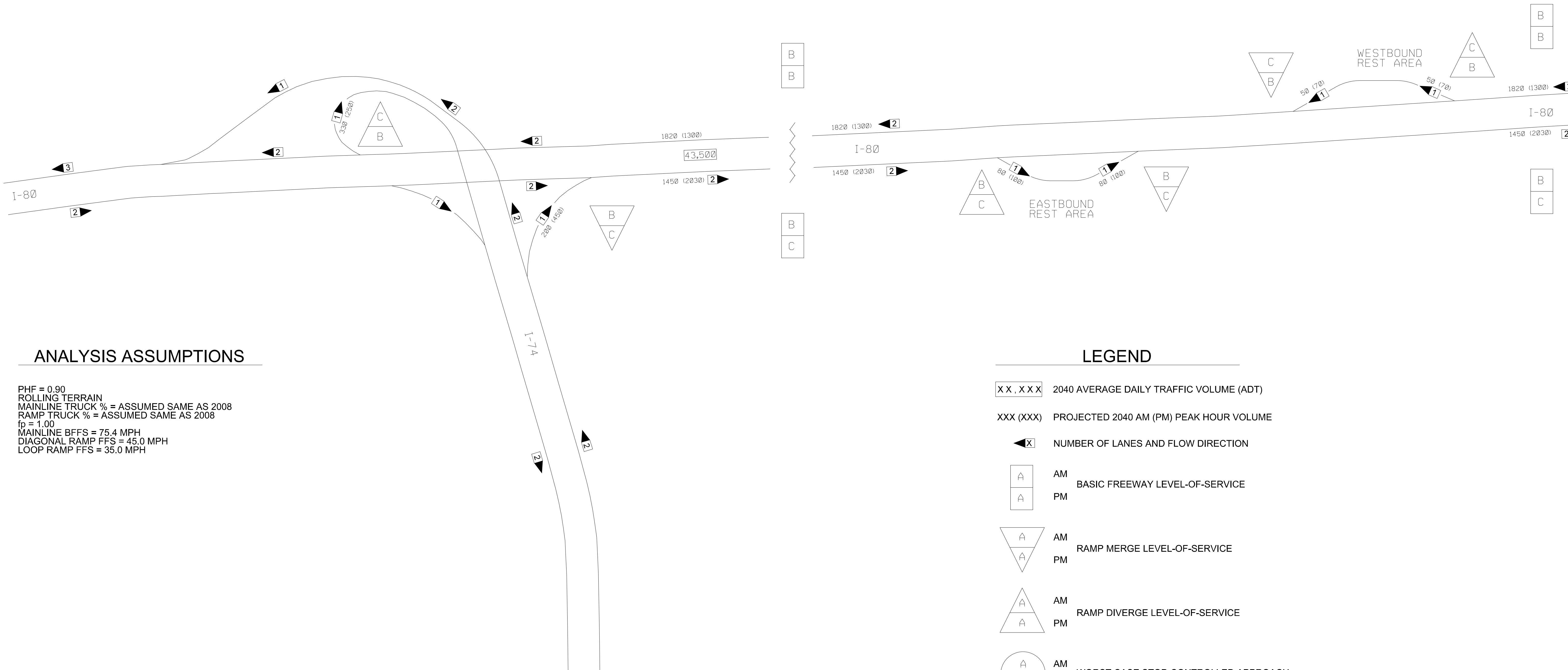
I-80 Segment	No-Build	Reconstruct Existing	Diamond	Partial Cloverleaf
	AM (PM)	AM (PM)	AM (PM)	AM (PM)
Eastbound				
Diverge, diagonal off-ramp	B (C)	B (C)	B (C)	B (C)
Merge, loop on-ramp	B (C)	B (B)	n/a	B (C)
Merge, diagonal on-ramp	n/a	n/a	B (B)	B (C)
Westbound				
Diverge, diagonal off-ramp	B (B)	B (B)	B (B)	B (B)
Merge, loop on-ramp	C (B)	B (B)	n/a	A (A)
Merge, diagonal on-ramp	n/a	n/a	B (B)	B (B)

I-80 Segment	Compressed Diamond	Diverging Diamond	Single Point Urban
	AM (PM)	AM (PM)	AM (PM)
Eastbound			
Diverge, diagonal off-ramp	B (C)	B (C)	B (C)
Merge, loop on-ramp	n/a	n/a	n/a
Merge, diagonal on-ramp	B (B)	B (B)	B (B)
Westbound			
Diverge, diagonal off-ramp	B (B)	B (B)	B (B)
Merge, loop on-ramp	n/a	n/a	n/a
Merge, diagonal on-ramp	B (B)	B (B)	B (B)

The traffic operations are projected to operate at LOS C or better for the I-80/Middle Road merge and diverge locations across all alternatives. As many of the alternatives have design characteristics similar, or the same, as other alternatives, it was expected that they would be operationally similar. Additionally, the No-Build I-80 freeway segment LOS results are similar to those of all the Build alternatives, demonstrating there are no significant mainline traffic operations impacts to I-80 operations.

The introduction of the westbound on-ramp from Middle Road does not significantly affect traffic operations at the Middle Road on-ramp location, the basic freeway lane between ramps, and the rest area off-ramp diverge location.

It can be concluded that the Build alternatives operate at acceptable levels along I-80 freeway analysis segments. Therefore, all are carried forward for further evaluation. The following section will examine potential I-80 impacts due to queuing from the ramp terminal intersections.



ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH

LEGEND

XX,XXX	2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
X	NUMBER OF LANES AND FLOW DIRECTION
A / A (AM / PM)	BASIC FREEWAY LEVEL-OF-SERVICE
A / A (AM / PM)	RAMP MERGE LEVEL-OF-SERVICE
A / A (AM / PM)	RAMP DIVERGE LEVEL-OF-SERVICE
A / A (AM / PM)	WORST CASE STOP-CONTROLLED APPROACH LEVEL-OF-SERVICE

NORTH
NOT TO SCALE

Bettendorf IOWA

IOWADOT

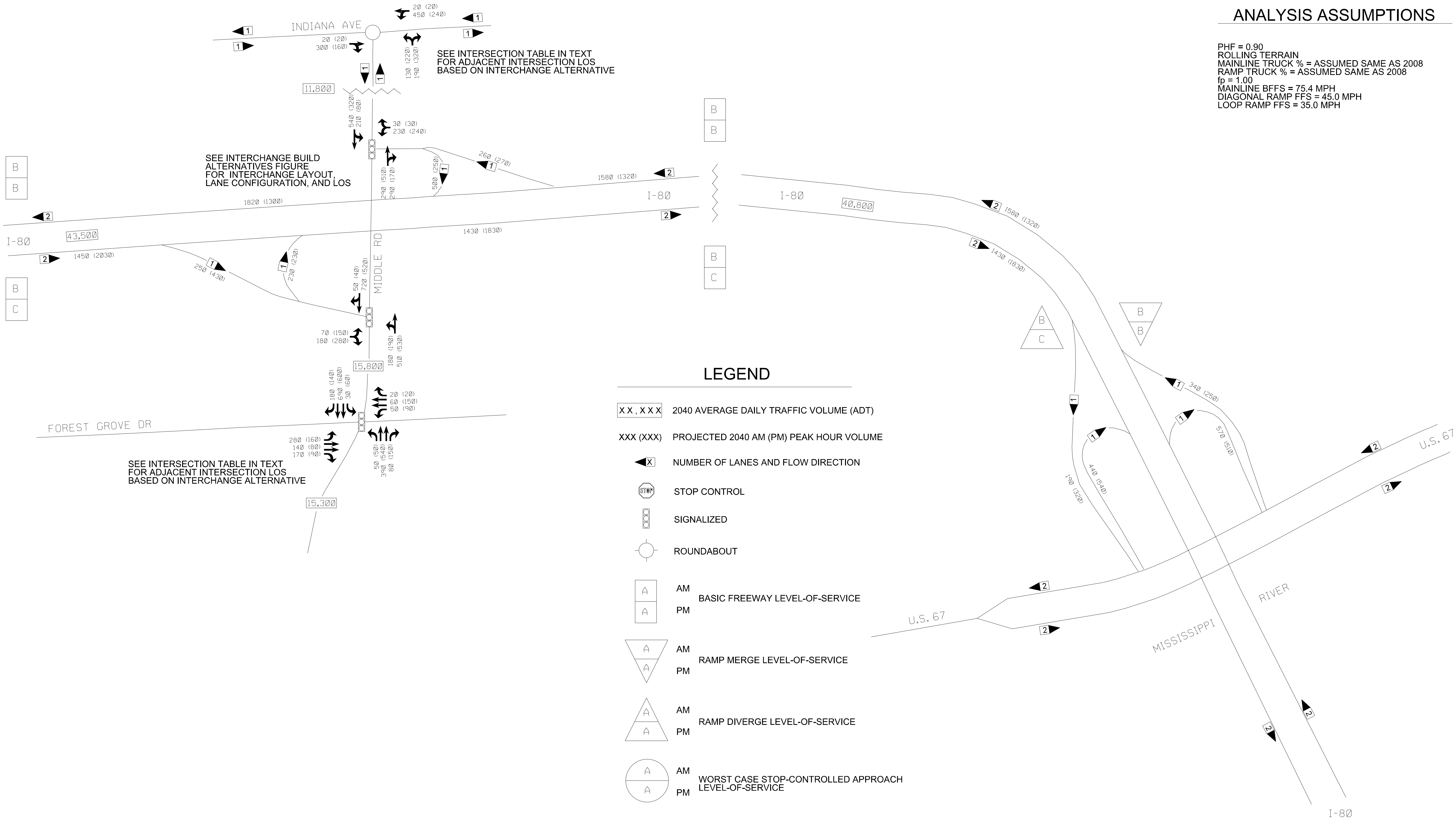
I-80 TRAFFIC OPERATIONS ANALYSIS
2040 BUILD CONDITIONS
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

FIGURE 2.3-1 (A)

ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH



NORTH
NOT TO SCALE

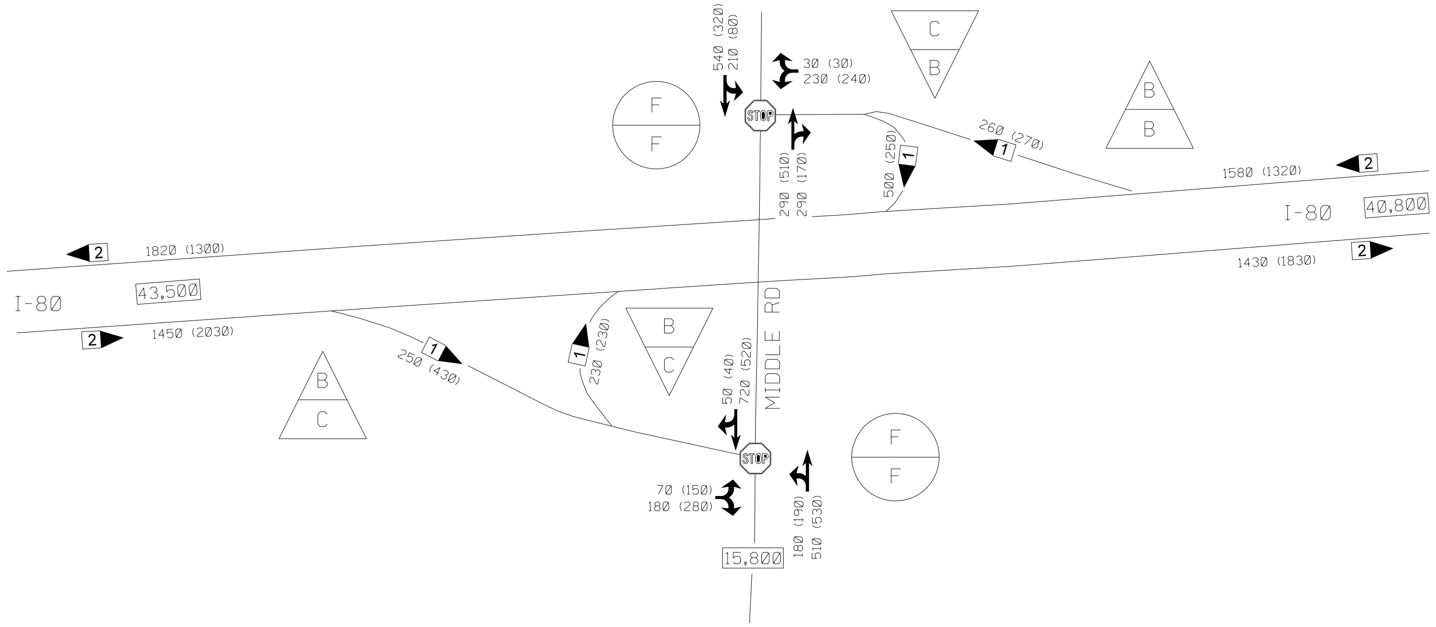
Bettendorf IOWA

IOWADOT

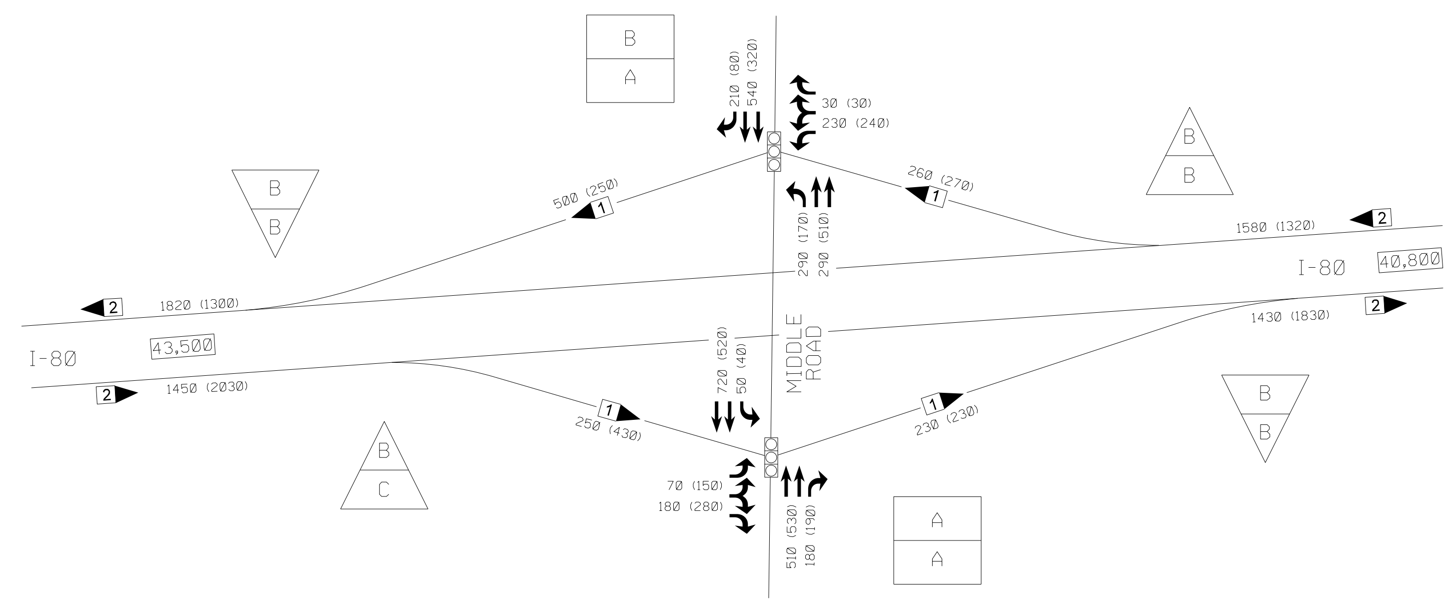
I-80 TRAFFIC OPERATIONS ANALYSIS
2040 BUILD CONDITIONS
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

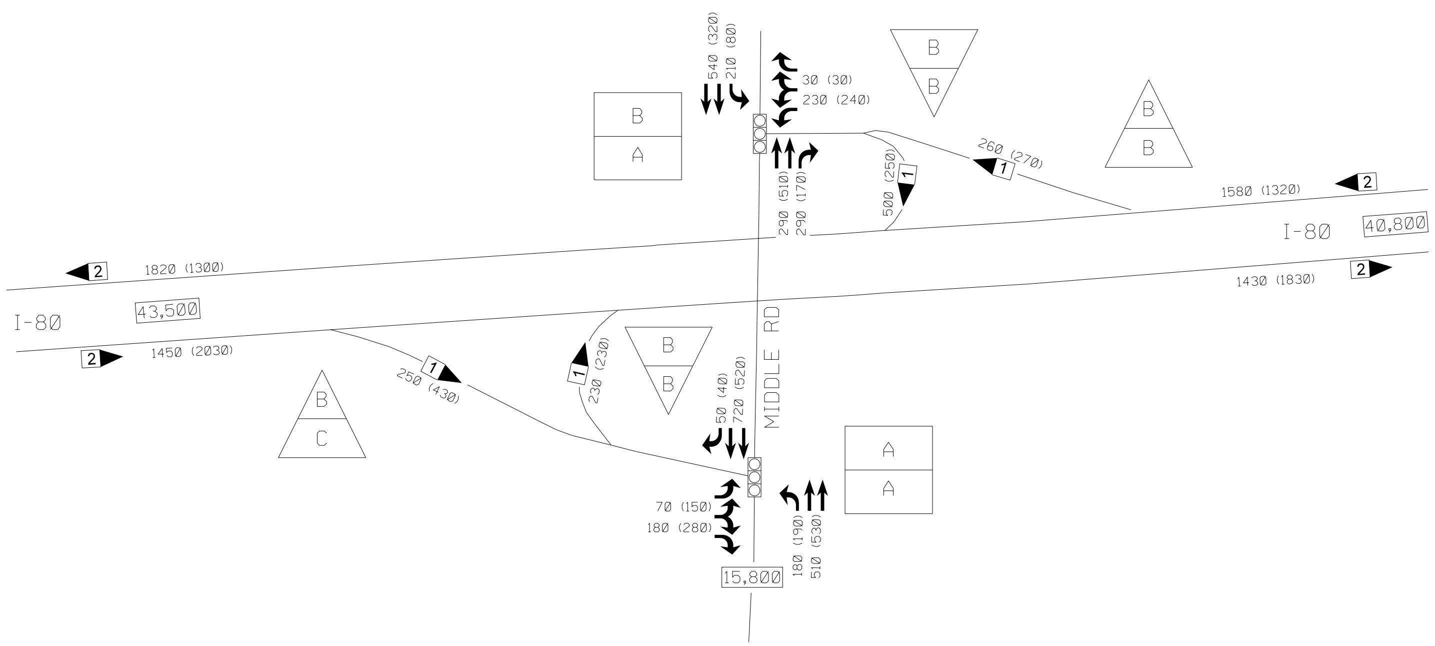
FIGURE 2.3-1 (B)



2040 NO-BUILD



2040 DIAMOND



2040 RECONSTRUCT EXISTING

LEGEND

XX,XXX	2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
◄X	NUMBER OF LANES AND FLOW DIRECTION
A / A — AM / PM	RAMP MERGE LEVEL-OF-SERVICE
A / A — AM / PM	RAMP DIVERGE LEVEL-OF-SERVICE
A / A — AM / PM	WORST CASE STOP-CONTROLLED APPROACH LEVEL-OF-SERVICE
A / A — AM / PM	SIGNALIZED INTERSECTION LEVEL-OF-SERVICE

ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH

PLOT: 1:08:29 PM 3/6/2014 FILE: \\HRGCRNAS\Data\185390\JUR\Updated_Traffic_03092012_TCW\2014\JR_MostCurrent\2.3-2&2.3-4_2040 BUILD OPS - INTERCHANGE.dgn

NORTH
NOT TO SCALE

Bettendorf IOWA

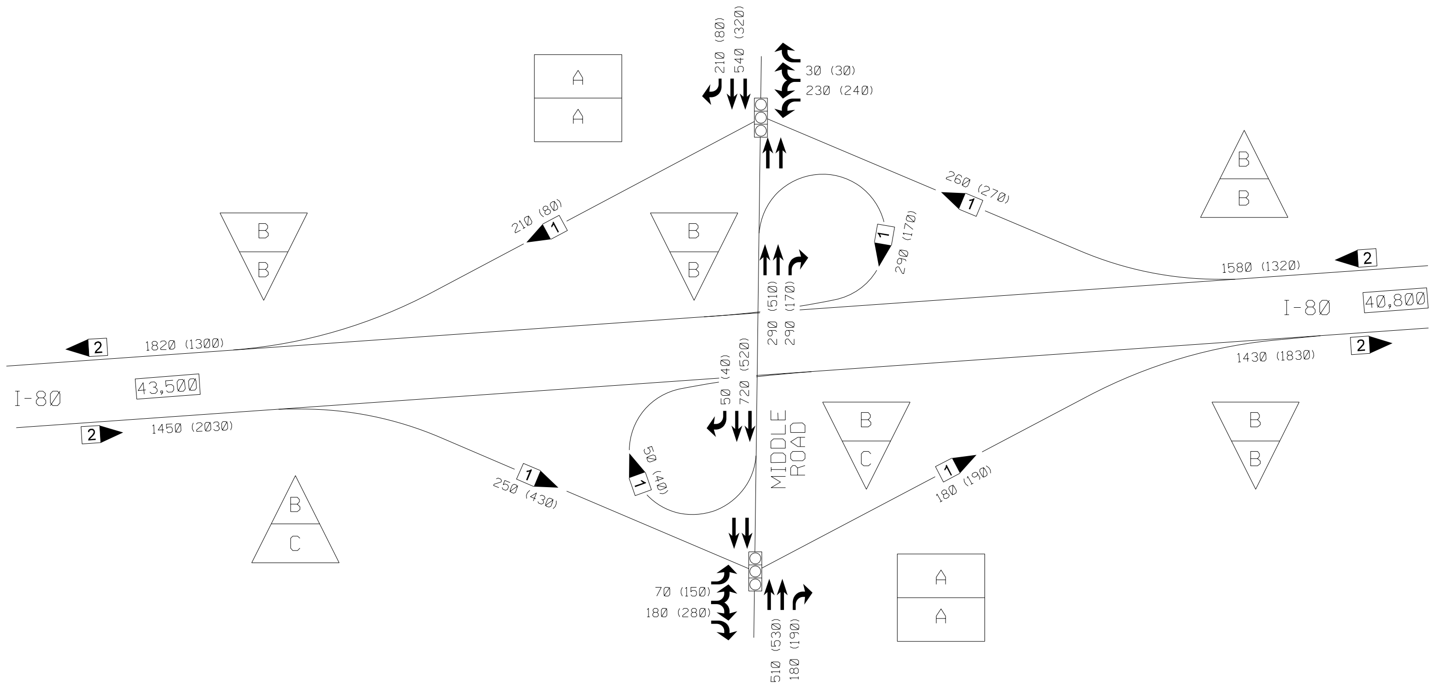
IOWADOT

I-80/MIDDLE ROAD INTERCHANGE TRAFFIC OPERATIONS ANALYSIS 2040 BUILD ALTERNATIVES

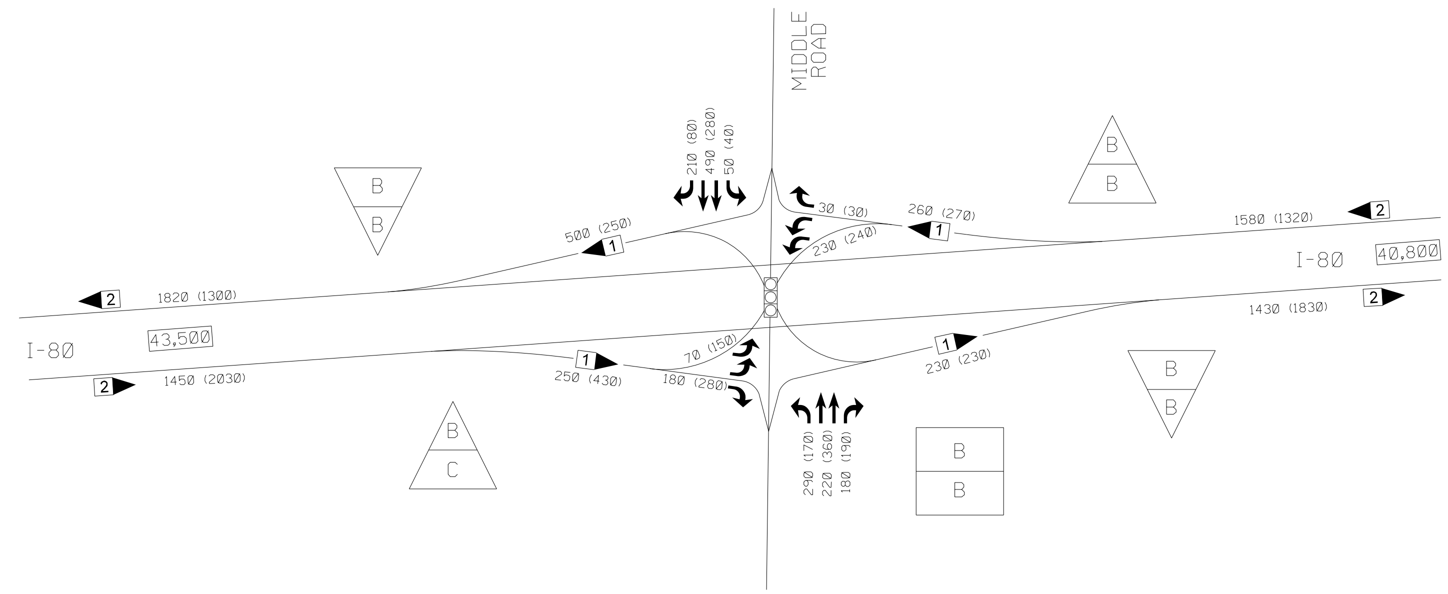
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

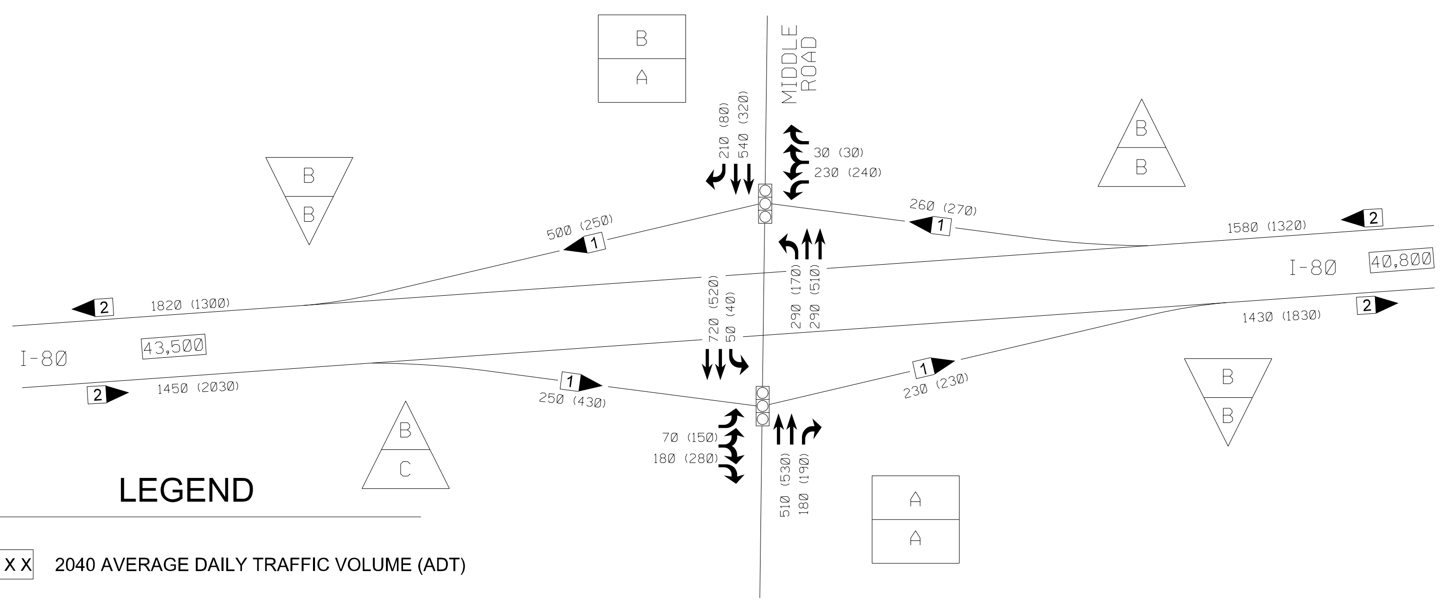
FIGURE 2.3-2 (A)



2040 PARCLO



2040 SPUI



LEGEND

XX,XXX 2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)

XXX (XXX) PROJECTED 2040 AM (PM) PEAK HOUR VOLUME

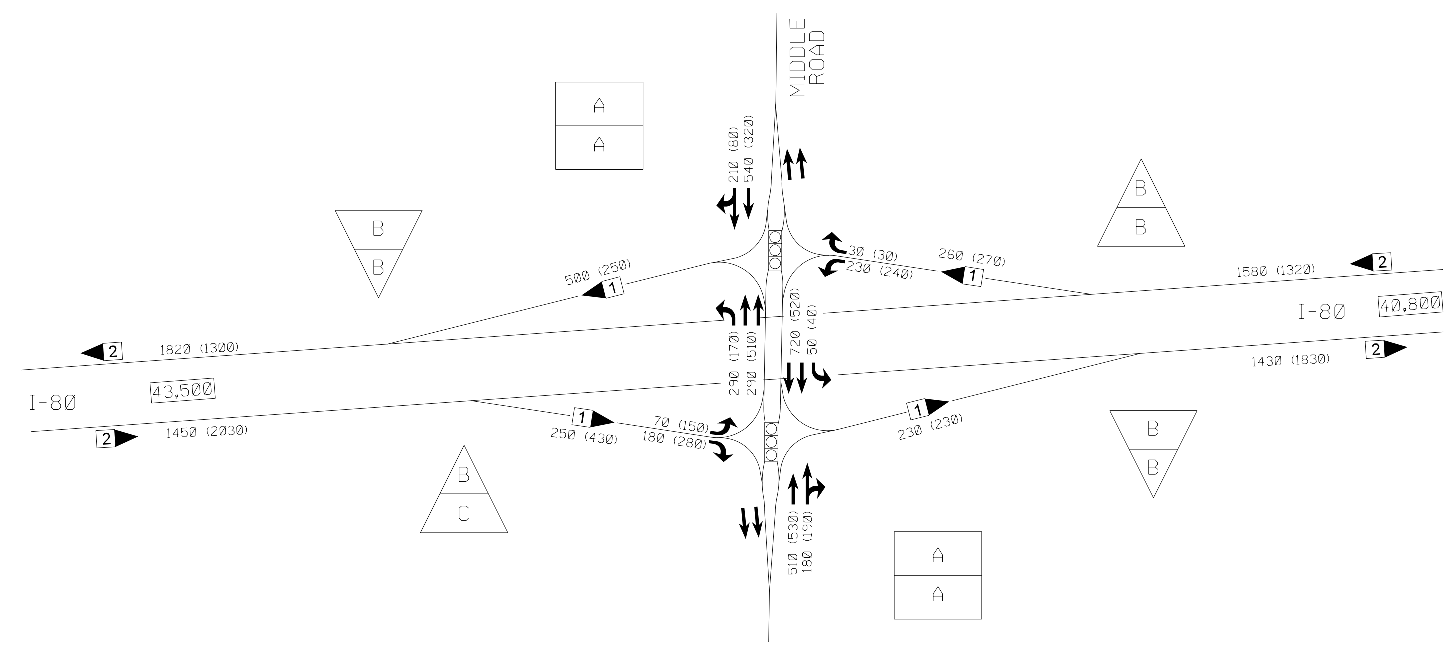
X NUMBER OF LANES AND FLOW DIRECTION

AM / PM RAMP MERGE LEVEL-OF-SERVICE

AM / PM RAMP DIVERGE LEVEL-OF-SERVICE

AM / PM SIGNALIZED INTERSECTION LEVEL-OF-SERVICE

2040 COMPRESSED DIAMOND

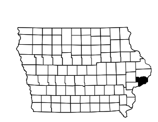


2040 DIVERGING DIAMOND

ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH

NORTH
NOT TO SCALE



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IOWADOT

I-80/MIDDLE ROAD INTERCHANGE
TRAFFIC OPERATIONS ANALYSIS
2040 BUILD ALTERNATIVES
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

FIGURE 2.3-2 (B)

Middle Road Corridor Intersections

The No-Build conditions were previously analyzed with forecasted 2040 traffic volumes. All study area at-grade intersections were measured to operate at LOS F at the worst case stop-controlled approach under 2040 traffic volumes.

Proposed improvements to the Middle Road cross-street intersections at Indiana Avenue and Forest Grove Drive were primarily based on: needs established in the No-Build conditions analysis, future projects identified in the 2040 Quad Cities LRTP, and typical roadway cross-sections near the intersections. The Middle Road/Indiana Avenue intersection was analyzed as a three-leg single-lane roundabout as identified in the 2040 Quad Cities LRTP. The Middle Road/Forest Grove intersection was analyzed as a signalized 4-leg intersection, built-out to a 4-lane cross-section in all directions. Each approach consisted of an exclusive left-turn and right-turn lane.

Ramp terminal intersections were improved based on similar established needs, but also dependent upon interchange geometrics of each respective Build alternative. Lane configurations of the ramp terminal intersections are provided in **Figure 2.3-2**.

The Build alternatives were analyzed with SimTraffic microsimulation to measure delay and queue lengths at Middle Road signalized intersections through the study area. HCS 2010 was used to analyze a single-lane roundabout at the Middle Road/Indiana Avenue intersection. **Table 2.3-5**, on the following page, displays the intersection LOS and associated control delay measures for each signalized Build alternative intersection. The eight Build alternatives can be reduced to six basic forms of interchanges for the initial screening process for traffic operations.

Table 2.3-5: Middle Road Intersections Traffic Operations Analysis – 2040 Build Alternatives (SimTraffic/HCS 2010#)

Intersection	Reconstruct Existing		Diamond		Partial Cloverleaf	
	LOS/Delay (sec/veh)		*LOS/Delay (sec/veh)*		*LOS/Delay (sec/veh)*	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**
I-80/Middle Road Ramp Terminal Intersections						
Eastbound I-80	A/8.2	A/9.5	A/5.8	A/7.8	A/5.2	A/7.5
Westbound I-80	B/10.9	A/10.0	B/11.1	A/8.9	A/6.6	A/7.1
Local Network Intersections						
Middle Road/Indiana Avenue#	A/9.98	A/6.7	A/9.98	A/6.7	A/9.98	A/6.7
Middle Road/Forest Grove Drive	B/16.1	A/9.7	B/16.9	B/15.9	B/16.9	B/15.7

Intersection	Compressed Diamond		Diverging Diamond		Single Point Urban	
	LOS/Delay (sec/veh)		*LOS/Delay (sec/veh)*		*LOS/Delay (sec/veh)*	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**
I-80/Middle Road Ramp Terminal Intersections						
Eastbound I-80	A/5.9	A/9.6	A/9.4*	A/9.7*	B/13.7	B/13.4
Westbound I-80	B/11.6	A/10.0	A/9.5*	A/7.7*		
Local Network Intersections						
Middle Road/Indiana Avenue#	A/9.98	A/6.7	A/9.98	A/6.7	A/9.98	A/6.7
Middle Road/Forest Grove Drive	B/17.0	B/15.8	B/15.6	B/12.5	B/18.0	B/18.4

Note: Intersections analyzed as signalized intersections unless noted.
** Intersection LOS represents the northbound and southbound Middle Road crossover intersection.*
 # Middle Road/Indiana Avenue intersection analyzed as a roundabout with HCS 2010.

The eastbound and westbound ramp terminal intersections, Middle Road/Indiana Avenue intersection, and Middle Road/Forest Grove Drive intersection all operated at LOS B or better in the analysis Build alternatives utilizing 2040 AM/PM peak hour volumes. Overall, individual intersections operated similarly across all Build alternatives, indicating that each option would be expected to operate adequately.

95th percentile queue lengths were measured on the off-ramp terminal intersection approach to Middle Road to identify locations where queue spillback impacts I-80 mainline operations. **Table 2.3-6** identifies the greatest measured queue on the respective ramp approach.

Table 2.3-6: I-80/Middle Road Ramp Terminal Intersections Queue Lengths – 2040 Build Alternatives (SimTraffic)

I-80/Middle Road Ramp Terminal Intersections	Reconstruct Existing 95th % Queue (ft.)		Diamond 95th % Queue (ft.)		Partial Cloverleaf 95th % Queue (ft.)	
	AM	PM	AM	PM	AM	PM
Eastbound I-80	79	97	61	98	75	94
Westbound I-80	105	106	107	101	93	89

I-80/Middle Road Ramp Terminal Intersections	Compressed Diamond 95th % Queue (ft.)		Diverging Diamond 95th % Queue (ft.)		Single Point Urban 95th % Queue (ft.)	
	AM	PM	AM	PM	AM	PM
Eastbound I-80	71	98	54	65	90	211
Westbound I-80	110	114	74	69	185	189

The measured queue lengths among the analysis Build alternatives were typically less than 115 feet in both the AM and PM peak periods. The exceptions occurred with the SPUI alternative where queue lengths approached, or exceeded, 200 feet in both directions in the PM peak period and in the westbound direction in the AM peak period. This is due to the longer cycle lengths required by the SPUI alternative to accommodate the large intersection area and number of turning movements.

It is not anticipated that queue lengths experienced in any of the six analysis Build alternatives will impact I-80 operations based on the projected 2040 traffic volumes. For a ramp design speed of 60 mph, the stopping sight distance is approximately 570 feet. For ramps that exceed 1,500 feet in length from terminal intersection to the gore area near the diverge location, this allows for a maximum queue length to approach 900 feet. As shown, all queue lengths do not approach this distance.

Summary of 2040 Planning Year Build Alternatives Operations Analysis

Through the evaluation of the No-Build conditions and six analysis Build alternatives, it was found that all Build alternatives adequately handle forecasted 2040 traffic volumes. I-80 mainline, merge, and diverge segments within the study area are expected to operate at LOS C or better. Middle Road at-grade intersections are expected to operate at LOS B or better. Therefore, with regards to forecasted 2040 traffic volumes, all Build alternatives are viable options and are carried forward for further analysis.

2.3.3 Traffic Operations Analysis – 2040 Sub-Area Conditions

The following traffic operations analysis examines how the proposed Build alternatives affect I-80 operations based on traffic volumes developed for a 2040 Sub-Area Scenario. The analysis also focuses on traffic operations along Middle Road, measuring intersection LOS and queue lengths at the ramp terminal intersections to determine potential impacts to mainline I-80 operations. **The intent of this Sub-Area analysis is**

not for the justification of the interchange modifications, but to aid in the evaluation of the expandability of the alternatives to meet travel demand beyond the 2040 planning horizon.

I-80 Operations

Similar to the 2040 Planning Year analysis, the I-80 freeway segments outside of the I-80/Middle Road interchange emerge/diverge segments experienced negligible impact from the differing types of interchange Build alternatives. Therefore, the analysis segments, provided in **Table 2.3-7** and represented graphically in **Figure 2.3-3**, apply across all Build alternatives within the 2040 Sub-Area Scenario.

Table 2.3-7: I-80 Traffic Operations Analysis – 2040 Sub-Area Conditions (HCS 2010)

I-80 Segment	2040 Traffic Operations AM (PM)	I-80 Segment	2040 Traffic Operations AM (PM)
Eastbound		**Westbound**	
Merge, I-74 to I-80	D (E)	Merge, U.S. Hwy 67 to I-80	D (C)
Mainline, East of I-74	C (E)	Mainline, East of Middle Road	C (C)
Diverge, Eastbound Rest Area	D (E)	Middle Road Interchange	*See Table 2.3-8*
Merge, Eastbound Rest Area	C (E)	Mainline, West of Middle Road	D (C)
Mainline, West of Middle Road		Diverge, Westbound Rest Area	E (C)
Middle Road Interchange	*See Table 2.3-8*	Merge, Westbound Rest Area	E (C)
Mainline, East of Middle Road	C (C)	Mainline, East of I-74	D (C)
Diverge, I-80 to U.S. Hwy 67	C (D)	Diverge, I-80 to I-74	E (C)

This Sub-Area Scenario contains significantly more traffic than the forecasted 2040 traffic volumes, which is reflected in the operations analysis. Several freeway segments operated at LOS D and E, particularly in the westbound AM peak period and eastbound PM peak period. Based on these traffic volumes, consideration to widening of I-80 is necessary to reduce vehicle density to meet LOS criteria.

The traffic operations within the I-80/Middle Road interchange No-Build conditions and analysis Build alternatives are provided in **Table 2.3-8** and represented graphically in **Figure 2.3-4**. Similar to the 2040 Planning Year peak hour analysis in the previous section, diagonal and loop ramps were analyzed with a single lane.

Table 2.3-8: I-80/Middle Road Interchange Traffic Operations Analysis – 2040 Sub-Area Build Alternatives (HCS 2010)

I-80 Segment	No-Build	Reconstruct Existing	Diamond	Partial Cloverleaf
	AM (PM)	AM (PM)	AM (PM)	AM (PM)
Eastbound				
Diverge, diagonal off-ramp	D (E)	D (E)	D (E)	D (E)
Merge, loop on-ramp	C (D)	C (C)	n/a	C (D)
Merge, diagonal on-ramp	n/a	n/a	C (C)	C (D)
Westbound				
Diverge, diagonal off-ramp	D (C)	D (C)	D (C)	D (C)
Merge, loop on-ramp	D (C)	D (C)	n/a	B (B)
Merge, diagonal on-ramp	n/a	n/a	D (C)	D (C)

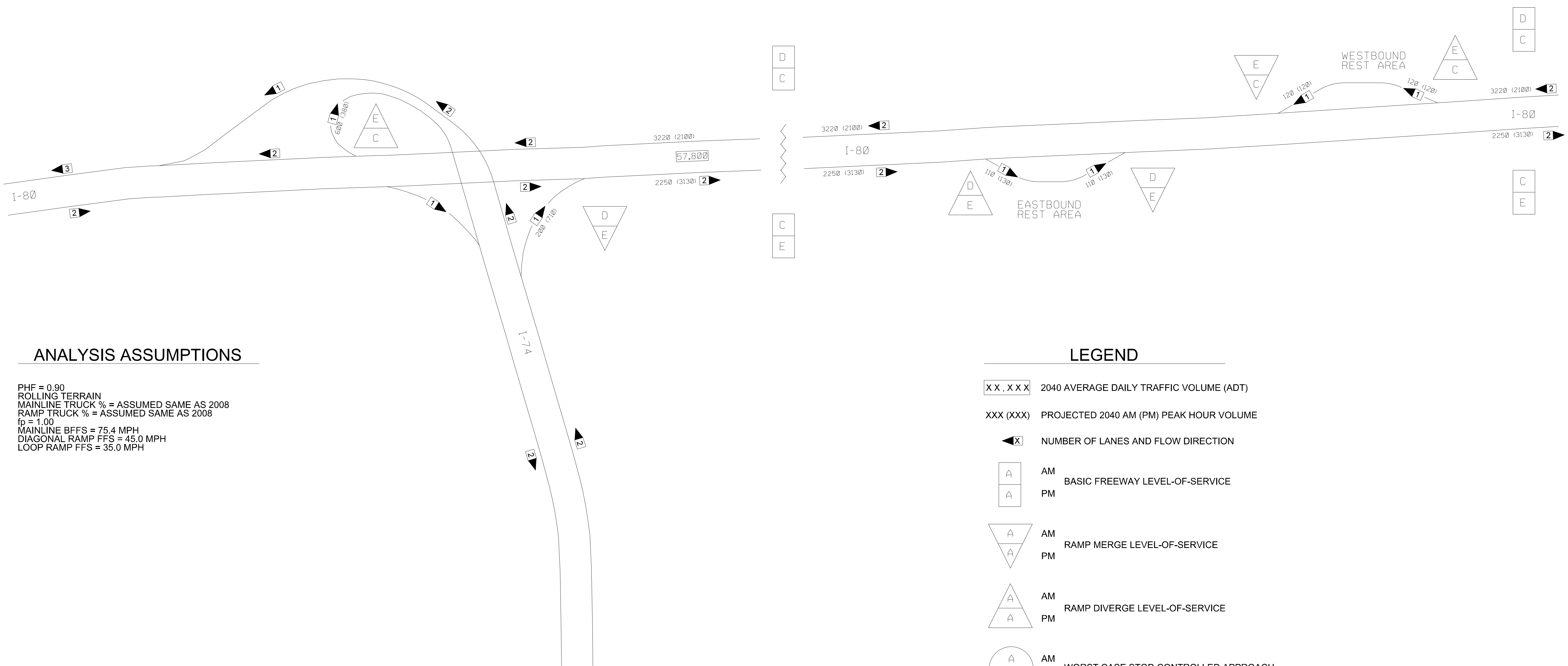
I-80 Segment	Compressed Diamond	Diverging Diamond	Single Point Urban
	AM (PM)	AM (PM)	AM (PM)
Eastbound			
Diverge, diagonal off-ramp	D (E)	D (E)	D (E)
Merge, loop on-ramp	n/a	n/a	n/a
Merge, diagonal on-ramp	C (C)	C (C)	C (C)
Westbound			
Diverge, diagonal off-ramp	D (C)	D (C)	D (C)
Merge, loop on-ramp	n/a	n/a	n/a
Merge, diagonal on-ramp	D (C)	D (C)	D (C)

Overall, the LOS results were similar across all Build alternatives at the respective I-80 merge or diverge segment. All analyzed interchange segments operated at LOS D or better, except for LOS E at the eastbound diverge location in the PM peak period.

In the I-80 eastbound direction, diamond-type interchange configurations tended to operate better at the merge location, measuring LOS C in both the AM and PM peak periods. The Parclo configurations operated at LOS D for both the loop on-ramp and diagonal on-ramp locations in the PM peak periods.

In the I-80 westbound direction, the diagonal off-ramp diverge location operated at LOS D in the AM peak period across all Build alternatives. Similarly, LOS D was reported for both the diagonal and loop on-ramp merge locations across all Build alternatives. The lone exception was for the Parclo loop ramp merge location operating at LOS B.

As previously stated, the Sub-Area analysis was developed to evaluate expandability within the Build alternatives based on traffic volumes that are greater than those representative of the 2040 Planning Year volumes. As shown in the Sub-Area analysis, there are segments along I-80 that do not meet operational goals of LOS C. However, the traffic operations were similar across all Build alternatives, with no discernable LOS differences except for the eastbound merge LOS. The preferred alternative will provide a look at projected operations based on the Sub-Area volumes with a 6-lane I-80 mainline.



ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH

LEGEND

XX,XXX	2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
X	NUMBER OF LANES AND FLOW DIRECTION
A AM / A PM	BASIC FREEWAY LEVEL-OF-SERVICE
A AM / A PM	RAMP MERGE LEVEL-OF-SERVICE
A AM / A PM	RAMP DIVERGE LEVEL-OF-SERVICE
A AM / A PM	WORST CASE STOP-CONTROLLED APPROACH LEVEL-OF-SERVICE

NORTH
NOT TO SCALE

Bettendorf IOWA

IOWA DOT

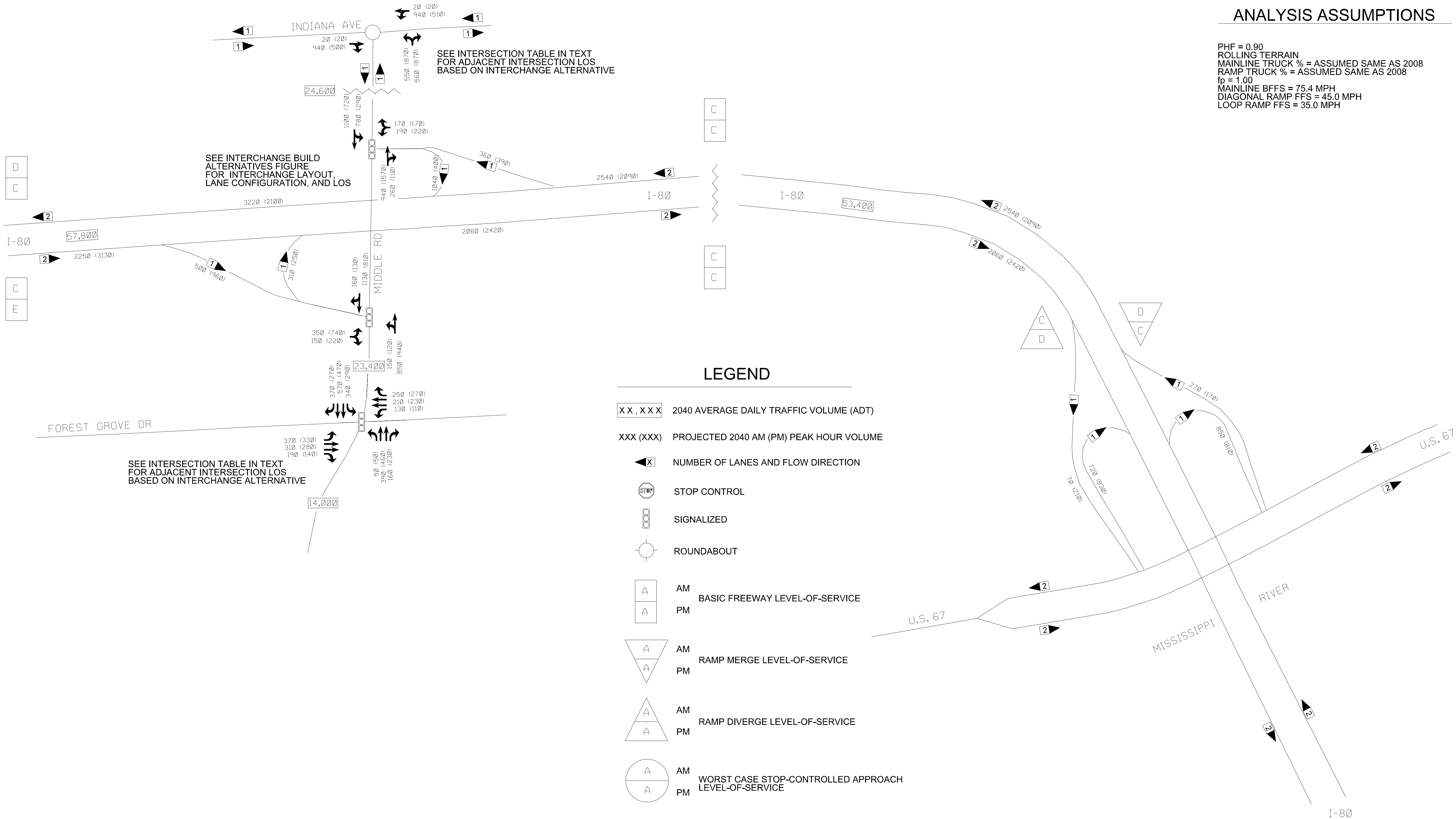
I-80 TRAFFIC OPERATIONS ANALYSIS
SUB-AREA CONDITIONS
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

FIGURE 2.3-3 (A)

ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH



NORTH

NOT TO SCALE

Bettendorf IOWA

IOWA DOT

I-80 TRAFFIC OPERATIONS ANALYSIS
SUB-AREA CONDITIONS
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

FIGURE 2.3-3 (B)

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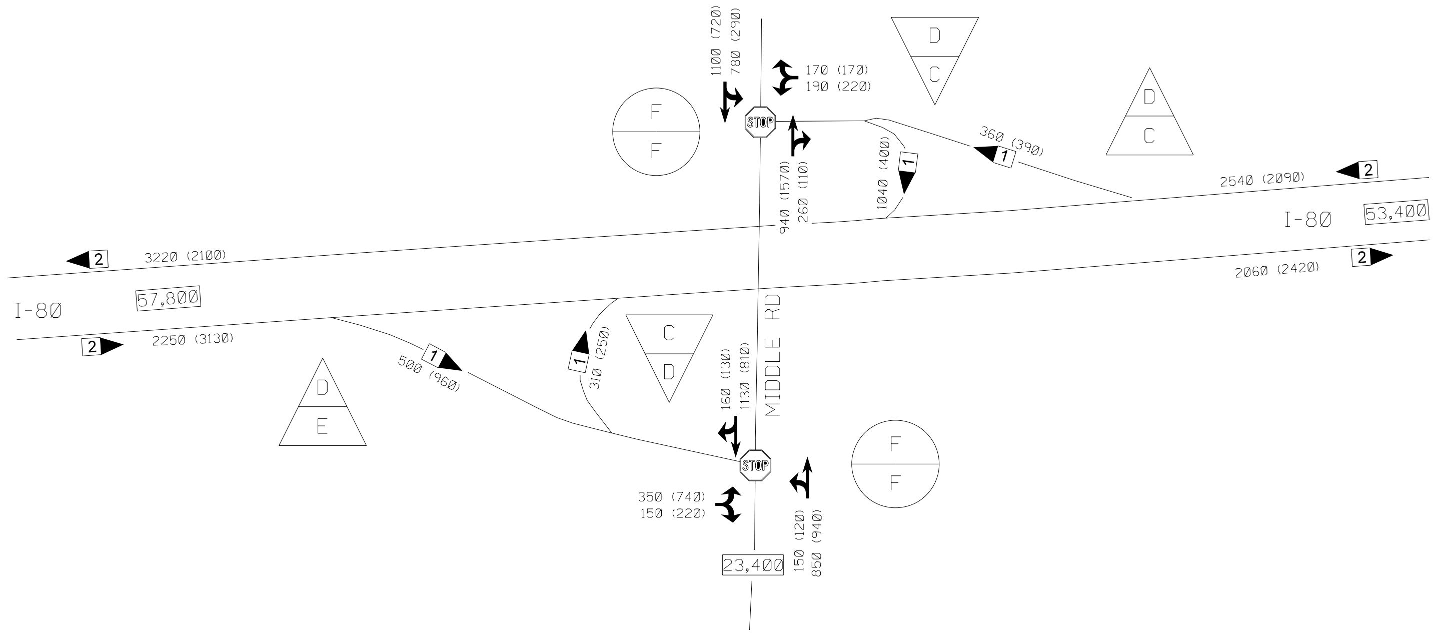
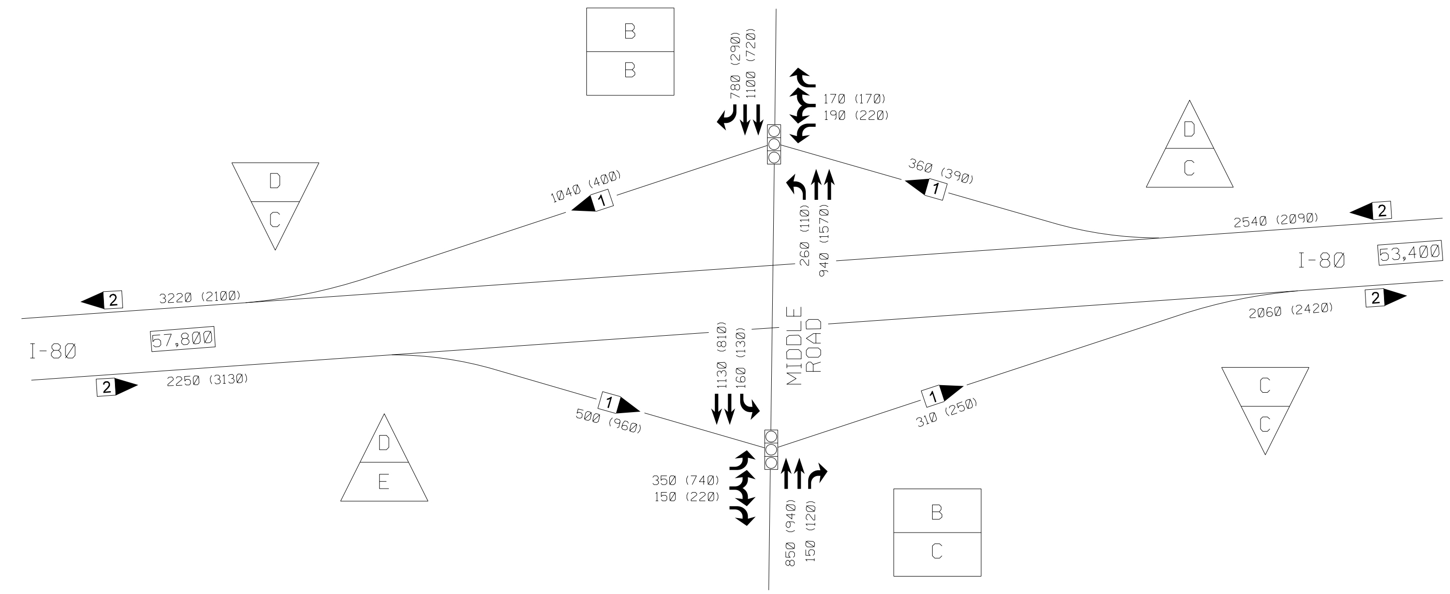
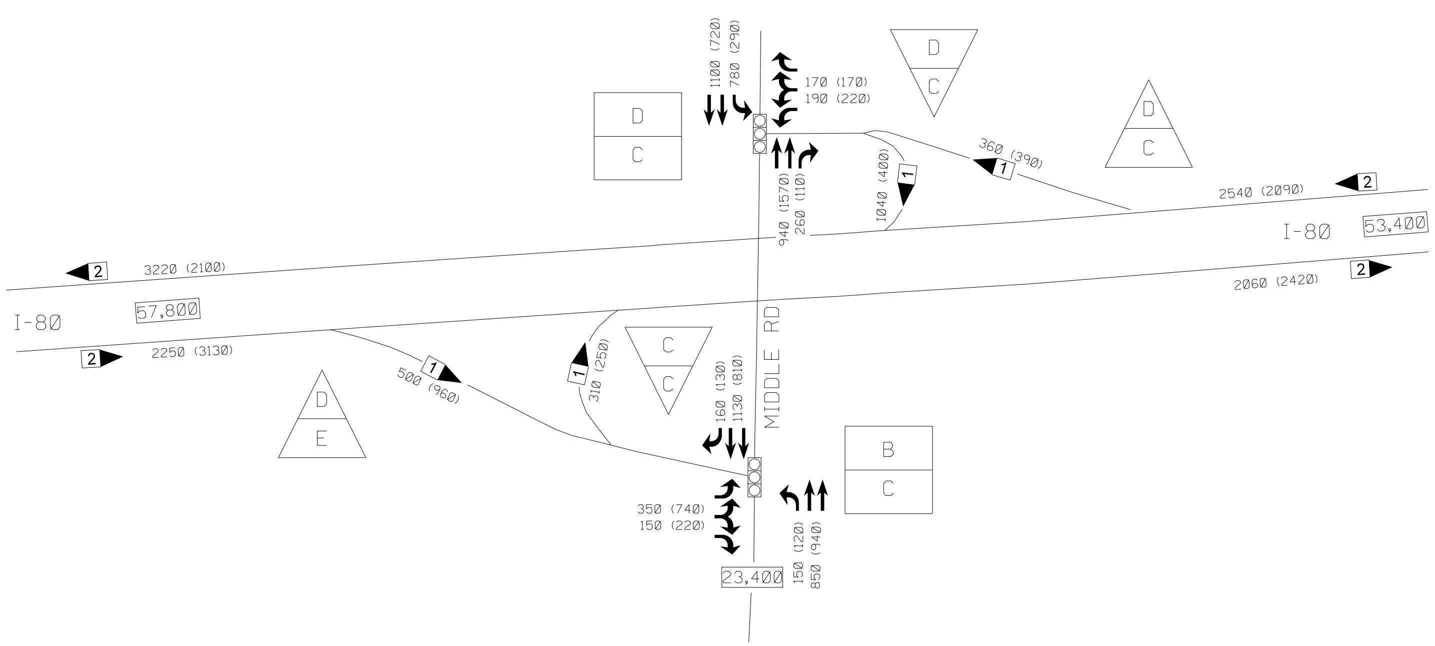


2040 NO-BUILD



2040 DIAMOND



2040 RECONSTRUCT EXISTING

LEGEND

XX,XXX	2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
X	NUMBER OF LANES AND FLOW DIRECTION
A / A (AM / PM)	RAMP MERGE LEVEL-OF-SERVICE
A / A (AM / PM)	RAMP DIVERGE LEVEL-OF-SERVICE
A / A (AM / PM)	WORST CASE STOP-CONTROLLED APPROACH LEVEL-OF-SERVICE
A / A (AM / PM)	SIGNALIZED INTERSECTION LEVEL-OF-SERVICE

ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH

PLOT: 1:11:34 PM 3/6/2014 FILE: \\HRGCRNAS\Data\185390\IJR\Updated_Traffic_03092012_TCW\2014 IJR_MostCurrent\2.3-2&2.3-4_2040 BUILD OPS - INTERCHANGE.dgn

NORTH
NOT TO SCALE

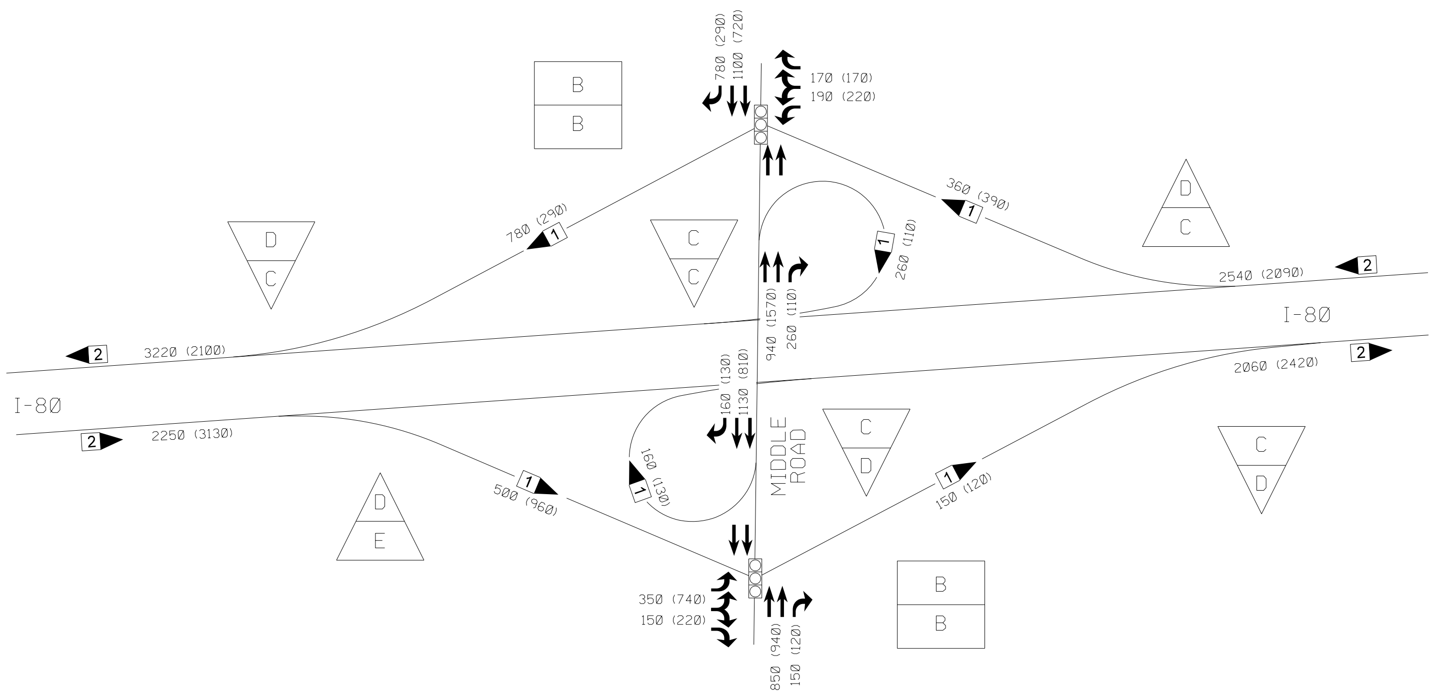
Bettendorf IOWA

IOWADOT

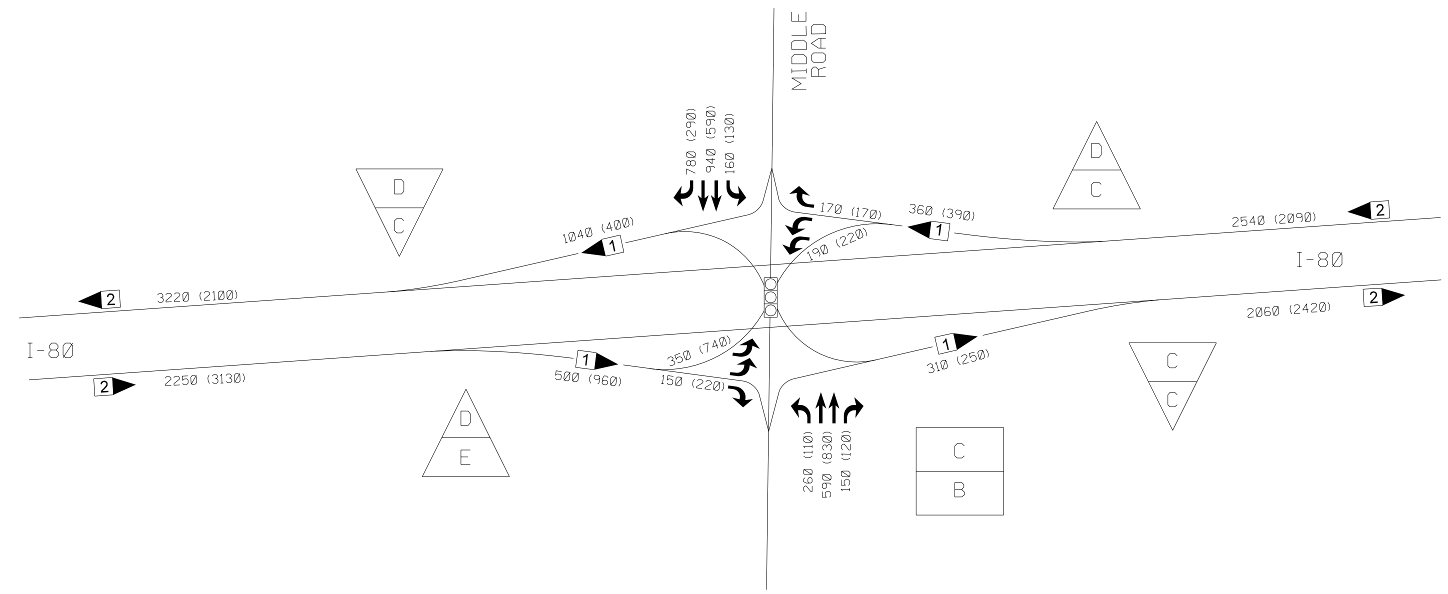
I-80/MIDDLE ROAD INTERCHANGE
TRAFFIC OPERATIONS ANALYSIS
2040 SUB-AREA BUILD ALTERNATIVES
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

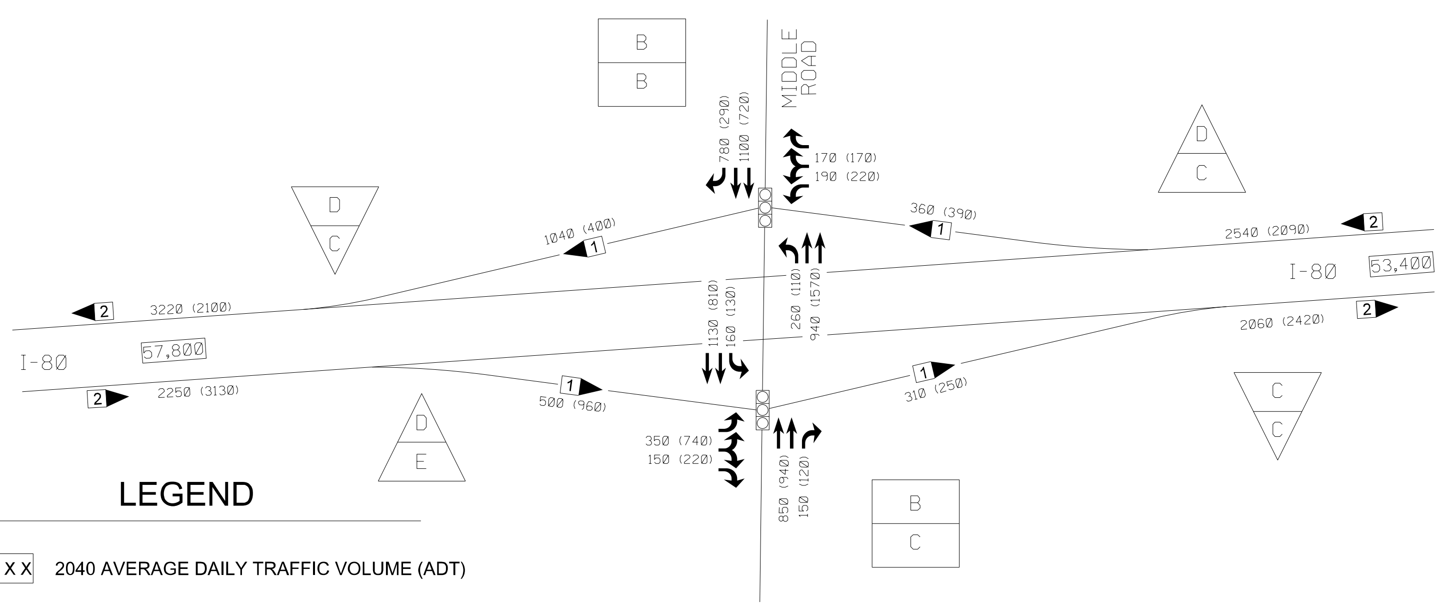
FIGURE 2.3-4 (A)



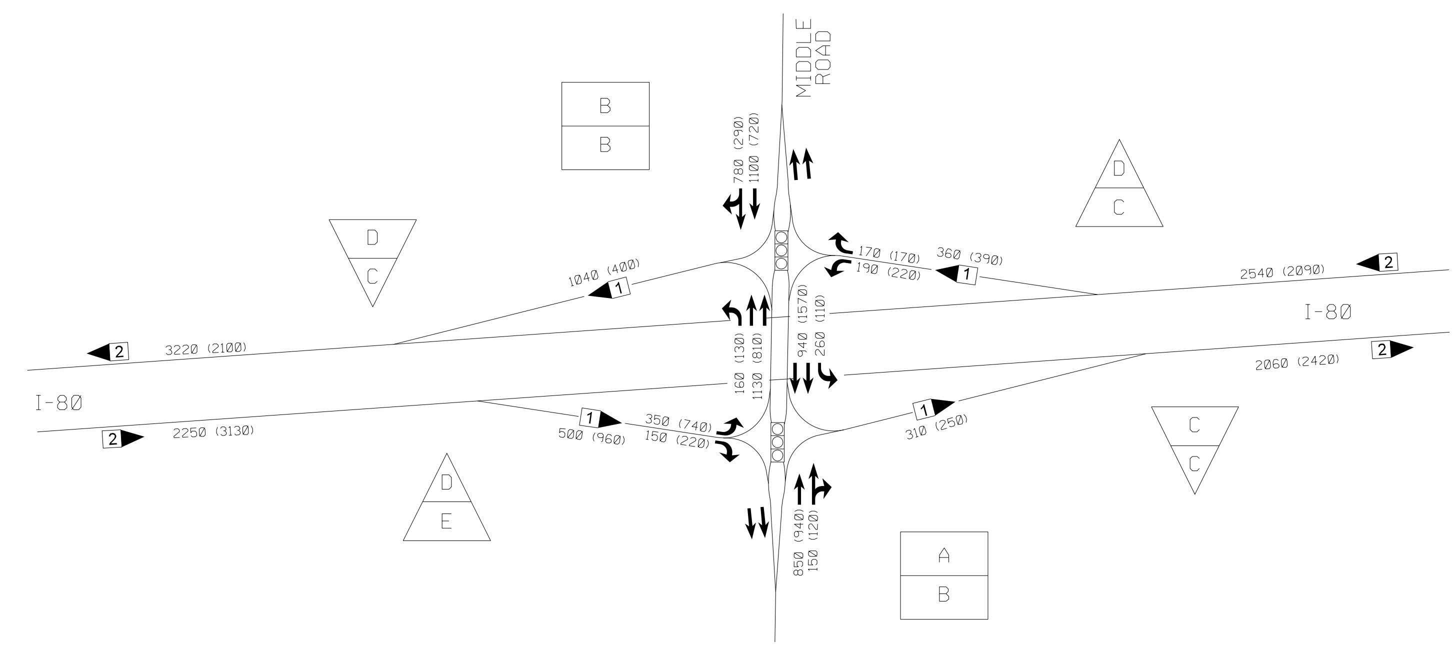
2040 PARCLO



2040 SPUI



2040 COMPRESSED DIAMOND



2040 DIVERGING DIAMOND

LEGEND

- XX,XXX — 2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
- XXX (XXX) — PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
- X — NUMBER OF LANES AND FLOW DIRECTION
- A / A (AM / PM) — RAMP MERGE LEVEL-OF-SERVICE
- A / A (AM / PM) — RAMP DIVERGE LEVEL-OF-SERVICE
- A / A (AM / PM) — SIGNALIZED INTERSECTION LEVEL-OF-SERVICE

NORTH

NOT TO SCALE

ANALYSIS ASSUMPTIONS

PHF = 0.90
ROLLING TERRAIN
MAINLINE TRUCK % = ASSUMED SAME AS 2008
RAMP TRUCK % = ASSUMED SAME AS 2008
fp = 1.00
MAINLINE BFFS = 75.4 MPH
DIAGONAL RAMP FFS = 45.0 MPH
LOOP RAMP FFS = 35.0 MPH

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I-80/MIDDLE ROAD INTERCHANGE
TRAFFIC OPERATIONS ANALYSIS
2040 SUB-AREA BUILD ALTERNATIVES
I-80 AND MIDDLE ROAD
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FIGURE 2.3-4 (B)

PLOT: 1:12:20 PM 3/6/2014

Middle Road Intersection Operations

The proposed improvements for each of the Build alternatives in the 2040 Planning Year traffic operations analysis were carried forward into the Sub-Area Scenario analysis. This includes signalizing study area intersections and adding turn lanes as warranted. The Middle Road intersection corridor was again analyzed with SimTraffic microsimulation software, measuring delay and vehicle queue length at each study area intersection.

Table 2.3-9 provides the traffic operation at the study area signalized intersections. Traffic operations were measured at LOS C or better for both the eastbound and westbound I-80 ramp terminal intersections across nearly all Build alternatives. The lone deviation was LOS D for the Reconstruct Existing Build alternative westbound ramp terminal intersection in the AM peak period. It can be concluded that outside of the Reconstruct Existing Build alternative, the proposed Build alternatives developed in the 2040 Planning Year analysis can adequately handle the Sub-Area traffic volumes.

Table 2.3-9: Middle Road Intersections Traffic Operations Analysis – 2040 Sub-Area Build (SimTraffic/HCS 2010#)

Intersection Intersection/Approach Control	**Reconstruct Existing** *LOS/Delay (sec/veh)*		**Diamond** *LOS/Delay (sec/veh)*		**Partial Cloverleaf** *LOS/Delay (sec/veh)*	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**
I-80/Middle Road Ramp Terminal Intersections						
EB I-80	B/18.5	C/22.7	B/15.2	C/20.1	B/11.7	B/16.6
WB I-80	D/37.8	C/24.4	B/18.5	B/12.3	B/10.6	B/11.0
Local Network Intersections						
Middle Road/Indiana Avenue#	F/374.8	F/66.3	F/374.8	F/66.3	F/374.8	F/66.3
Middle Road/Forest Grove Drive	C/24.2	C/23.7	C/22.9	B/17.0	C/22.9	B/17.8

Intersection Intersection/Approach Control	**Compressed Diamond** *LOS/Delay (sec/veh)*		**Diverging Diamond** *LOS/Delay (sec/veh)*		**Single Point Urban** *LOS/Delay (sec/veh)*	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**
I-80/Middle Road Ramp Terminal Intersections						
EB I-80	B/14.1	C/20.6	B/19.4*	B/14.3*	C/20.1	B/18.5
WB I-80	B/16.9	B/11.0	B/13.6*	B/14.8*		
Local Network Intersections						
Middle Road/Indiana Avenue#	F/374.8	F/66.3	F/374.8	F/66.3	F/374.8	F/66.3
Middle Road/Forest Grove Drive	C/20.4	B/17.7	C/21.1	B/16.1	C/23.3	B/19.9

Note: Intersections analyzed as signalized intersections unless noted.
** Intersection LOS represents the northbound and southbound Middle Road crossover intersection.*
 # Middle Road/Indiana Avenue intersection analyzed as a roundabout with HCS 2010.

Traffic operations at the Middle Road/Forest Grove Drive intersection were measured at LOS C or better across all Build alternatives. The Middle Road/Indiana Avenue single-lane roundabout intersection measured LOS F in both the AM and PM peak periods. This was primarily due to the high projected volumes turning from Indiana Avenue (both directions) to Middle Road and the lane configuration developed in the 2040 Planning Year analysis. It would be expected that additional lanes may be warranted at the intersection based on experienced traffic volumes.

The distance between the Middle Road interchange ramp terminal intersections and the adjacent intersections are approximately 2,300 feet to Indiana Avenue and 2,300 feet to Forest Grove Drive. Therefore, the operations of the adjacent intersections are not anticipated to impact interchange operations, particularly since the poor operations are in the morning peak when traffic is headed towards the interchange and not impacting interchange operations.

The following table presents measured queue lengths at the ramp approach of the eastbound and westbound I-80 ramp terminal intersections. As previously discussed, the ramps are typically greater than 1,500 feet in length between the diverge gore location and terminal intersection with Middle Road. At a 60 mph design speed, the stopping sight distance is 570 feet, which equates to a maximum of available queue length on the off-ramp of approximately 900 feet.

Table 2.3-10: I-80/Middle Road Ramp Terminal Intersections Queue Lengths – 2040 Sub-Area Build Alternatives (SimTraffic)

I-80/Middle Road Ramp Terminal Intersections	Reconstruct Existing		Diamond		Partial Cloverleaf	
	95th % Queue (ft.)		*95th % Queue (ft.)*		*95th % Queue (ft.)*	
	AM	PM	AM	PM	AM	PM
Eastbound I-80	231	131	208	453	181	236
Westbound I-80	160	403	155	137	146	128

I-80/Middle Road Ramp Terminal Intersections	Compressed Diamond		Diverging Diamond		Single Point Urban	
	95th % Queue (ft.)		*95th % Queue (ft.)*		*95th % Queue (ft.)*	
	AM	PM	AM	PM	AM	PM
Eastbound I-80	168	335	193	207	261	237
Westbound I-80	130	120	210	93	173	90

All measured queue lengths were approximately 450 feet or less, with most less than 300 feet. Queue lengths measured in excess of 400 feet include the westbound I-80 off-ramp in the Reconstruct Existing PM peak period (403 feet) and the eastbound off-ramp in the PM peak period in the Diamond interchange. It can be concluded that each of the Build alternatives adequately handle Sub-Area Scenario traffic volumes, albeit at varying queue lengths.

Summary of Sub-Area Scenario Traffic Operations

It can be concluded that the Build alternatives with a new interchange configuration would be expected to accommodate traffic volumes consistent with the Sub-Area Scenario. The traffic operations of the preferred alternative and a 6-lane I-80 cross-section will be discussed later in the document, to quantify the effect of an additional lane in each direction along I-80. The ramp terminal intersections adequately handle the scenario traffic volumes, with measured intersection LOS at C or better and queue lengths at approximately 450 feet or less.

While the detailed information utilized to develop the sub-area model provides the best available projection of traffic volumes due to planned land use development; shifts in traffic patterns, additional changes in land use, and modifications to overall metropolitan area travel will likely impact future traffic volumes. Therefore, the preferred alternative shall accommodate flexibility in capacity expansion along I-80, the interchange ramps and terminal intersection, and the Middle Road corridor. The Reconstruct Existing Interchange alternative does not provide the necessary capacity expansion

2.3.4 Build Alternatives Evaluation

The development of Build alternatives gave significant consideration to traffic operations, safety and geometric design, environmental impacts, ROW impacts, constructability and project cost. This included minimizing impacts to Spencer Creek and the existing homestead to the north of I-80, weighing subsequent mitigation-related impacts to other criteria such as project cost and constructability.

Concept Comparison

Table 2.3-11 provides a summary of the key criteria evaluated across the alternatives.

Traffic Operations

The traffic operations analysis presented in the previous sections indicate that each of the identified Build alternatives would be expected to operate adequately based on the forecasted 2040 traffic volumes. This conclusion was reaffirmed for all Build alternatives in the Sub-Area Scenario, except the Reconstruct Existing Interchange alternative did not provide adequate Level of Service for the planned land use beyond the 2040 planning year.

Ramp approach queues at the ramp terminal intersection were all measured at adequate lengths to minimize impacts to I-80 mainline traffic operations. With 2040 traffic volumes, most queues across the Build alternatives were typically less than 115 feet in both the AM and PM peak periods. Queue lengths increased slightly in the SPUI Build alternative to around 200 feet due to increased cycle lengths at the combined eastbound and westbound ramp terminal intersection. All measured queue lengths were approximately 450 feet or less in the Sub-Area Scenario, with the most being less than 300 feet. Even at the maximum measured queue length, the ramp approach queues are not expected to impact I-80 mainline operations.

Driver expectancy plays an integral role in traffic operations, particularly in areas that have a significant number of motorists not familiar with the area, even though it is not directly measured through analysis. Standard diamond-type interchange configurations are the most common type of interchange, as they are typically used in rural settings and adaptable to constraints posed in urban settings. Variations such as the Compressed Diamond, DDI, and SPUI are based on a standard diamond interchange. Motorists are familiar with the typical turning locations to head a specific direction on the freeway.

The existing interchange configuration violates this driver expectancy, where motorists traveling northbound on Middle Road must turn left prior to the I-80 crossing in order to travel eastbound. This can create turbulence as motorists weave across lanes of traffic in order to orient themselves within the correct lane to complete their movement onto I-80. Additional signing would be required in the build-out of Middle Road to facilitate traffic operations as traffic volumes increase.

Design Standards, Safety, and Expandability
All proposed Build alternatives were developed to meet current Iowa DOT design criteria. Therefore, only the existing No-Build condition fails to meet geometric design standard criteria.

The number of Interstate access locations within the I-80/Middle Road interchange is one of the evaluation criterion used in the selection of a preferred alternative. The existing interchange configuration contains four access points to I-80. The proposed Build alternatives contain either four or six access points, depending on configuration.

Additional access points within the interchange are expected to negatively impact traffic operations and safety along I-80 due to the introduction of new traffic conflict points into the mainline travel way. Each access location, whether it is a merge or diverge location, introduces a traffic conflict point. Traffic conflict points are locations where a vehicle leaves, enters, or crosses a traffic lane. The turbulence created by these conflicting movements affects operations along the Interstate mainline, typically due to lane changes, speed differential between mainline and merging traffic, diverging traffic that has slowed down on the Interstate mainline to exit, motorist perception and reaction of merging or diverging traffic associated with the conflict point. Thirty (30) of the 54 crashes within the interchange crash study area were located within a diverge segment, merge segment, or segment between the off-ramp and loop on-ramp in each direction. It would be expected that additional Interstate access locations within the interchange would introduce additional safety concerns associated with the respective alternative.

The conceptual Build alternatives include either four or an increase to six access locations. The Parclo-type interchange configurations include six access locations, introducing two additional merge locations.

The concept of expandability addresses the opportunities to add additional capacity to the interchange when warranted by traffic volumes. One of the benefits of diagonal ramps is the ability to add a second ramp lane and/or add dual turn lanes along the crossroad. The conventional ramp terminal intersections of diamond-type interchanges accommodates this expansion, particularly if planned when designing the bridge structure to accommodate a wider crossroad section.

The inclusion of loop ramps within a standard-type diamond, or Parclo, represents an expanded concept as the additional capacity is located in the loop ramps. However, this alternative introduces an additional access point to achieve the additional capacity.

One benefit of the Compressed Diamond Interchange is the flexibility to reconfigure the interchange into a DDI, which provides additional capacity compared to a diamond configuration.

Stream and Wetland Impacts
Spencer Creek is located throughout the existing I-80 / Middle Road Interchange. The proposed project would impact Spencer Creek. Impacts to the floodway, floodplain (both 100 year and 500 year), and the number of and span length of crossings are anticipated regardless of the alternative selected. The United States Army Corps of Engineers (USACE) policy defines a sequential process to avoid, minimize, and mitigate for adverse impacts to the aquatic ecosystem (general statement of USACE mitigation policy from 33 CFR 320.4 (r)). The proposed build alternatives have been developed based on the need to avoid and minimize impacts to Spencer Creek by constructing bridges. The existing configuration, representing the No-Build and Reconstruct Existing alternatives, poses the least impact to the creek as the interchange as they follow ramp alignments that typically avoid the creek. However, the Reconstruct Existing alternative impacts the creek in the northwest quadrant due to the required extension of the acceleration lane to meet design standards. The additional pavement north of the I-80 mainline requires fill limits to be extended north into Spencer Creek.

The impact to the floodway and floodplain is most significant in the Creek Avoidance alternative. While the alternative does minimize the number of crossings and bridge span length, the alignment runs through or directly adjacent to the floodway and floodplain boundaries for greater lengths than the other alternatives. The Standard Diamond Interchange with 30 mph Loops also has significant impacts to the creek.

The Compressed Diamond, DDI, and SPUI Build alternatives provide less impact on Spencer Creek than the Standard Diamond Build alternatives. However, the tradeoff is that a greater bridge length is required in the northwest quadrant to mitigate (avoid) creek impacts as they span the creek multiple times and at a location where the creek runs parallel with I-80.

Wetlands are present at multiple locations throughout the study area, typically along Spencer Creek and its tributaries. The overall impact from the Build alternatives is expected to be between 1.0 (Reconstruct Existing) and 4.1 acres (Creek Avoidance). The Standard Diamond alternatives were typically around three acres and the Compressed Diamond, DDI, and SPUI alternatives were slightly more than one acre. In all alternatives, culverts would need to be extended to the grading limits.

Bridges
The resultant area of bridges is a combination of several factors, including the number of stream crossings based on the proposed layout, mitigation efforts to avoid impact to the creek and construction cost considerations. Potential stream crossings occur in both the northwest and northeast quadrants of the interchange, however the stream is further away from the I-80 mainline in the northeast quadrant than it is in the northwest.

Build alternatives utilizing a diagonal ramp in the northwest quadrant or a 'tight' westbound I-80 ramp terminal intersection, with regards to the close proximity to the I-80 mainline, typically have a greater square footage of bridge deck and span length. A ramp bridge length of 980 feet is required for the Compressed Diamond and Homestead Avoidance alternatives and a length of 1,200 is required for the DDI and SPUI alternatives. However, a longer bridge length minimizes impacts to the creek and requires less mitigation efforts through the study and design phase.

Right-of-Way Impacts
ROW impacts are a factor of ramp terminal intersection location and inclusion of diagonal ramps in the northwest and southeast quadrants. A greater ROW impact equates to less developable land around the interchange and greater cost to the project. All Build alternatives include diagonal ramps in all four quadrants except the Reconstruct Existing alternative. Therefore these alternatives have some level of ROW impact due to the necessity of ROW in these two new quadrants. As the ramp terminal intersections move further away from I-80 mainline, such as the Creek Avoidance and Standard Diamond with 30 mph Loops (Parclo) alternatives, the required amount of ROW increases. The Compressed Diamond, DDI, and SPUI alternatives require the least amount of ROW of the Build alternatives with a new interchange configuration.

Homestead Avoidance
The avoidance of the homestead in the northwest quadrant was one of the considerations in developing alternatives. In addition to the existing configuration, the Homestead Avoidance with 25 mph Loops, Compressed Diamond, DDI, and SPUI Build alternatives do not require relocation of the homestead.

Opinion of Conceptual Project Cost
The opinion of project cost is reflective of interchange configuration, mitigation of environmental impacts, and other costs throughout the footprint of the proposed interchange. The Reconstruct Existing alternative was the lowest cost Build alternative, due to utilizing a similar ramp alignment. Most of the Build alternatives fell between $32 and $39 million.

Other Impacts
Other direct impacts that apply to the Build alternatives include the golf course in the northwest quadrant and rest areas west of Middle Road.

Initial Screening of Alternatives

The criteria utilized in the selection of a preferred alternative have been documented up to this point within the IJR. The comparison of key interchange components were discussed in the previous sub-section. The City of Bettendorf and Iowa DOT District staff reviewed the No-Build alternative and Build alternatives, and each alternative's respective impacts, on January 7, 2014, in order to identify a preferred alternative. The alternative evaluation process included elimination of alternatives that failed to meet or posed significant impact across multiple criteria. The following summarizes the key determining factors regarding this evaluation process, with supplemental information in **Table 2.3-11**.

<u>No-Build (Do Nothing) Alternative</u> – eliminated from consideration because it fails to meet traffic operation criteria, current Iowa DOT design criteria or provide for expanded traffic capacity.

<u>Alternative 1 – Reconstruct Existing Alternative</u> – eliminated from consideration because it does not provide additional traffic carrying capacity beyond the 2040 planning year to meet traffic operation criteria at the ramp terminal intersections.

<u>Alternative 2 – Standard Diamond Alternative</u> – eliminated from consideration because it requires greater impact to the stream and wetlands, additional ROW and less developable land than many of the other concepts. The proposed configuration also requires relocation of the homestead and does not provide for expanded capacity based on the proposed configuration. The addition of loop ramps creates a Parclo interchange, represented and further analyzed in Alternative 2a and 3.

<u>Alternative2a – Standard Diamond Interchange with 25mph Loops</u> – provides the same diamond configuration as Alternative 2 with the addition of two loop ramps. This alternative was eliminated from consideration because it increases the number of I-80 access points from four to six, requires more ROW than many of the other concepts, requires relocation of the homestead, and provides less developable land for future development.

<u>Alternative 3 – Standard Diamond Interchange with 30 mph Loops</u> – provides a standard diamond configuration with ramp terminal intersections spaced further away from I-80 than Alternative 2 and 2a due to large loop ramps. The location of the ramp terminal intersections significantly impacted many of the key evaluation criteria. This alternative was eliminated because it increases the number of I-80 access points from four to six, requires relocation of the homestead, requires three crossings of Spencer Creek and one of the highest bridge surface areas, and had nearly the greatest impact of all Build alternatives on the stream, wetlands, and ROW.

<u>Alternative 4 – Homestead Avoidance Diamond Interchange with 25 mph Loops</u> – eliminated from consideration because it increases the number of I-80 access points from four to six, creates a less desirable configuration of offset ramp terminal intersections

north of I-80, and requires one of the greatest bridge surface areas and estimated costs of all Build alternatives.

Alternative 5 – Creek Avoidance Diamond Interchange with Loop Ramps – eliminated from consideration because it increases the number of I-80 access points from four to six, requires relocation of the homestead, and contains the greatest impact to the floodway, floodplains, wetlands, ROW, and estimated cost of all Build alternatives.

Alternative 6 – Compressed Diamond Interchange – minimizes impacts to stream, floodway and floodplain, wetlands, and ROW when compared to the standard diamond-type interchanges. Maintains four I-80 access locations, includes a single bridge to span Spencer Creek, and does not require relocation of the homestead. Overall measures of key evaluation criteria were very similar to the DDI and SPUI alternatives. The Compressed Diamond Alternative was carried forward for further consideration.

Alternative 7 – Diverging Diamond Interchange – minimizes impacts to stream, floodway and floodplain, wetlands, and ROW when compared to the standard diamond-type interchanges. Maintains four I-80 access locations, includes two curved bridges and a long bridge to span Spencer Creek, does not require relocation of the homestead, and provides additional interchange capacity than Build alternatives 2-6. Overall measures of key evaluation criteria were very similar to the Compressed Diamond and SPUI alternatives. The DDI Alternative was carried forward for further consideration.

Alternative 8 – Single Point Urban Interchange – minimizes impacts to stream, floodway and floodplain, wetlands, and ROW when compared to the standard diamond-type interchanges. Maintains four I-80 access locations, includes two curved bridges and a long bridge to span Spencer Creek, does not require relocation of the homestead, and provides additional interchange capacity than Build alternatives 2-6. Overall measures of key evaluation criteria were very similar to, or slightly less than, the Compressed Diamond and DDI alternatives. The SPUI alternative was carried forward for further consideration.

Selection of Preferred Alternative

Thee Build alternatives were carried forward for final comparison of key evaluation criteria: Compressed Diamond, DDI, and SPUI.

All three Build alternatives meet traffic operations criteria, meet current design standards, incorporate four access points with I-80, and provide the flexibility in handling additional capacity. The DDI and SPUI had the additional capacity built into the interchange concept, while the Compressed Diamond configuration included the flexibility to add another left-turn lane to the I-80 on-ramp in each direction on Middle Road. However, the additional capacity may not be needed if the area does not reach the full potential of development.

The impacts to the floodway, 100 year floodplain, 500 year floodplain, wetlands, and ROW were similar across the three Build alternatives. The SPUI alternative imposed slightly less impact to the floodway, 100 year floodplain, wetlands, and ROW. It should be noted that the differences in estimated impacts between the SPUI and the other two Build alternatives were minimal: 0.7 acres floodway impact, 0.9 acres 100 year floodplain impact, 0.2 acres wetlands, and 5.2 acres or less of ROW.

The DDI and SPUI alternatives required an additional crossing of Spencer Creek related to the northbound Middle Road to westbound I-80 movement. These two alternatives also required two curved bridges and similar total bridge area compared to the Compressed Diamond alternative.

The estimated cost of the compressed diamond configuration was slightly higher than the DDI and higher than the SPUI, estimated at $38.6 million compared to $38.4 million and $36.0 million, respectively.

Alternative 6 – Compressed Diamond Interchange was selected as the preferred alternative. As many of the impacts were very similar across the three alternatives carried forward for final evaluation, the compressed diamond configuration provided the least bridge surface area and required one less crossing of Spencer Creek. Further, the configuration provided the flexibility to add traffic capacity in the future if warranted. The DDI and SPUI configurations included this additional capacity already with the initial design, so depending on the realized development in the area, those concepts provide excess capacity that may not be needed in the near future. The Compressed Diamond could be converted to a DDI in the future with some modifications.

Concept Alternative Comparison Matrix

Key Criteria	No-Build (Do Nothing)	Alternative 1 Reconstruct Existing	Alternative 2 Standard Diamond	Alternative 2A Standard Diamond with 25 mph Loops, (Parclo)	Alternative 3 Standard Diamond with 30 mph Loops, (Parclo)	Alternative 4 Homestead Avoidance with 25 mph Loops	Alternative 5 Creek Avoidance	Alternative 6 Compressed Diamond	Alternative 7 DDI	Alternative 8 SPUI
Meets Traffic Operation Criteria[1]	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Meets Current DOT Design Criteria	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provides for Expanded Traffic Capacity	No	No	No	Yes	Yes	Yes	Yes	Yes[2]	Yes[3]	Yes[3]
Number of Access Points to I-80	4	4	4	6	6	6	6	4	4	4
Impact to Floodway (acres)	0	1.5	4.2	4.2	9.1	3.0	9.3	3.1	3.1	2.4
Impact to 100 Year Floodplain (acres)	0	0.6	6.2	6.2	11.8	3.4	18.5	2.9	2.9	2.0
Impact to 500 Year Floodplain (acres)	0	0	0	0	0	0	0.2	0	0	0
Impact to Wetlands (acres)	0	1.0	3.0	3.0	3.3	2.0	4.1	1.3	1.3	1.1
Spencer Creek Crossings (number)	0	0	2	2	3	2	1	1	2	2
Area of Ramp Bridges (square feet)	0	0	13,500	13,500	29,400	25,600	7,500	32,200	31,700	25,600
Area of I-80 Bridges (square feet)	0	38,100	33,600	33,600	34,500	38,200	35,700	40,300	40,300	40,300
Right of Way (acres)	0	0.8	21.8	21.8	40.0	18.9	56.1	14.1	13.1	8.9
Requires Relocation of Homestead	0	No	Yes	Yes	Yes	No	Yes	No	No	No
Cost ($ in millions)	0	21.9	32.1	33.8	40.8	38.3	38.6	38.6	38.4	36.0

[1] Traffic operations criteria were evaluated using sensitivity model numbers.
[2] Allows for future expansion if longer I-80 bridge is constructed to accommodate dual turn lanes on Middle Road or conversion to DDI.
[3] Additional capacity is inherent with concept.

2.3.5 Preferred Alternative

The preferred alternative is the Compressed Diamond Interchange configuration. After a review of the No-Build and Build alternatives, it was found that this alternative best met the goals and objectives of the project by meeting the purpose and need and evaluation criteria. The following summarizes benefits of the Compressed Diamond Interchange preferred alternative:

The Compressed Diamond alternative met traffic operations and geometric design standards criteria. It allowed for the flexibility for expanded traffic capacity, by providing for future widening of I-80 to a 6-lane cross-section, allows for dual exit ramps after subsequent I-80 widening, provides the ability to accommodate ramp metering in the future and provides for widening of Middle Road through the interchange in conjunction with additional left-turn lanes (for dual left-turn lanes) at the ramp terminal intersections.

A comparison between traffic operations of a 4-lane and 6-lane I-80 cross-section, incorporating the Sub-Area analysis traffic volumes and preferred alternative configuration is provided in **Table 2.3-12**. As shown, traffic operations improved for all analyzed segments, with those operating at LOS D and E improved to LOS C.

Table 2.3-12: I-80/Middle Road Interchange Traffic Operations Analysis – 2040 Sub-Area 4 Lane & 6 Lane I-80 Cross-Sections (HCS 2010)

Direction	2040 - 4 Lane *LOS/Density (pc/mi/ln)*		2040 - 6 Lane *LOS/Density (pc/mi/ln)*	
	AM	**PM**	**AM**	**PM**
Eastbound I-80				
Basic Freeway – West of Middle Road	C/24.8	E/40.4	B/15.3	C/21.2
Diverge - I-80 off-ramp	D/29.3	E/39.1	C/20.8	C/27.0
Merge - I-80 on-ramp	C/22.6	C/26.0	B/14.4	B/16.3
Basic Freeway – East of Middle Road	C/22.1	C/25.8	B/14.0	B/15.8
Westbound I-80				
Basic Freeway – East of Middle Road	C/24.2	C/21.2	B/15.0	B/13.6
Diverge - I-80 off-ramp	D/28.8	C/26.0	C/20.0	B/18.5
Merge - I-80 on-ramp	D/30.4	C/21.8	C/21.5	B/14.2
Basic Freeway – West of Middle Road	D/34.4	C/21.4	C/19.2	B/13.6

The preferred alternative minimizes impacts to Spencer Creek when compared to the standard diamond and Parclo interchange alternatives. Impacts were similar to the DDI and SPUI alternatives, but greater than the reconstructing the existing configuration on a similar alignment. The diagonal ramp in the northeast quadrant does not impact the creek due to location of the ramp terminal intersection, south of the creek. Stream impacts are mitigated in the northwest quadrant by single on-ramp bridge that extends approximately 980 feet over two crossings of Spencer Creek and the adjacent floodway.

Due to the tight proximity of the ramp terminal intersections to I-80, the ROW impacts are minimized even with the ramps in the previously unoccupied northwest and southeast quadrants. This not only reduces overall project cost, but it maximizes the available developable land. Further, the tight configuration does not require relocation of the existing homestead in the northwest quadrant.

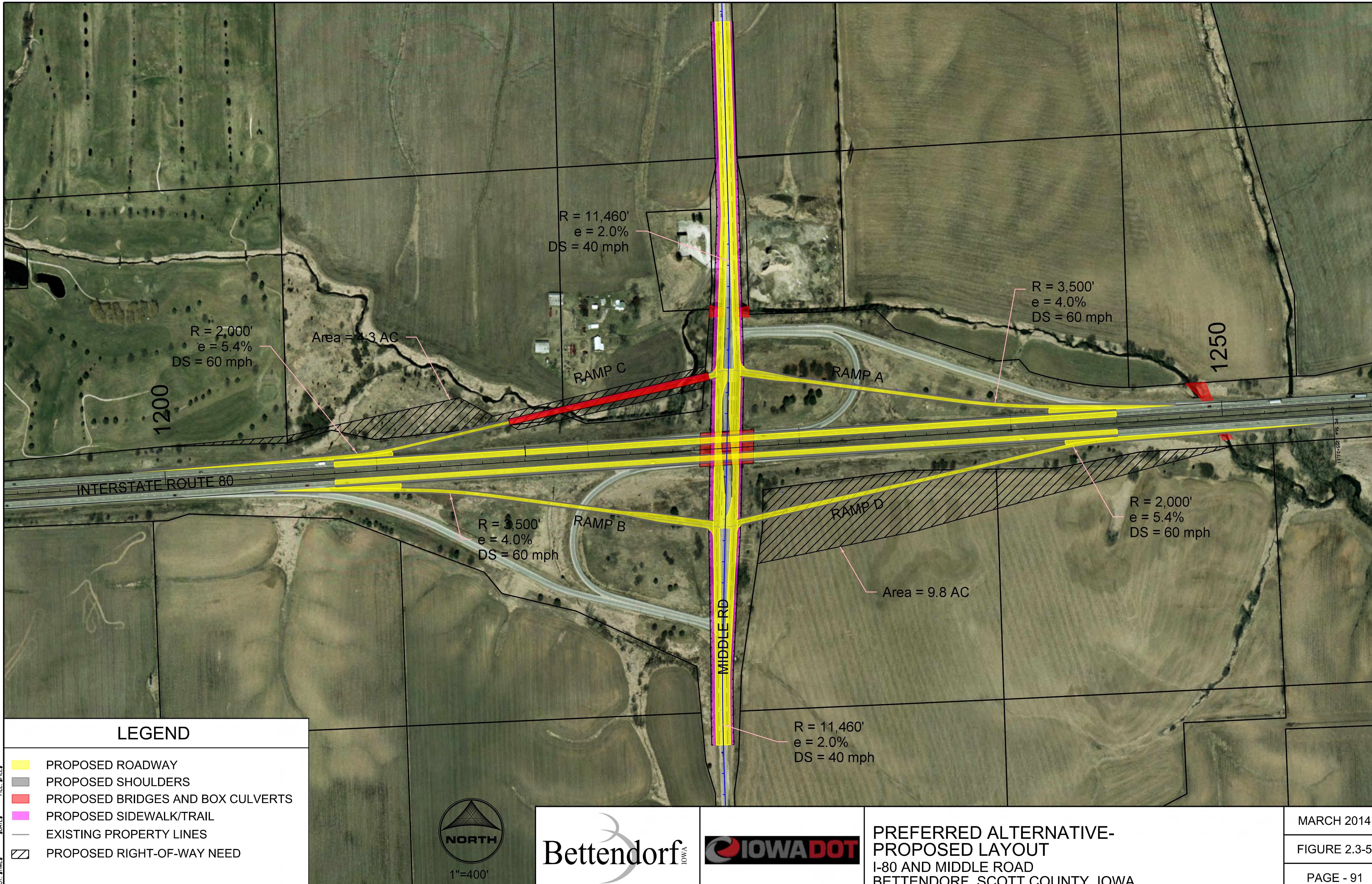
Figure 2.3-5 shows the proposed layout of the Compressed Diamond Interchange alternative. The graphic shows the proposed roadway and design criteria, bridges and box culverts, and ROW needs. A future 6-lane I-80 cross-section is shown to display compatibility with an additional I-80 mainline lane in each direction widened to the outside.

Figure 2.3-6 provides the preliminary signing plan based on the proposed interchange layout.

Table 2.3-13 presents a summary of the conceptual-level opinion of probable construction costs for the Compressed Diamond Interchange preferred alternative, broken out to identify costs for segments within the entire project. It should be noted that these costs reflect raising the I-80 profile as described in the following section, where the comparison matrix did not account for the I-80 profile adjustment as it is applicable across all Build alternatives. **Appendix E** provides a more detailed breakdown of the conceptual level opinion of probable construction costs for all Build Alternatives, as well as a more detailed breakout for the individual Compressed Diamond Interchange segments.

Table 2.3-13: Opinion of Probable Construction Cost Summary

Description	Opinion of Probable Construction Cost
Ramp A	$1,800,000
Ramp B	$1,600,000
Ramp C	$10,000,000
Ramp D	$6,200,000
I-80 Bridges and Mainline	$17,800,000
Middle Road Corridor	$8,400,000
Total	**$45,800,000**



Bettendorf IOWA

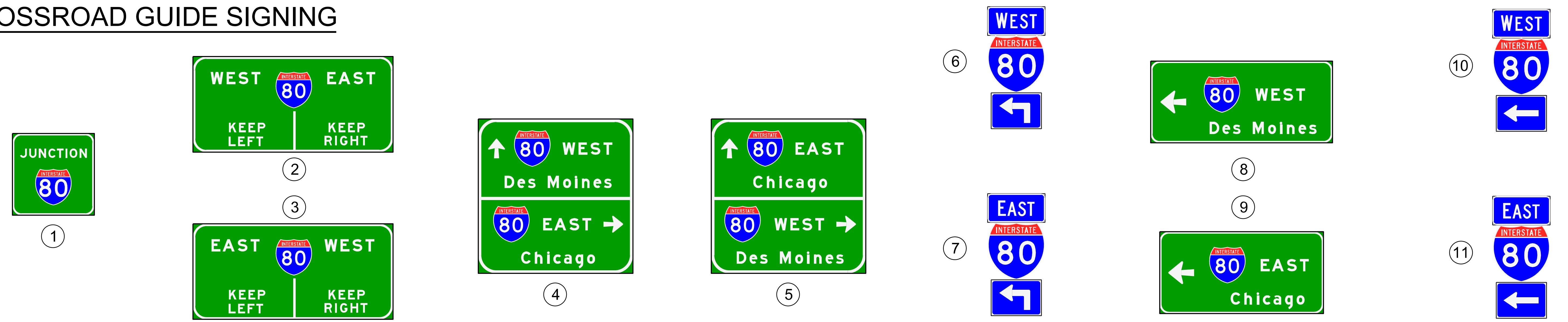
IOWADOT

PREFERRED ALTERNATIVE-
PROPOSED LAYOUT
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

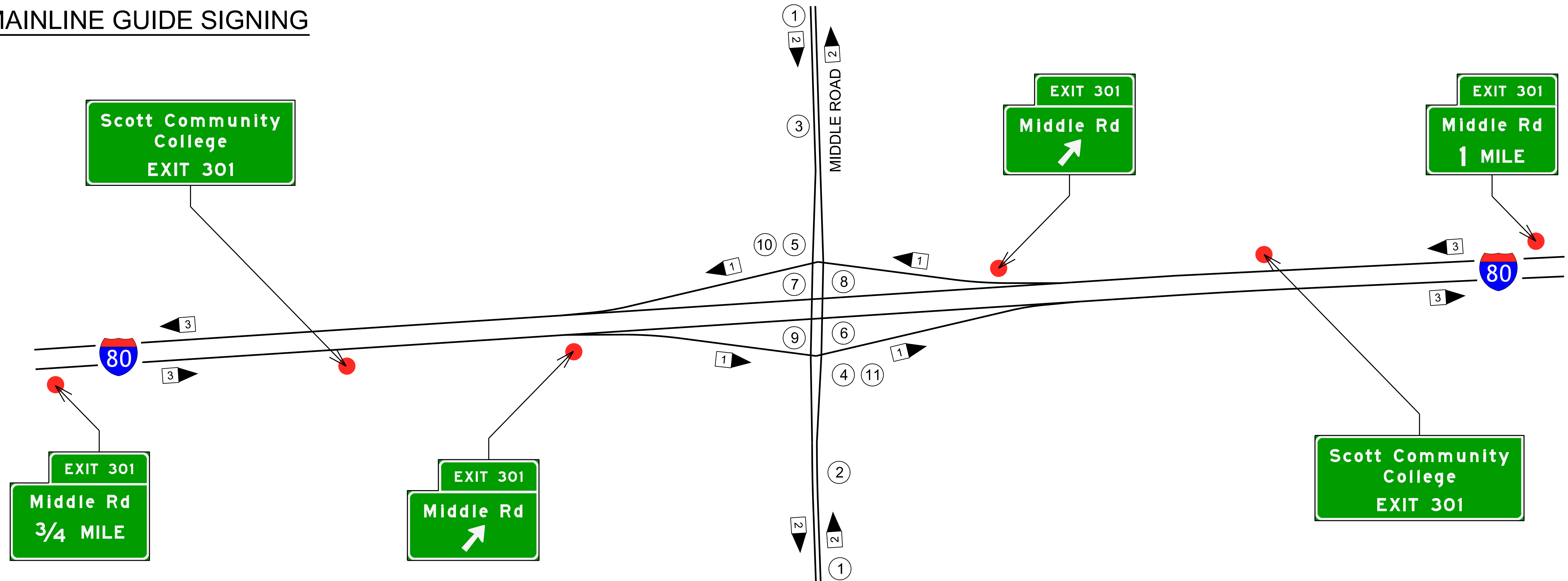
MARCH 2014

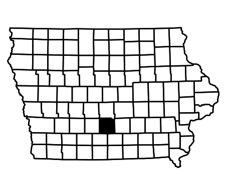
FIGURE 2.3-5

CROSSROAD GUIDE SIGNING



MAINLINE GUIDE SIGNING





LEGEND

GROUND MOUNT GUIDE SIGN

NUMBER OF LANES AND FLOW DIRECTION

NORTH

NOT TO SCALE

HRGreen

IOWADOT

PROPOSED
GUIDE SIGNING CONCEPT
I-80 and Middle Road Interchange
Bettendorf, Iowa

MARCH 2014

FIG. 2.3-6

2.3.6 Preferred Alternative – Constructability and Phased Construction

The proposed Compressed Diamond Interchange alternative is constructable given the existing roadway conditions and design constraints. The proposed Middle Road profile, typical sections, and Middle Road turn lanes and access control limits are shown in **Figure 2.3-7**, **Figure 2.3-8**, and **Figure 2.3-9**, respectively. Additional interchange geometrics details are provide in **Appendix F**.

In order to meet vertical clearance minimum design standard of 16.5 feet, the I-80 profile was raised between the proposed ramp connections with I-80. This equates to approximately 3,700 feet of I-80 mainline. The following summarizes changes to the I-80 and Middle Road profiles within the study area.

The I-80 profile consists of the following modifications (as shown in **Appendix F**):

- Profile raised for approximately 3,700 feet along I-80 alignment
- Consists of two vertical curves in each direction, resulting in the following slopes in the direction of travel (length between vertical point of intersection):
    - o Eastbound: -0.813% (400 feet), -0.170% (2,000 feet), and -1.525 (1,300 feet)
    - o Westbound: +1.760% (900 feet), 0.388% (2,450 feet), and 0.749% (350 feet
- Proposed on-ramp and off-ramp ramp tie-in locations with I-80 are located outside of adjusted profile limits (**Figure 2.3-9** and **Appendix F**)

The Middle Road profile consists of the following characteristics and modifications (as shown in **Figure 2.3-7**):

- Project limits extend approximately 1,400 feet and 2,000 feet to the south and north of I-80 mainline, respectively
- From southern project limit northward, proposed profile matches existing profile underneath I-80 bridges at -4.220% (from south to north)
- North of I-80 bridges, proposed grade of +2.207% (from north to south) to northern project limit

It is anticipated that construction of the proposed improvements to the I-80/Middle Road interchange would be completed in its entirety and phased construction would not be utilized. However, it is feasible to build the new diagonal ramps one half at a time should funding streams dictate a phased implementation. Overall phasing of the project in order to accommodate adjustments to profile and plan requirements, is potentially (however, not the only option):

- Construct Ramp D
- Construct Ramp B
- Reconstruct I-80 Bridges
- Reconstruct Middle Road
- Construct Ramps A and C

Because the proposed Middle Road profile south of I-80 follows the existing profile, the ramps in the southwest (ramp B) and southeast (ramp D) quadrants can be built prior to other improvements within the interchange. Ramp B and D tie-in points with I-80 are outside of the extents of the I-80 profile adjustment.

Ramp D could also be constructed as a stand-alone project, with the option to remove or maintain the southbound Middle Road to eastbound I-80 loop on-ramp. If the loop ramp is removed, it addresses safety and I-80 access point concerns previously identified within this report. However, this would create two ramp terminal intersections south of I-80 and modify turning movement paths along Middle Road that may necessitate localized intersection improvements. If the loop ramp remains in service, southbound Middle Road to eastbound I-80 movements would be accommodated via the existing loop on-ramp. Left-turns from southbound Middle Road to Ramp D would be prohibited.

I-80 bridges need to be reconstructed prior to reconstruction of Middle Road in order to provide for vertical clearance minimum design standard and accommodate the proposed wider Middle Road cross-section. After the I-80 bridges are complete, construction of Middle Road may begin. This process lowers the profile of Middle Road north of I-80 and will require proper sequencing to accommodate turning movements between Middle Road and I-80.

The Middle Road typical section consists of an urban 4-lane cross-section, divided by a raised median, with a 10 foot trail on the west side and 5 foot sidewalk on the east side. The typical cross-section accommodates dual left-turn lanes approaching both ramp terminal intersections, providing the option to initially build a single turn lane and add the second when warranted by traffic volumes. An overview of the proposed Middle Road turn lane lengths and access control limits is provided in **Figure 2.3-9**, with additional detail in **Appendix F**.

Turning movement volumes at the two ramp terminal intersections were developed for the 2020 Opening Year conditions through a straight-line projection between 2008 and 2040 volumes. The Compressed Diamond Interchange preferred alternative layout was analyzed with stop-controlled, from the ramp approach, ramp terminal intersections. **Table 2.3-14** presents the operational measures of the stop-controlled off-ramp approach at both the eastbound and westbound I-80 ramp terminal intersections.

Table 2.3-14: I-80/Middle Road Ramp Terminal Intersections Traffic Operations Analysis – 2020 Opening Year Conditions (HCS 2010)

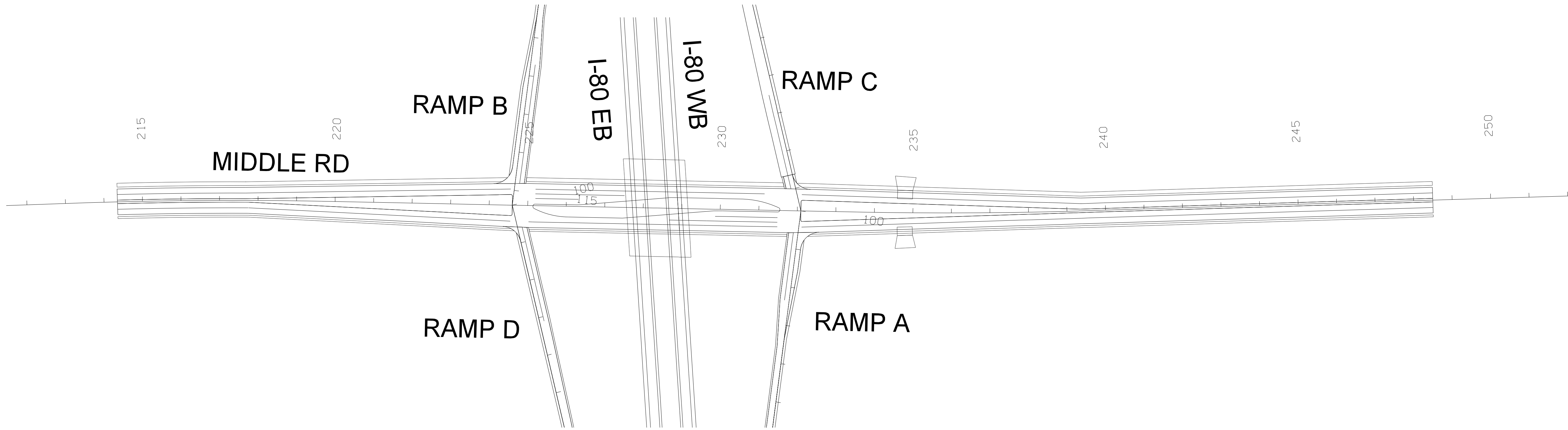
Intersection Stop-Controlled Approach	**2020 Preferred Alternative** *LOS/Delay (sec/veh)*	
	AM	**PM**
I-80/Middle Road Ramp Terminal Intersections		
EB I-80 Off-Ramp	B/11.6	B/11.8
WB I-80 Off-Ramp	D/27.6	C/20.5

An analysis of the projected 2020 traffic volumes warrants signalization of the westbound I-80 ramp terminal intersection in the 2020 Opening Year based on the established LOS criteria and projected traffic operations. The operations analysis measured LOS D in the AM peak hour primarily due to the relationship of left-turning vehicles from the off-ramp approach and lack of adequate gaps in the Middle Road traffic flow. The HCM methodology calculated a 95th percentile queue length of approximately 3.13 vehicles, which does not impact I-80 mainline operations. The eastbound I-80 ramp terminal intersection is projected to operate at LOS B in both the AM and PM peak periods, accommodating projected traffic volumes from a stop-controlled off-ramp approach.

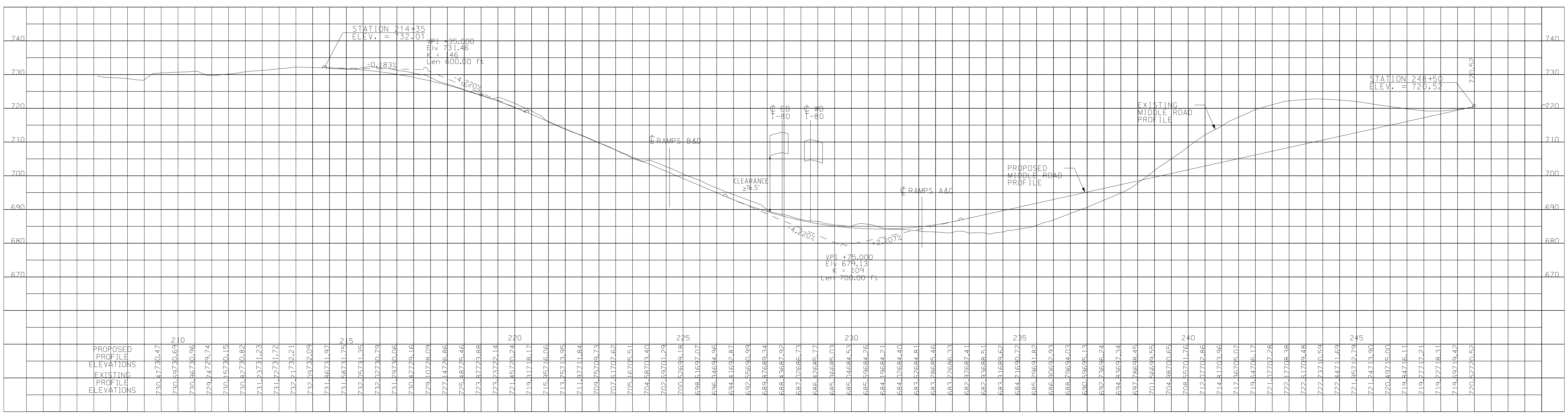
Construction sequencing will be utilized to maintain all movements within the interchange throughout the project. With the ramp terminal intersections being located closer to I-80 than the existing interchange as well as new ramps in two of the quadrants, it provides the opportunity for the ramps to be constructed separate from the existing ramps.

Traffic on I-80 will be maintained at all times; however, it may be necessary to reduce traffic down to a single lane in one or both directions during removals, reconstruction of the I-80 bridges over Middle Road, and when tying ramps with the I-80 mainline. Specific construction sequencing of the I-80 bridges and I-80 mainline improvements will be coordinated as part of the design process. While it is anticipated that these efforts accommodate all interchange movements through the project, short-term, intermittent closures may be required to tie final connections.

Traffic will be maintained along Middle Road as possible. Intermittent closures will be needed when setting bridge beams and other deck work. Middle Road will likely be constructed one half at a time, maintaining traffic on the current section until one half of ultimate cross-section is complete.



MIDDLE ROAD PROPOSED PLAN VIEW



MIDDLE ROAD PROPOSED PROFILE

NORTH

1"=300'

Bettendorf IOWA

IOWADOT

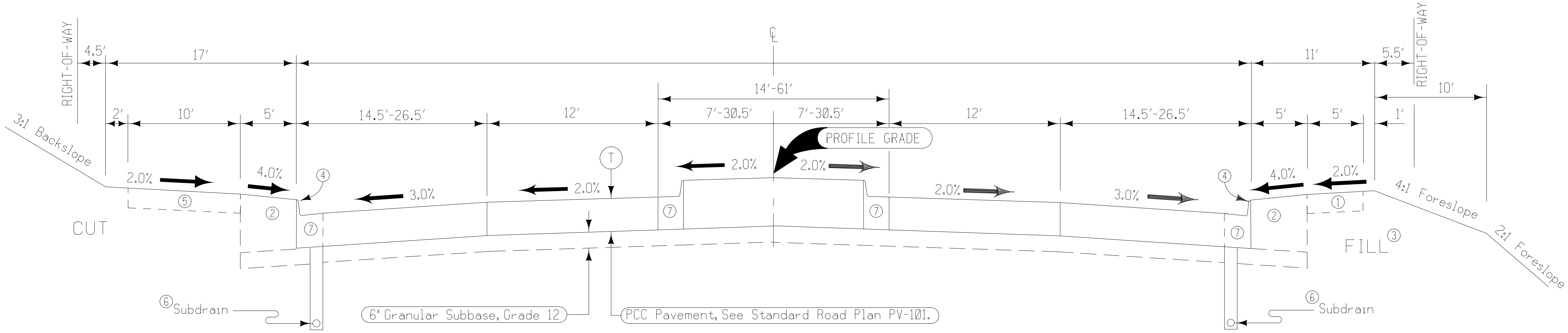
PROPOSED MIDDLE ROAD PLAN AND PROFILE

I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

FIGURE 2.3-7

HBG-1



MIDDLE ROAD
TYPICAL SECTION

Notes:

Normal sections shown may be appropriately modified for areas specifically designated by the Engineer, such as intersections or superelevated curves.

Refer to other drawings for details of shoulder design and construction.

1. 5' Wide Sidewalk - By Others
2. Excavate and Backfill 3.0'.
3. Backfill
4. 6" Standard Curb
5. 10' Wide Trail - By Others
6. Refer to Standard Road Plan RF-19C.
7. "Curb and Gutter, P.C. Concrete, 2.5 FT." Contractor option to pour monolithically w/ 12' outside lane or to place separately w/ tie bar provided at Contractor's expense.

LOCATION			T			
ROAD IDENTIFICATION	STATION TO STATION		Inches	Feet	Feet	Feet
MIDDLE ROAD @ I-80			9			

Bettendorf IOWA

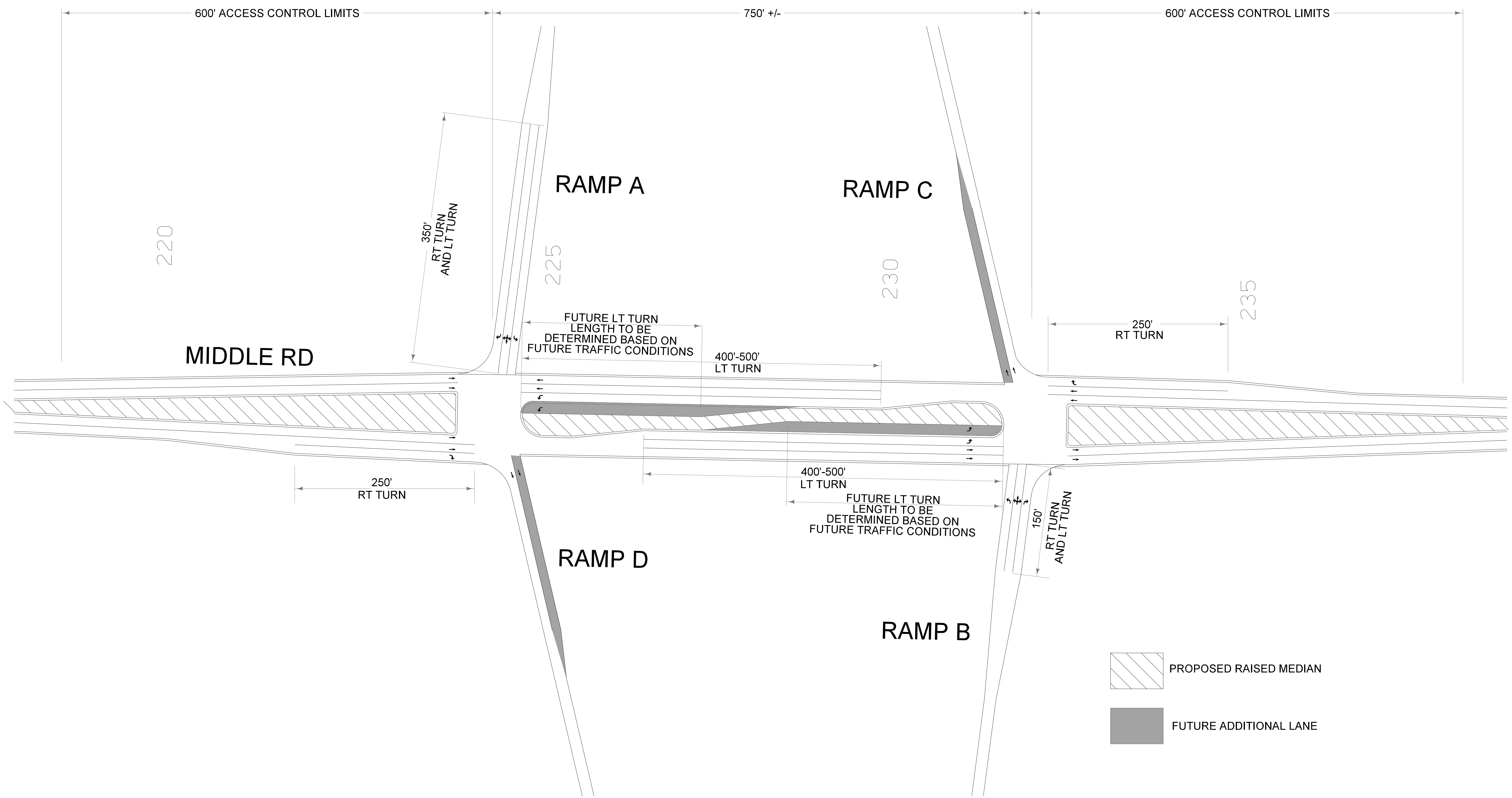
IOWADOT

PROPOSED MIDDLE ROAD
TYPICAL SECTION
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

FIGURE 2.3-8

PLOT: $TIME$ $DATE$ FILE: $FILE$



NOT TO SCALE

Bettendorf IOWA	IOWADOT	PROPOSED MIDDLE ROAD TURN LANES AND ACCESS CONTROL LOCATIONS I-80 AND MIDDLE ROAD BETTENDORF, SCOTT COUNTY, IOWA	MARCH 2014 FIGURE 2.3-9 PAGE - 98

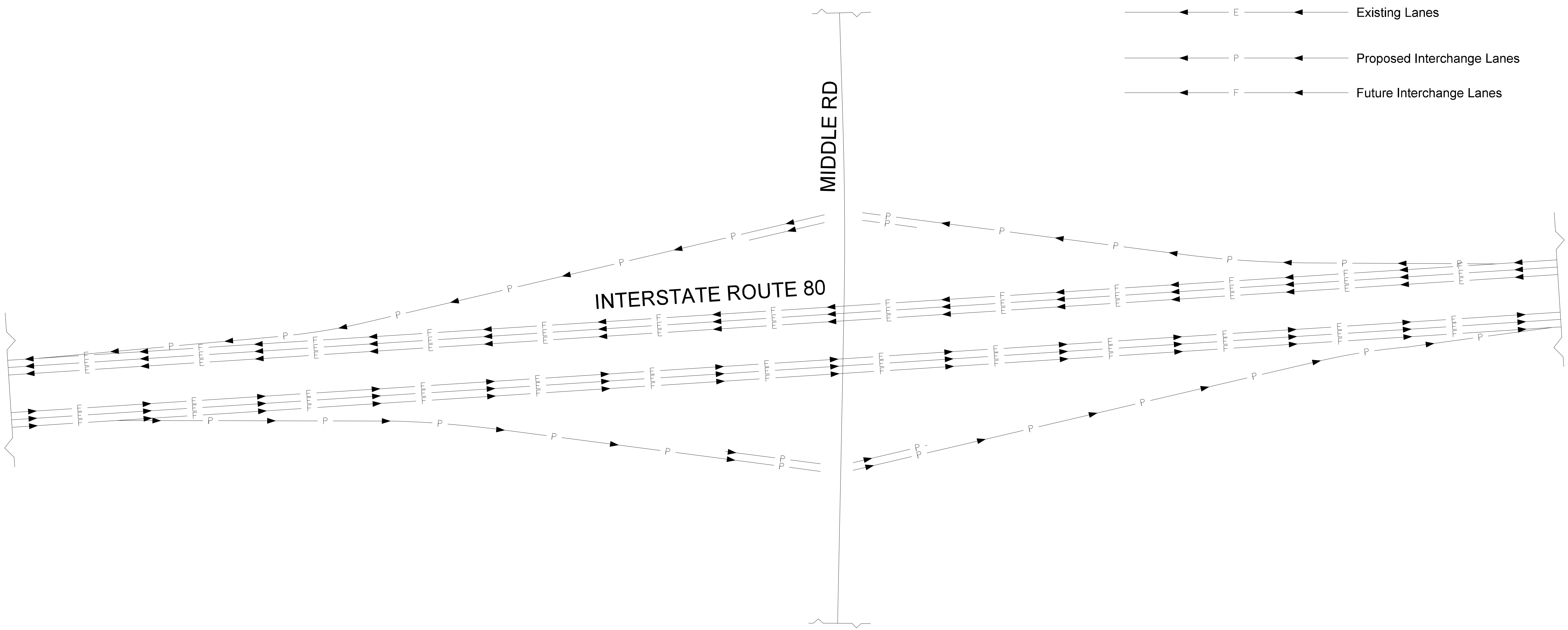
2.3.7 Preferred Alternative – I-80 Lane Configuration, Lane Continuity, and Interchange Ramp Spacing

Lane continuity and lane balance is achieved through the study area for both the existing 4-lane and potential future 6-lane I-80- conditions. **Figure 2.3-10** shows the preferred alternative with a 6-lane section on I-80. Two or three continuous lanes in each direction are carried through the study area, absent of auxiliary lanes and basic lane drops. Single exit and entrance lanes are present at all merge and diverge areas. The ramp approaches to Middle Road add a second turning lane, accommodating a left and right-turn lane.

Interchange ramp spacing within the study area meets minimum distance requirements between ramps of 1,600 feet, as identified in *AASHTO 2005*. In the westbound direction, the introduction of an on-ramp in the northwest quadrant extends the merge location further west than the existing configuration. The proposed distance between these two ramp location is approximately 2,740 feet gore area to gore area (location of convergence or divergence of I-80 freeway lane and ramp lane).

AASHTO 2005 also identifies a recommended minimum interchange spacing of one mile in urban areas. As previously mentioned, the I-74 interchange is approximately 3 miles west of Middle Road and the U.S. Highway 67 interchange is approximately 5 miles east of Middle Road. If the illustrative interchange project near 257th Avenue is carried forward in the future to a study phase, that study will need to account for the current I-80/Middle Road configuration. It should be noted, that 257th Avenue is approximately 3 miles east of Middle Road.

It can be concluded that the preferred alternative provides lane continuity along I-80 through the study area and meets recommended minimum interchange and ramp spacing guidelines provided as provided by *AASHTO 2005*.



PREFERRED ALTERNATIVE-
COMPRESSED DIAMOND

NORTH
NOT TO SCALE

Bettendorf IOWA

IOWA DOT

I-80 LANE CONFIGURATION
AND LANE CONTINUITY
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

MARCH 2014

FIGURE 2.3-10

2.3.8 Preferred Alternative – Pedestrian Mobility

Pedestrian facilities are not currently provided in the vicinity of the I-80/Middle Road interchange. The preferred alternative design incorporates pedestrians via a 10-foot path along the west side of Middle Road and 5-foot sidewalk on the east side through the interchange. This width is consistent of the existing path along Middle Road south of 53rd Street. It is planned that this trail will be extended northward towards, and through, the I-80/Middle Road interchange to provide connectivity between the study area and the developed areas of Bettendorf to the south.

Further refinement of the proximity of the pedestrian path through the interchange will be addressed in the design process, accounting for available horizontal clearance under the I-80 bridges and ramp terminal intersections. The path will be designed to maintain ADA criteria and current design standards.

2.3.9 Preferred Alternative – Safety Review

The existing I-80/Middle Road interchange is a partial cloverleaf, or folded diamond, with ramps in the northeast and southwest quadrants. Each of the four ramps consists of a single travel lane. The two ramp terminal intersections are stop-controlled from the off-ramp approach and lack exclusive turn lanes on the Middle Road approaches.

The preferred alternative includes reconstruction of the existing interchange to a compressed diamond interchange. This alternative would remove the existing loop on-ramps in the northeast and southwest quadrants and locate the ramp terminal intersections closer to I-80.

The crash history (2008-2012) within the study area was presented in Policy Statement #1.

FHWA Desktop Reference Library

The *FHWA Desktop Reference* maintains a registry of crash reduction estimates that might be expected if a specific countermeasure or group of countermeasures is implemented with respect to intersection crashes, roadway departure and other non-intersection crashes, and pedestrian crashes. The crash reduction estimates are known as Crash Reduction Factors (CRFs). A CRF is the percentage crash reduction that might be expected after implementing a given countermeasure. Within the CRF reference library, crash reduction factors exist for intersection, roadway departure and non-intersection crashes. In some cases, the CRF is expressed as a Crash Reduction Function which is dependent on a variable. It is important to note that a CRF represents the long-term expected reduction in crashes and this estimate is based on crash experience at a limited number of study sites as part of a previous research study; therefore the actual reduction in crashes may vary.

The preferred alternative includes future signalization of both ramp terminal T-intersections when warranted. Under existing conditions, each ramp terminal intersection was stop-controlled from the minor approach. The FHWA Desktop Reference provides several CRFs for conversion of a stop-controlled intersection to a signalized intersection, ranging from -50 to 74 depending on a multitude of intersection criteria and study type. Typically, a positive crash reduction factor was provided for all crashes except rear-end type crashes (represented by the -50 above).

It is anticipated that left-turn lane(s) will be constructed from Middle Road to the I-80 on-ramp. Depending on intersection criteria and study type, the CRFs ranged 7 to 62 for 3-leg intersections, indicating that adding left turns would be expected to improve safety at the intersection.

Bridge widening, applicable to both I-80 mainline and Middle Road sections, provided CRFs typically between 45 and 55, with many applications approaching 95 for roadway departure crashes.

2010 Highway Safety Manual

The *2010 Highway Safety Manual* maintains a registry of Crash Modification Factors (CMFs) through the Crash Modification Factors Clearinghouse. A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. It is important to note that a CMF represents the long-term expected reduction in crashes and this estimate is based on crash experience at a limited number of study sites as part of a previous research study; therefore the actual reduction in crashes may vary.

The *2010 Highway Safety Manual* provides a CMF of 0.55 for modifying a cloverleaf ramp to a straight ramp, equating to a predicted 45 percent reduction in total crashes. Conversely, the Crash Modification Factor Clearinghouse identifies a CMF of 0.77 for providing a loop ramp instead of long ramp within an interchange. This represents a 23 percent predicted reduction in total crashes.

The CMF's are based on research reported within *The Handbook of Road Safety Measures*. The research found that accident rates on ramps increase in the following order: straight ramps (lowest accident rates), clover ramp, long ramp, short ramp, loop (highest accident rates). These results are in accordance with the results from the comparison between different layouts of grade-separated interchanges. The lowest accidents rates have been found in diamond interchanges, which are built with straight ramps only. Directional and semi-directional ramps would be considered long ramps according to *The Handbook of Road Safety Measures.*

Intersection Conflict Points

Eliminating the loop ramp modifies the northbound Middle Road to westbound I-80 movement and southbound Middle Road to eastbound I-80 movement from free right-turns to a left-turn at a ramp terminal intersection. This decreases the number of conflict points along mainline I-80 by removing one access location. However, it increases the number of conflict points at the northbound terminal intersection. A conflict point occurs where one vehicle path crosses, merges or diverges with, or queues behind the path of another vehicle.

Crash Reduction Factors or Crash Modification Factors were not found regarding this type of interchange modification. However, an increase in the number of conflict points increases the potential of a crash at an intersection. Crossing conflicts are caused by the intersection of two traffic streams. Typical crash types associated with crossing conflicts include broadside crashes and head-on crashes, which are typically more severe than other crash types.

FHWA Enhanced Interchange Safety Analysis Tool (ISATe)
The Enhanced Interchange Safety Analysis Tool (ISATe) was published by the FHWA in 2012. ISATe provides a means for assessing the safety effects of geometric features and traffic control options, along with traffic volumes of an existing interchange, and predicting the safety performance of a new interchange where no interchange previously existed. ISATe uses safety performance functions (SPF) that were developed from existing freeway locations collected by the FHWA. SPF's are provided for mainline and ramp segments and are dependent upon the following factors:

- Area Type: General character of land use surrounding the interchange, preferably based on FHWA urban area boundaries.
    - Urban or Rural
- Mainline:
    - Number of through lanes
    - Horizontal curvature
    - Cross section data
        - Lane width
        - Shoulder widths
        - Median widths
    - Presence of barrier/rumble strips
    - Presence of ramp access points (including ramp characteristics)
    - Presence of weaving segments
    - Average Daily Traffic
- Ramp:
    - Number of lanes
    - Length
    - Type of ramp
    - Horizontal curvature
    - Cross section data
        - Lane width
        - Shoulder widths
    - Presence of barrier
    - Presence of ramp access points along ramp facility
    - Presence of weaving segments along ramp facility
    - Average Daily Traffic

The eastbound entrance ramp segment of both the existing and preferred geometric configurations was studied using ISATe under 2040 traffic conditions and the resulting crash data for each configuration is shown in **Table 2.3-15**. The crash output data is divided into categories according to the KABCO scale which is used by the *Highway Safety Manual.* The KABCO scale provides five levels of injury severity; which are:

- K – Fatal injury: an injury that results in death;
- A – Incapacitating: any injury, other than a fatal injury, that prevents the injured person from walking, driving, or normally continuing the activities the person was capable of performing before the injury occurred;
- B – Non-incapacitating evident injury: any injury, other than a fatal injury or incapacitating injury, that is evident to observers at the scene of the crash in which the injury occurred;
- C – Possible Injury: any injury reported or claimed that is not a fatal injury, incapacitating injury, or non-incapacitating evident injury and includes claim of injuries not evident;
- O – No injury/Property Damage Only (PDO)

Table 2.3-15: ISATe Analysis Results

Crash Severity	Unit	Existing Configuration	Preferred Configuration	Percent Decrease
K	Estimated Average Crash Frequency Per Year	0.0	0.0	-
A		0.0	0.0	-
B		0.1	0.1	-
C		0.2	0.1	50.0%
O		0.6	0.3	50.0%
TOTAL		**1.0**	**0.5**	**50.0%**

Under 2040 traffic volumes, the preferred eastbound entrance ramp segment geometric configuration offers a 50.0% reduction in the estimated average crash frequency per year and possible injury related injuries are reduced by 50.0% under the preferred eastbound entrance ramp segment geometric configuration. The estimated average crash frequency of fatal, incapacitating and non-incapacitating evident injuries remained constant between the geometric configurations.

<u>*Summary*</u>

The reconstruction of the existing interchange will be expected to decrease the likelihood of crashes when compared with the No-Build alternative. The research data and ISATe analysis provides supporting information that the proposed interchange modifications would maintain or improve overall safety conditions.

2.3.10 Policy Statement #3 Summary

The third policy statement asks that an analysis be provided to demonstrate that the proposed improvements do not adversely affect existing and expected future traffic on the I-80 corridor.

Eight Build alternatives were developed to address the project purpose and need. Each of these alternatives were analyzed utilizing AM/PM peak hour 2040 Planning Year traffic volumes and volumes developed for a special 2040 Sub-Area scenario, which measured each alternative's flexibility in accommodating additional traffic volumes. All Build alternatives met LOS goals along I-80 mainline segments and at the ramp terminal intersections (signalized, compared to unsignalized in the No-Build conditions). All queue lengths were measured at distances not expected to impact I-80 operations. Therefore, with regards to traffic operations and future traffic volumes, all Build alternatives were carried forward for further evaluation.

Under the 2040 Sub-Area traffic volumes, many I-80 mainline segments operated at LOS D or E across all Build alternatives. However, only the Reconstruct Existing Build alternative did not accommodate traffic at LOS C or better at a ramp terminal intersection. All other Build alternatives measured LOS C or better at both ramp terminal intersections in the AM and PM peak hours. With regards to queue lengths, it is not expected that the ramp approach queue lengths will impact I-80 operations under signalized ramp terminal intersection conditions.

All Build alternatives and the No-Build conditions were evaluated across several different criteria, such as traffic operations, geometric design standards, environmental impacts, ROW and homestead relocation, and construction costs. It was found that the Compressed Diamond Interchange concept provided the least amount of cumulative impact when compared to the other Build alternatives and No-Build conditions.

The proposed Compressed Diamond Interchange preferred alternative consists of diagonal ramps in each of the four quadrants, with ramp terminal intersection separation of approximately 750 feet. Each of the ramp terminal intersections will be signalized and designed to accommodate dual left-turn lanes onto the respective I-80 on-ramp. The Middle Road typical section incorporates two lanes in each direction separated by a raised median, with a 10-foot trail on the west side and a 5-foot sidewalk on the east side to accommodate pedestrian travel.

Lane continuity is maintained through the interchange, with two mainline through lanes in each direction. The proposed interchange maintains spacing greater than 1.0 miles between adjacent interchanges (*AASHTO 2005* minimum for urban area) and ramp separation greater than 1,600 feet between the westbound I-80/Middle Road on-ramp and rest area off-ramp.

The proposed Compressed Diamond Interchange was developed with consideration to widening of I-80 to a six-lane cross-section. This scenario was analyzed with 2040 Sub-Area traffic volumes and demonstrated that the proposed interchange and improved I-80 corridor met LOS goals of C or less. A safety analysis was also conducted between the No-Build conditions and preferred alternative with the conclusion that the proposed improvements would be expected to decrease the overall number of crashes within the interchange.

The proposed interchange geometrics were developed to incorporate phased construction, if desired. A potential phasing includes:

1. Construct ramp in southeast quadrant
2. Construct ramp in southwest quadrant
3. Reconstruct I-80 bridges
4. Reconstruct Middle Road
5. Construct ramps in northwest and northeast quadrants

It can be concluded, through the operational and safety analysis of the proposed improvements contained within this policy statement that the preferred Build Alternative is not expected to adversely affect existing and expected future traffic on the I-80 corridor.

Policy Statement #3 criteria has been satisfied.

2.4 FHWA Policy Statement # 4

FHWA policy statement # 4 states:

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 (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)).

2.4.1 Turning Movements and Access Control

This policy requires full-access interchanges unless one of the listed special purposes exists. The existing I-80/Middle Road interchange provides for all traffic movements and connects I-80 to an existing public roadway, Middle Road. The proposed Compressed Diamond Interchange preferred alternative also provides for all movements between I-80 and Middle Road at the ramp terminal intersections. Further, the Compressed Diamond Interchange is a familiar design, consistent with the expectations of motorists on exit and entry points at an Interstate interchange.

The Iowa DOT will require access control a minimum of 600 feet from the diagonal ramp intersection point with Middle Road, extending away from I-80. Deviations from this will require approval from the FHWA.

A shared driveway to an existing homestead and abandoned commercial property is located approximately 325 feet north of the existing westbound I-80 ramp terminal intersection. This equates to approximately 500-feet of separation based on the proposed compressed diamond configuration. The separation is permissible for an existing access, but should be relocated to a minimum separation of 600 feet upon redevelopment.

2.4.2 Design Standards

The proposed geometry of the preferred alternative will meet Iowa DOT and AASHTO design criteria. The concept will be further evaluated during the final design process.

No design exceptions are anticipated and there are no provisions for special purpose access.

2.4.3 Policy Statement #4 Summary

The proposed improvements to the I-80/Middle Road interchange will provide for all traffic movements and will be designed to meet or exceed current design standards.

Policy Statement #4 criteria has been satisfied.

2.5 FHWA Policy Statement # 5

FHWA policy statement # 5 states:

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 in 23 CFR part 450, and the transportation conformity requirements of 40 CFR parts 51 and 93.

The fifth policy statement asks about the consistency between the proposed interchange improvements and transportation/land use changes planned by the local governments in the area. The City of Bettendorf is the local governmental planning agency with jurisdiction in the study area, which is a member of the Bi-State Regional Commission. The proposed improvements are completely within the city of Bettendorf's jurisdiction and the proposed interchange reconstruction is part of the Bi-State Regional Commission's 2040 Quad Cities Long Range Transportation Plan. In addition, the City and Bi-State Regional Commission have allocated funds in the Metropolitan Transportation Improvement Program for this project.

2.5.1 Planning Consistency

The City of Bettendorf has documented the planning process and future land use of the interchange area within their latest Comprehensive Plan. Within the plan, they developed an I-80/Middle Road Sub-Area Plan, where they discuss the location and background of the sub-area, identify future land use, the purpose of the sub-area plan, development standards and recommended actions. The I-80 Middle Road Sub-Area Land Use Map, from the City of Bettendorf Comprehensive Plan, is provided in **Appendix A**.

The City of Bettendorf worked with the Bi-State Regional Commission to include the I-80/Middle Road sub-area future land use plan in the latest 2040 Quad Cities LRTP (provided in **Appendix A**) and 2040 travel demand model. In addition to the sub-area plan, the 2040 Quad Cities LRTP and 2040 travel demand model accounts for the continued northward growth of Bettendorf towards the I-80 corridor. The proposed development, planned for by the City of Bettendorf, has been included within the identification of transportation needs and development of projects within the 2040 Quad Cities LRTP.

Both the City of Bettendorf Comprehensive Plan and Bi-State Regional Commission includes improvements the I-80/Middle Road interchange and the Middle Road corridor through the study area. Within the 2040 Quad Cities LRTP, the Middle Road projects within the study area include:

- Interchange upgrade to I-80 and Middle Road interchange (IJR in TIP FFY11-14; construction in 2021-2040 timeframe)
- 4-lane reconstruction of Middle Road between Forest Grove Drive and Indiana Avenue (2021-2040 timeframe)
- 4-lane reconstruction of Middle Road between Crow Creek Road and Forest Grove Drive (2021-2040 timeframe)

The Quad Cities Metropolitan Planning Area Transportation Policy Committee approved a request to include the proposed I-80/Middle Road interchange project (ID No. IA-16, Interstate 80 (Middle Road EB Entrance Ramp)), for federal fiscal year 2019 funding in the Quad Cities Transportation Improvement Program. The February 24, 2014, committee meeting minutes, from which the approval was granted, are included in **Appendix J**. The Bi-State Regional Commission formally updates their Transportation Improvement Plan each year in October and will include the aforementioned I-80/Middle Road Interchange project in the 2014 update.

2.5.2 Other Planned Improvements

As the City of Bettendorf continues to expand northward, significant improvements to the local roadway network are planned. The projects along arterial and collector roadways, and some local streets, are identified in the 2040 Quad Cities LRTP. These projects will continue to upgrade the local system, as well as improve network connectivity and provide improved access to the I-80/Middle Road interchange area.

The following projects have been identified in the 2040 Quad Cities LRTP (also shown in **Figure 2.1-2**):

Indiana Avenue

- Roundabout at the intersection of Indiana Avenue and Middle Road (2021-2040 timeframe)
- 2-lane reconstruction of Indiana Avenue between Barr Road and Middle Road (2021-2040 timeframe)
- 2-lane reconstruction of Indiana Avenue between Middle Road and Wells Ferry Road (2021-2040 timeframe)

Forest Grove Drive

- 4-lane reconstruction of Forest Grove Drive between Devils Glen Road and Middle Road (2021-2040 timeframe)
- Above project is part of Forest Grove Drive corridor reconstruction. Other Forest Grove Drive projects identified include West City Limits to Eagle Ridge Road

(TIP FY2012; LRTP 2011-2020 timeframe) and Eagle Ridge Road to Devils Glen Road (2011-2020 timeframe)

Hopewell Avenue
- 2-lane reconstruction of Hopewell Avenue between Middle Road and Criswell Street (2011-2020 timeframe)

Tanglefoot Lane
- 4-lane new construction of Tanglefoot Lane between Middle Road and Valley Drive (2021-2040 timeframe)
- New construction (number of lanes to be determined) of Tanglefoot Lane between Valley Drive and U.S. Highway 67 (2021-2040 timeframe)

Utica Ridge Road
- 4-lane widening of Utica Ridge Road between 53rd Street and Forest Grove Drive (2021-2040 timeframe

Criswell Street
- 4-lane reconstruction of Criswell Street between Forest Grove Drive and Valley Street (2021-2040 timeframe)
- 4-lane new construction of Criswell Street between Valley Drive and U.S. Highway 67 (2011-2020 timeframe)

The 2040 Quad Cities LRTP also identifies several illustrative projects. These are projects that do not have established funding or identified timeframe. Illustrative projects identified in the plan include:
- I-80 reconstruction – feasibility study
- I-80 new interchange (near 257th Avenue) – feasibility study
- I-80/I-74 reconstruction with access to the north – feasibility study
- East Mississippi River Bridge (east of I-74 between Bettendorf and East Moline) – feasibility study

Recent projects in the area include capacity and safety improvements at the following locations:
53rd Avenue
- Reconstruction to urban 2-lane roadway with grading for additional lanes when warranted by capacity between Devils Glen Road and Middle Road.
- Intersection with Middle Road reconstructed to single-lane roundabout with capacity for dual-lane roundabout as approach lanes are added.

Tanglefoot Lane
- Reconstruction to urban 2-lane roadway with grading for additional lanes when warranted by capacity west of Middle Road
- Intersection with Middle Road reconstructed to ultimate build-out configuration

Interstate 74

- I-74 'Major Project' consists of capacity improvement projects along the I-74 corridor that includes reconstructing interchanges, adding a third through lane in each direction, and reconstructing the bridge across the Mississippi River. The first project, or phase, began prior to 2011.

Middle Road

- Reconstruction of Middle Road Bridge over Crow Creek to urban 4-lane cross-section
- Reconstruction of Middle Road south of Crow Creek Intersection to 3-lane urban roadway, with curb and gutter along east side. Section graded for additional fourth lane on west side.
- Pedestrian trail constructed along east side of Middle Road south of 53rd Avenue into Bettendorf

2.5.3 Policy Statement #5 Summary

The proposed improvements to the I-80/Middle Road interchange are consistent with planning efforts undertaken and documented by the Bi-State Regional Commission and City of Bettendorf. The City of Bettendorf created a Sub-Area Plan of developable lands around the interchange, provided in their Comprehensive Plan. The city worked with the Bi-State Regional Commission to incorporate the Sub-Area Plan into the MPO's 2040 travel demand model and 2040 Quad Cities LRTP.

Other projects on the local network within and around the study area have also been identified through the 2040 Quad Cities LRTP. These projects, in conjunction with the proposed improvements along Middle Road and the I-80/Middle Road interchange, are part of the capacity improvements in northern Bettendorf to accommodate future development.

In addition, the City and Bi-State Regional Commission have allocated funds for an I-80/Middle Road interchange project in the Quad Cities Transportation Improvement Program for this project in federal fiscal year 2019.

Policy Statement #5 criteria has been satisfied.

2.6 FHWA Policy Statement # 6

FHWA policy statement # 6 states:

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 (23 U.S.C. 109(d), 23 CFR 625.2(a), 655.603(d), and 771.111).

This policy statement asks if the improvements proposed as part of this IJR were analyzed at the same time as part of a larger system of improvements expected to occur at adjacent interchanges or roadways that could influence the travel patterns at the subject interchange.

There are currently no planned interchange addition projects between the study area interchanges of I-80/I-74 to the west and I-80/U.S. Highway 67 to the east.

2.6.1 System Analysis

The I-80/Middle Road service interchange is located approximately 3 miles east of the I-80/I-74 systems interchange and 5 miles west of the I-80/U.S. Highway 67 service interchange. These distances meet recommended 1.0 mile minimum separation between interchanges in urban areas (*AASHTO 2004*). Eastbound and westbound I-80 rest areas are located west of Middle Road. The westbound rest area off-ramp is located approximately 2,740 feet from the preferred alternative westbound on-ramp. This is greater than the recommended minimum ramp separation of 1,600 feet (*AASHTO 2004*).

The 2040 Quad Cities LRTP identifies two projects within the study area as illustrative projects:

- Improvements to existing I-80/I-74 systems interchange with consideration to access to the north – feasibility study (3 miles west of Middle Road interchange)
- New interchange along I-80 near 257th Avenue – feasibility study (approximately 3 miles east of Middle Road interchange)

If constructed, these projects would likely affect traffic operations along I-80. However, as these projects have not been studied, do not have funding identified for study, and they are not programmed as a future project, they were not considered in this analysis. Both illustrative projects, if carried forward to an Interchange Justification Report, would be required to consider the current Middle Road interchange configuration in the traffic operations analysis.

2.6.2 Policy Statement #6 Summary

Middle Road is an existing, established interchange with no planned interchanges between Middle Road and the adjacent interchanges. The 2040 Quad Cities LRTP identifies several illustrative projects, one at the existing adjacent I-80/I-74 interchange and one new interchange near 257th Avenue, approximately 3 miles east of Middle Road. Since the implementation of these illustrative projects are uncertain and the proposed I-80/Middle Road access changes are to an existing, established interchange, a comprehensive corridor or network study is not required as part of this access modification request. Should the potential interchange projects come forward, they would need to consider the Middle Road interchange as an existing feature to incorporate into that future study.

Policy Statement #6 criteria has been satisfied.

2.7 FHWA Policy Statement # 7

FHWA policy statement # 7 states:

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 (23 CFR 625.2(a) and 655.603(d)). 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 (23 CFR 625.2(a) and 655.603(d)).

Policy Statement # 7 asks whether the interchange improvements proposed for the I-80/Middle Road interchange are dependent on improvements to the local transportation system that should be coordinated with the interchange improvements.

2.7.1 Local System Improvements

The rural area surrounding the I-80/Middle Road interchange, particularly to the south, is established with a roadway grid network, providing several connections between Middle Road and local cross-streets. Many of these roadways reflect a rural cross-section, with roadside ditches and no or turf shoulder. However, as the City of Bettendorf continues to grow northward, it is planned that these roadways will be improved to urban cross-sections with accommodation of increased vehicular capacity, curb and gutter, and pedestrian facilities, among other improvements. These improvements include Middle Road through the study area and the adjacent intersections with Indiana Avenue and Forest Grove Drive.

The City of Bettendorf and Bi-State Regional Commission are planning for this development, identifying a multitude of projects in the area within the 2040 Quad Cities LRTP. Existing roadway conditions of the arterial/collector roadway network and proposed improvements outlined in the LRTP have been discussed throughout this IJR document. These improvements will benefit roadway connectivity, increase capacity and traffic operations, and help distribute traffic between the City of Bettendorf and I-80.

The City of Bettendorf Comprehensive Plan outlined a Sub-Area Plan for the I-80/Middle Road interchange area. This plan included a detailed land use plan for the area surrounding the interchange and extending south along Middle Road. In order to facilitate this planned growth, roadway improvements will be necessary within the development to provide connections to collector and arterial roadways.

The collector and arterial roadways are established within the area. Indiana Avenue and Forest Grove Drive provide east-west parallel routes to I-80 to distribute trips on the local network along the corridor. Both provide connections to Middle Road, the north-south corridor through the study area. Middle Road provides key connections throughout Bettendorf and eventually connects to I-74.

Improvements to the I-80/Middle Road interchange are not dependent on these improvements to the local network. Local network connectivity is already in place and provides trip distribution in all directions from the interchange. It is anticipated that the proposed Middle Road interchange improvements will tie into the existing infrastructure at logical locations in order to meet design and operations criteria. It should be noted that the geometric improvement to current design standards for the existing I-80/Middle Road interchange necessitate reconstruction of the interchange, which can occur independent of local network improvements.

2.7.2 Local Agency Commitment

In April 2009 the City of Bettendorf purchased approximately 23 acres of land located in the NE quadrant of the Middle Road and I-80 Interchange. The City plans to develop this land into an office/research campus as described in the City of Bettendorf 2000 Comprehensive Plan. A sanitary sewer through this proposed development area is planned with construction to occur in 2013-2015 as described in the City's 2011-2017 Capital Improvement Plan. The City anticipates the Middle Road interchange area to eventually develop in all four quadrants. Additional local roads and infrastructure are included in the development plans to support the forecasted traffic generated from this development. The existing roadway network and future roads that are constructed as part of the development will continue to deliver traffic to and from the existing interchange. Construction of future roadways into the development areas would not impact interchange operations because the adjacent intersections are located far enough away from the interchange.

2.7.3 Policy Statement #7 Summary

Transportation improvements have been developed through extensive planning efforts by both the City of Bettendorf and the Bi-State Regional Commission in the development of a I-80/Middle Road Sub-Area Plan, 2040 Quad Cities LRTP, and the 2040 Quad Cities LRTP. Transportation improvements have been identified in the 2040 Quad Cities LRTP within and around the IJR study area. All projects were developed to address the continued northward growth of the City of Bettendorf and the associated increased travel demand on the local network.

The City of Bettendorf has begun the development process of developing land in the northeast quadrant of the interchange. This proposed development includes the commitment to construct sanitary sewer service through the study area, facilitating additional development in the other quadrants. Improvements to the local roadway network would benefit the collection and dispersion of traffic, providing alternative routes parallel to and across I-80.

Policy Statement #7 criteria has been satisfied.

2.8 FHWA Policy Statement # 8

FHWA policy statement # 8 states:

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 the environmental processing (23 CFR 771.111).

A Categorical Exclusion (CE) is currently being developed for the proposed reconstruction of the I-80/Middle Road interchange.

2.8.1 Environmental Process

Acceptance of the IJR, based upon the preliminary engineering concepts and general corridor location discussed in the IJR, will not foreclose opportunities to avoid, minimize or mitigate impacts identified in the NEPA document. The NEPA document is being prepared concurrently with this IJR and is expected to be approved by Iowa DOT/FHWA in the spring of 2014. This document will be the basis for approval of a selected location alternative.

The project was classified as a Categorical Exclusion in March 2006 by FHWA. Key environmental resources include the following:

- A wetland delineation was conducted in November 2009. Approximately 5.2 acres of wetland were determined to be jurisdictional by the U.S. Army Corps of Engineers. The proposed bridge in the NW quadrant would impact 0.3 acres of wetlands plus the potential of additional 0.2 acres of temporary construction impacts to wetlands.
- Spencer Creek's 100 year floodplain and floodway would be impacted by the proposed project. The proposed interchange would impact approximately 0.6 acres of 100 year floodplain and 0.2 acres of floodway. The proposed bridge in the NW quadrant would have one or two piers located in the floodway which will require floodway mitigation.
- Cultural resources were evaluated in March 2008. Three archeological sites and two historic properties were found within the study area but determined to not be eligible for the National Register of Historic Places. The Iowa Historic Preservation Office concurred with the findings in May 2008.
- Hidden Hills Golf Course is located in the NW quadrant of the project study area. The golf course is privately owned and operated and is not considered a Section 4(f) resource.

Of these, the impacts to the floodway, floodplain, and wetlands have the greatest influence on the configuration of the interchange. The NEPA document will evaluate the potential impacts the proposed interchange project would have on environmental resources in more detail.

2.8.2 Policy Statement #8 Summary

The proposed improvements project to the I-80/Middle Road interchange was classified as a Categorical Exclusion in March 2006 by FHWA. The document is being prepared concurrently with this IJR and will be the basis for approval of a selected location alternative. Key environmental resources include existing wetlands within the study area and Spencer Creek's 100 year floodplain and floodway. Three archeological sites and two historic properties have been evaluated were found, but determined to not be eligible for the National Register of Historic Places. A privately owned golf course in the northwest quadrant of the, Hidden Hills Golf Course, is not considered a Section 4(f) resource.

Policy Statement #8 criteria has been satisfied.

3 Conclusions and Recommendations

The City of Bettendorf and Bi-State Regional Commission have identified feasible roadway improvements along, to both the north and south of, the I-80 corridor to address future development and continued northward growth of Bettendorf. These improvements, typically consisting of rural to urban cross-section reconstruction, have been incorporated by the Bi-State Regional Commission 2040 travel demand model and 2040 Quad Cities LRTP, as discussed in Policy Statement #1.

Improvements to the Middle Road corridor have been identified within the 2040 Quad Cities LRTP, which includes reconstructing Middle Road from a rural 2-lane cross-section to an urban 4-lane cross-section northward through the I-80/Middle Road interchange. Middle Road runs through the center of Bettendorf, connecting I-80 to the city center, with several urban arterial and collector connections throughout Bettendorf. The I-80/Middle Road interchange is also included within these improvements, as the interchange is expected to be an important component to a northern gateway from I-80 into Bettendorf.

A review of the existing I-80/Middle Road interchange identified several design geometrics that do not meet current design standards or recommended minimum criteria. A summary of these locations is as follows:

- I-80 bridges over Middle Road considered Functionally Obsolete
- Clear distance on bridge deck less than recommended for existing bridges and less than current design standard for new bridge.
- Vertical clearance between Middle Road and I-80 bridges less than current design standard.
- Lateral clear distance from edge of Middle Road travel way and bridge piers does not meet current design standard.
- Middle Road clear distance between piers does not accommodate proposed improvements
- Loop ramp radius at merge location less than recommended minimum.
- Loop ramp horizontal curve length at merge location less than recommended minimum.
- Acceleration lane shorter than current design standard.
- Horizontal curve shorter than recommended minimum.
- Non-recoverable foreslopes of 2.5:1 to 3:1 are present throughout the interchange

A review of the existing crash data between 2008 and 2012 identifies an I-80/Middle Road interchange crash rate similar to that of other similar intersections within Iowa. Thirty (30) of the 54 crashes occurred within areas identified to be impacted by a merge or diverge location. While the existing interchange does not exhibit a crash rate that varies from the statewide average, there are segments within the interchange that can be improved to current design standards with the expectation that safety will be improved.

Traffic operations of the I-80 study area corridor under the No-Build conditions exhibit acceptable operations with regards to HCM methodology. The existing ramp terminal intersections fail as stop-controlled intersections with 2040 traffic volumes and warrant future improvements to meet projected traffic growth.

Eight build alternatives were developed for evaluation on the ability to update geometrics to current design standards and improve traffic operations to stated LOS goals. The Build alternatives, along with the No-Build conditions, were evaluated against several criteria, including but not limited to: traffic operations, design standards, expandability, safety, environmental impacts, bridge area, ROW impacts, avoidance of an existing homestead, project cost, and others. All Build alternatives provided the geometric ability to widen I-80 to a 6-lane cross-section in the future.

Forecasted 2040 traffic volumes were utilized to analyze traffic operations of the No-Build condition and eight Build alternatives. All Build alternatives provided adequate traffic operations based on these forecasted volumes. A 2040 Sub-Area Scenario was developed to analyze the ability for each alternative to accommodate additional carrying capacity beyond the 2040 planning year. With regards to I-80/Middle Road interchange operations, the existing interchange layout, even if improved to the Reconstruct Existing Interchange layout, demonstrated that it would not meet the long-range traffic operation goals based on the Sub-Area analysis.

The Compressed Diamond Interchange Build alternative was identified as the preferred alternative. While multiple alternatives contained design features that were advantageous towards their selection of a preferred alternative, the Compressed Diamond Interchange provided cumulative benefits across all evaluation criteria. Several of the key considerations and benefits of the Compressed Diamond Interchange configuration included:

- Met traffic operations goals
- Provided expandability through adding dual left-turn lanes along Middle Road or conversion to a DDI
- Met geometric design standards criteria
- Minimized impacts to Spencer Creek
- Avoided the homestead in the northwest quadrant
- Minimized ROW needs and project cost

The proposed Compressed Diamond Interchange preferred alternative consists of diagonal ramps in each of the four quadrants, with ramp terminal intersection separation of approximately 750 feet. Each ramp terminal intersection will be designed to accommodate future signalization and Middle Road dual left-turn lanes when warranted by traffic volumes. The Middle Road typical section incorporates two lanes in each direction separated by a raised median, with a 10-foot trail on the west side and a 5-foot sidewalk on the east side to accommodate pedestrian travel.

The two existing I-80 bridges are currently considered functionally obsolete and will be reconstructed in order to update them to current design standards. Further, the bridge will accommodate traffic demand and the proposed Middle Road cross-section through the interchange. In order to accommodate minimum bridge clearance between Middle Road and I-80 bridges, the I-80 profile will need to be raised for approximately 3,700 feet.

The Compressed Diamond Interchange alternative was evaluated for phased construction. One potential phasing scheme includes, but not limited to:

1. Construct ramp in southeast quadrant
2. Construct ramp in southwest quadrant
3. Reconstruct I-80 bridges
4. Reconstruct Middle Road
5. Construct ramps in northwest and northeast quadrants

This phasing sequence follows the series of events that needs to be completed prior to the next phase, primarily due to shifts in I-80 and Middle Road profile and width constraints of the existing I-80 bridges. Because the Middle Road profile is proposed to remain similar to existing south of I-80, the ramps in the southeast and southwest quadrants can be constructed first without other improvements in the study area. The ramp in the southeast quadrant may also be constructed as a stand-alone project, accommodating northbound to eastbound movements along the new ramp and maintaining southbound to eastbound movements on the existing loop ramp.

A 2020 Opening Year traffic operations analysis was completed at the two preferred alternative ramp terminal intersections with a stop-controlled condition from the off-ramp intersection approach. The eastbound ramp terminal intersection operated at LOS B in both the AM and PM peak periods. The westbound ramp teriminal intersection operated at LOS D and C in the AM and PM peak hours, respectively. A LOS D on a stop-controlled approach requires further improvement to the traffic operations based on the LOS criteria for ramp terminal intersections. In this instance, a signalized intersection is warranted to accommodate a high left-turn volume from the off-ramp approach. The 2040 analysis indicates that a traffic signal will be warranted within the study horizon at the eastbound ramp terminal intersection and traffic growth will dictate the specific period when a signal will be warranted.

Roadway improvements to the local network are not required for the reconstruction of the I-80/Middle Road interchange. The local system currently consists of a well-connected grid network, providing several connections between Middle Road and the surrounding development. The 2040 Planning Year analysis included a signalized intersection at Middle Road and Forest Grove Drive and a roundabout at the Middle Road/Indiana Avenue intersection. It should be noted that the interchange is expected to function adequately regardless of improvements to these two adjacent street intersections because the Middle Road movements are currently free-flow and the cross-street is stop-controlled.

Pedestrian mobility needs to be maintained along Middle Road through the interchange. The proposed typical section includes a 10-foot trail on the west side of Middle Road and a 5-foot sidewalk on the east side through the study area. Alternative pedestrian facility configurations can be explored in final design, with consideration to:

- Proper approach transition grades through the interchange
- Adequate width under I-80 bridges to allow mixing of pedestrians and bikes and two-way traffic
- Security measures under I-80 bridges, i.e. lighting and/or emergency call equipment
- Security fencing between I-80 facilities and pedestrian facility

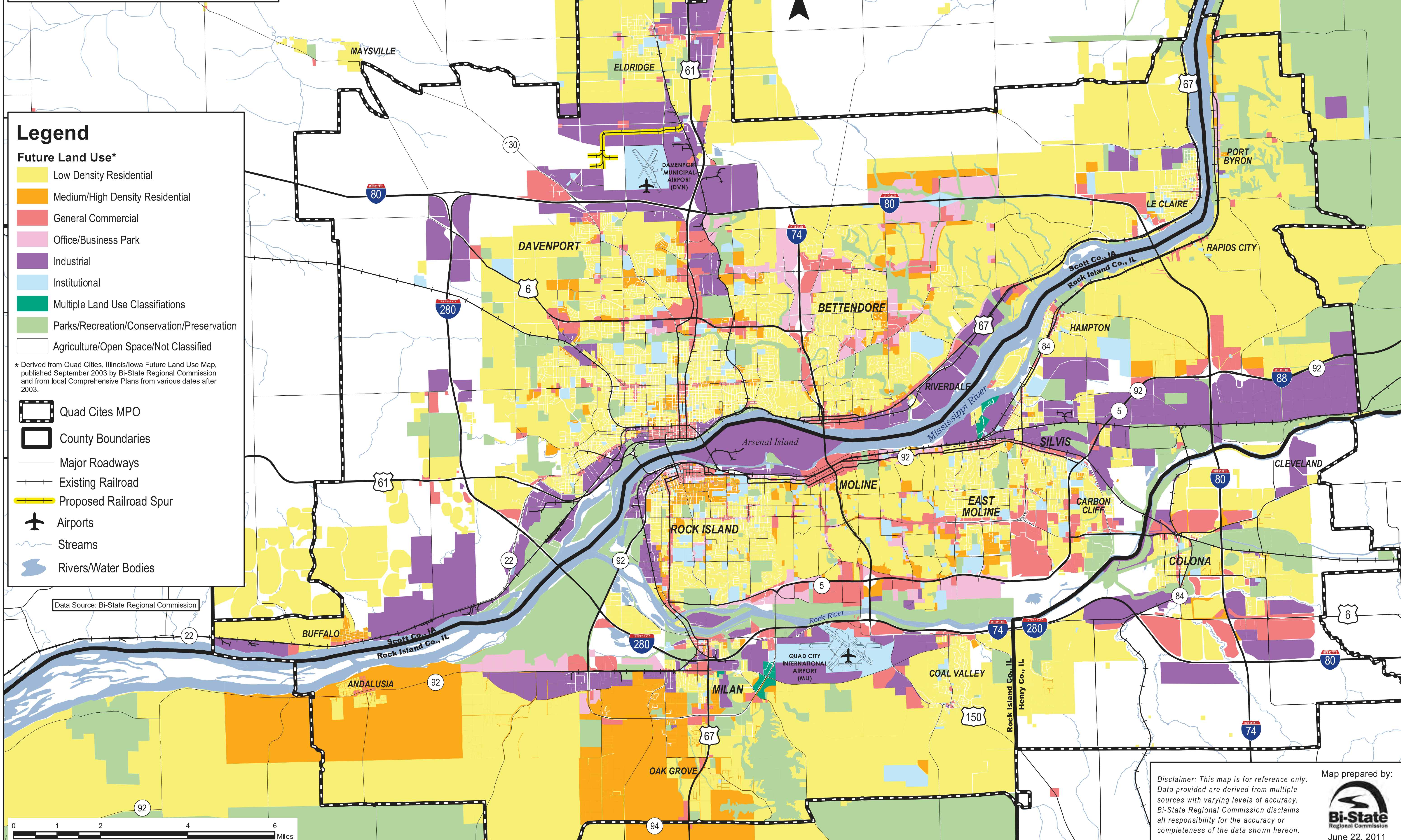
This Interchange Justification Report documents the results of analysis, studies and local planning efforts, which have established the needs for the interchange improvements. The analysis contained herein demonstrates that the eight FHWA criteria for new or revised access to the Interstate System have been met.

The Iowa Department of Transportation requests the Federal Highway Administration approve the proposed improvements at the I-80 and Middle Road interchange in Bettendorf, Iowa, for engineering and operational acceptance.

Appendix A: Supporting Planning Documents

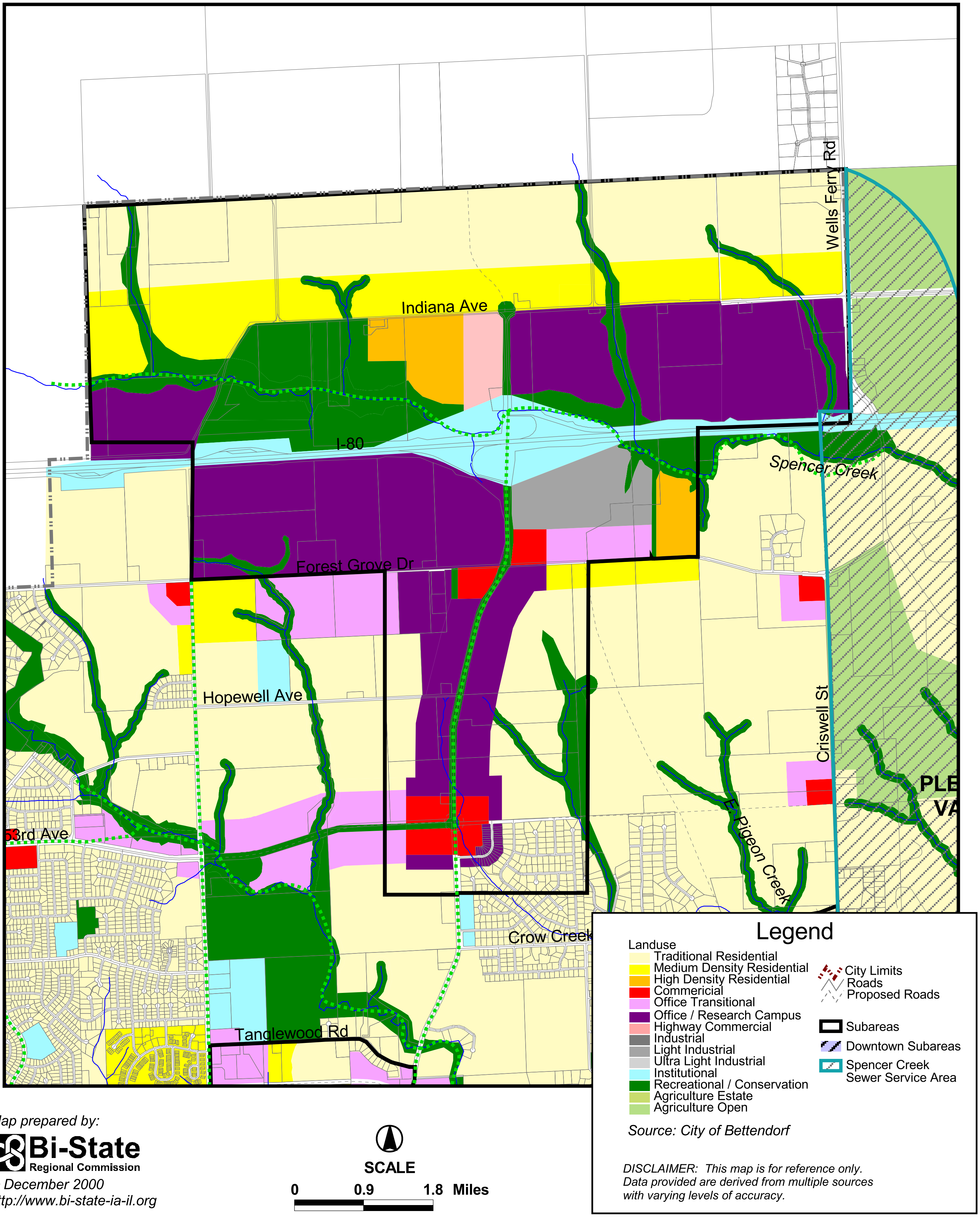
Appendix A: Supporting Planning Documents

MAP 3.6
Quad Cities Long Range Transportation Plan
Future Land Use



MAP 24

Bettendorf, Iowa
I-80 Middle Rd. Subarea Land Use



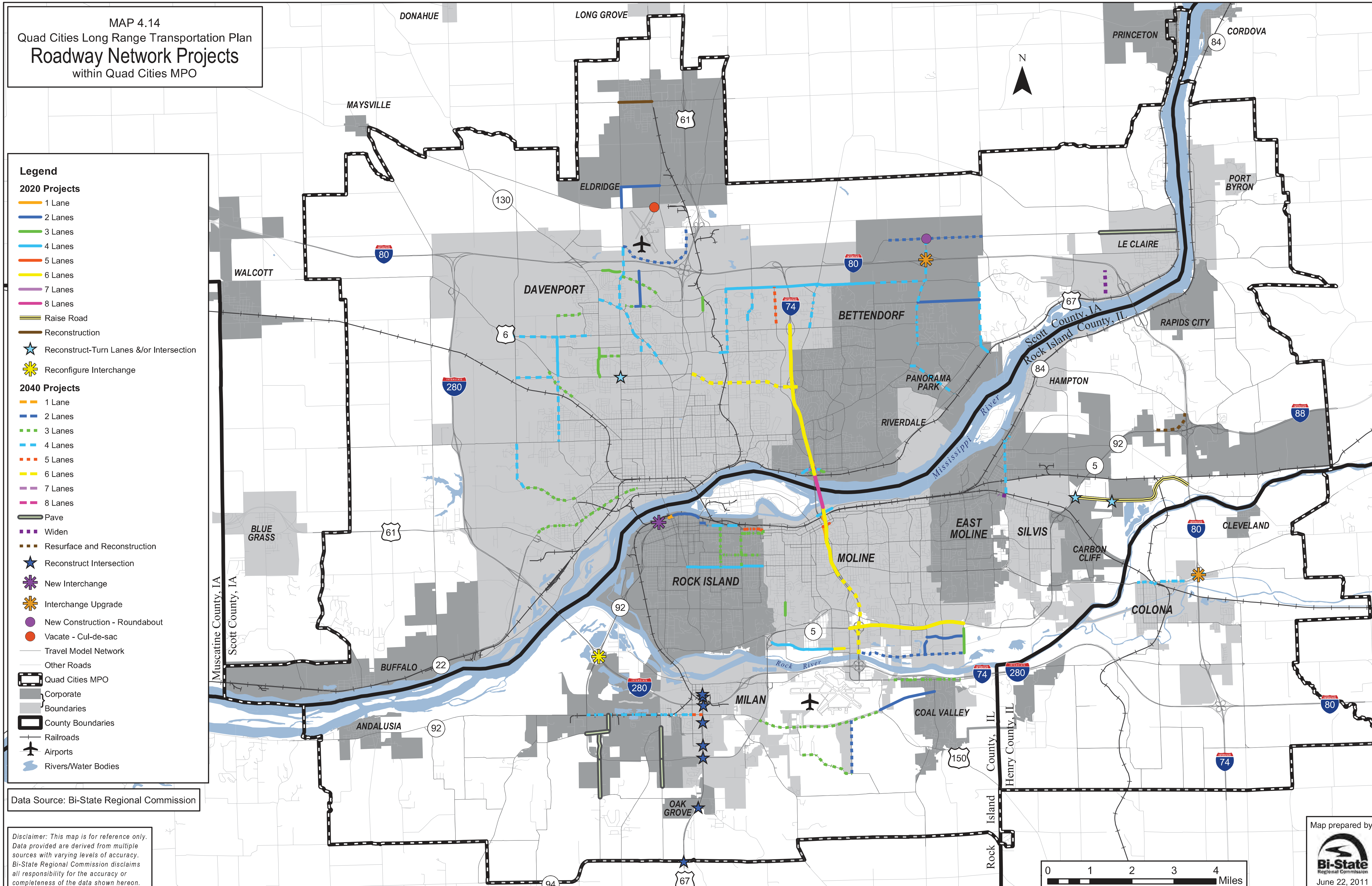
Map prepared by:

Bi-State
Regional Commission

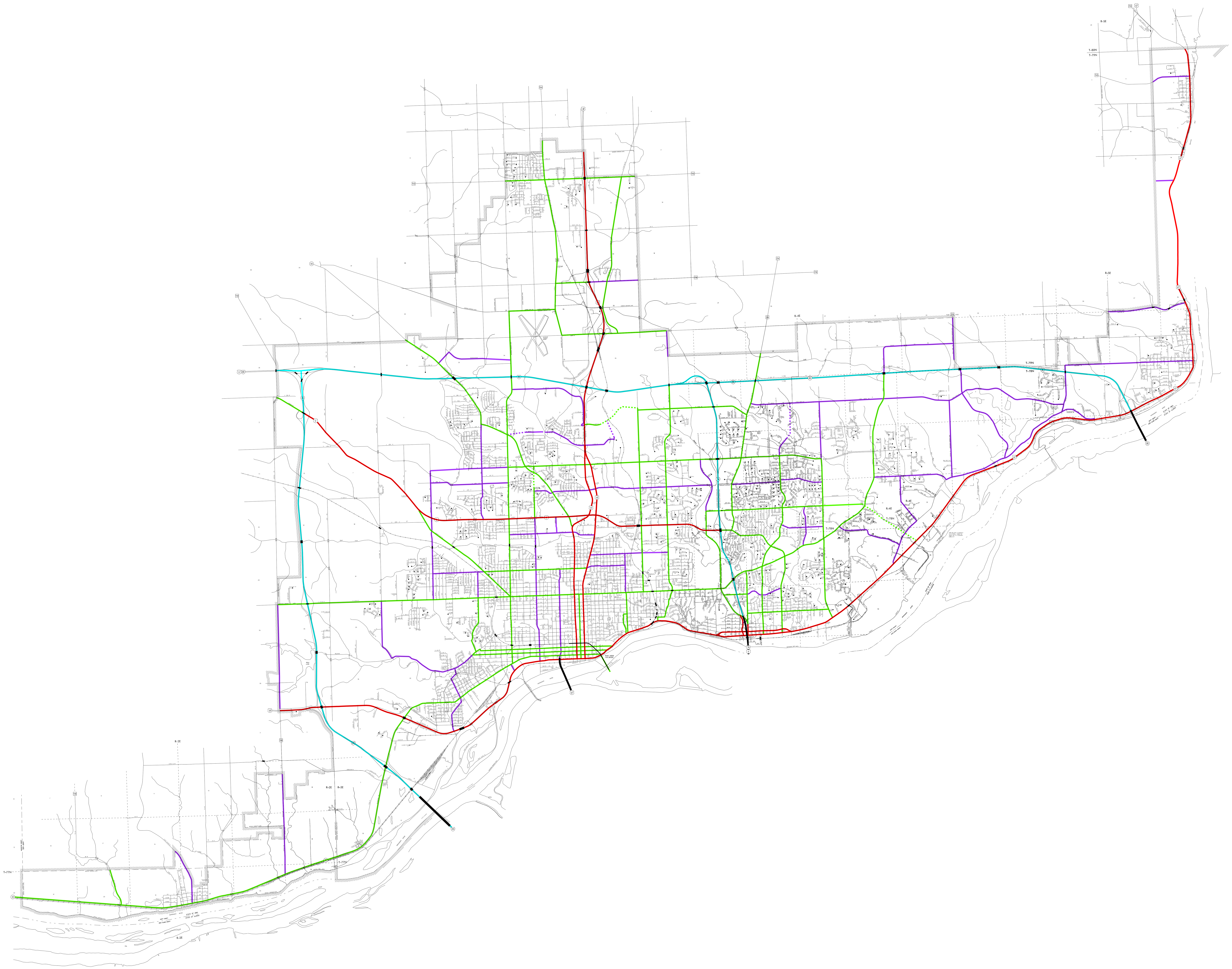
http://www.bi-state-ia-il.org

SCALE

0 0.9 1.8 Miles



MAP 4.14
Quad Cities Long Range Transportation Plan
Roadway Network Projects
within Quad Cities MPO
Legend
2020 Projects
1 Lane
2 Lanes
3 Lanes
4 Lanes
5 Lanes
6 Lanes
7 Lanes
8 Lanes
Raise Road
Reconstruction
Reconstruct-Turn Lanes &/or Intersection
Reconfigure Interchange
2040 Projects
1 Lane
2 Lanes
3 Lanes
4 Lanes
5 Lanes
6 Lanes
7 Lanes
8 Lanes
Pave
Widen
Resurface and Reconstruction
Reconstruct Intersection
New Interchange
Interchange Upgrade
New Construction - Roundabout
Vacate - Cul-de-sac
Travel Model Network
Other Roads
Quad Cities MPO
Corporate
Boundaries
County Boundaries
Railroads
Airports
Rivers/Water Bodies
Data Source: Bi-State Regional Commission
Disclaimer: This map is for reference only. Data provided are derived from multiple sources with varying levels of accuracy. Bi-State Regional Commission disclaims all responsibility for the accuracy or completeness of the data shown hereon.
DONAHUE
LONG GROVE
MAYSVILLE
ELDRIDGE
WALCOTT
DAVENPORT
BETTENDORF
PANORAMA PARK
RIVERDALE
PRINCETON
CORDOVA
PORT BYRON
LE CLAIRE
RAPIDS CITY
HAMPTON
EAST MOLINE
SILVIS
CARBON CLIFF
CLEVELAND
COLONA
MOLINE
ROCK ISLAND
BLUE GRASS
BUFFALO
MILAN
ANDALUSIA
COAL VALLEY
OAK GROVE
Scott County, IA
Rock Island County, IL
Muscatine County, IA
Scott County, IA
Rock Island County, IL
Henry County, IL
Mississippi River
Rock River
N
0 1 2 3 4 Miles
Map prepared by:
Bi-State Regional Commission
June 22, 2011



Federal Functional Classification System
The Urban Area of

Davenport
IOWA

Prepared by
IOWA DEPARTMENT OF TRANSPORTATION
Phone (515) 239-1669
In Cooperation with
UNITED STATES DEPARTMENT OF TRANSPORTATION

December 31, 1992

Revised 04-08-10

PRODUCED WITH CADD
06-08-11
SYSTEMS PLANNING

URBAN FEDERAL FUNCTIONAL CLASSIFICATIONS

- Interstate
- Other Principal Arterial
- Minor Arterial
- Collector
- Local
- Urban Area Boundary

Future classified routes shown as dashed lines.

SCALE IN MILES

SCALE IN KILOMETERS

Appendix B: 2008-2012 Crash Data

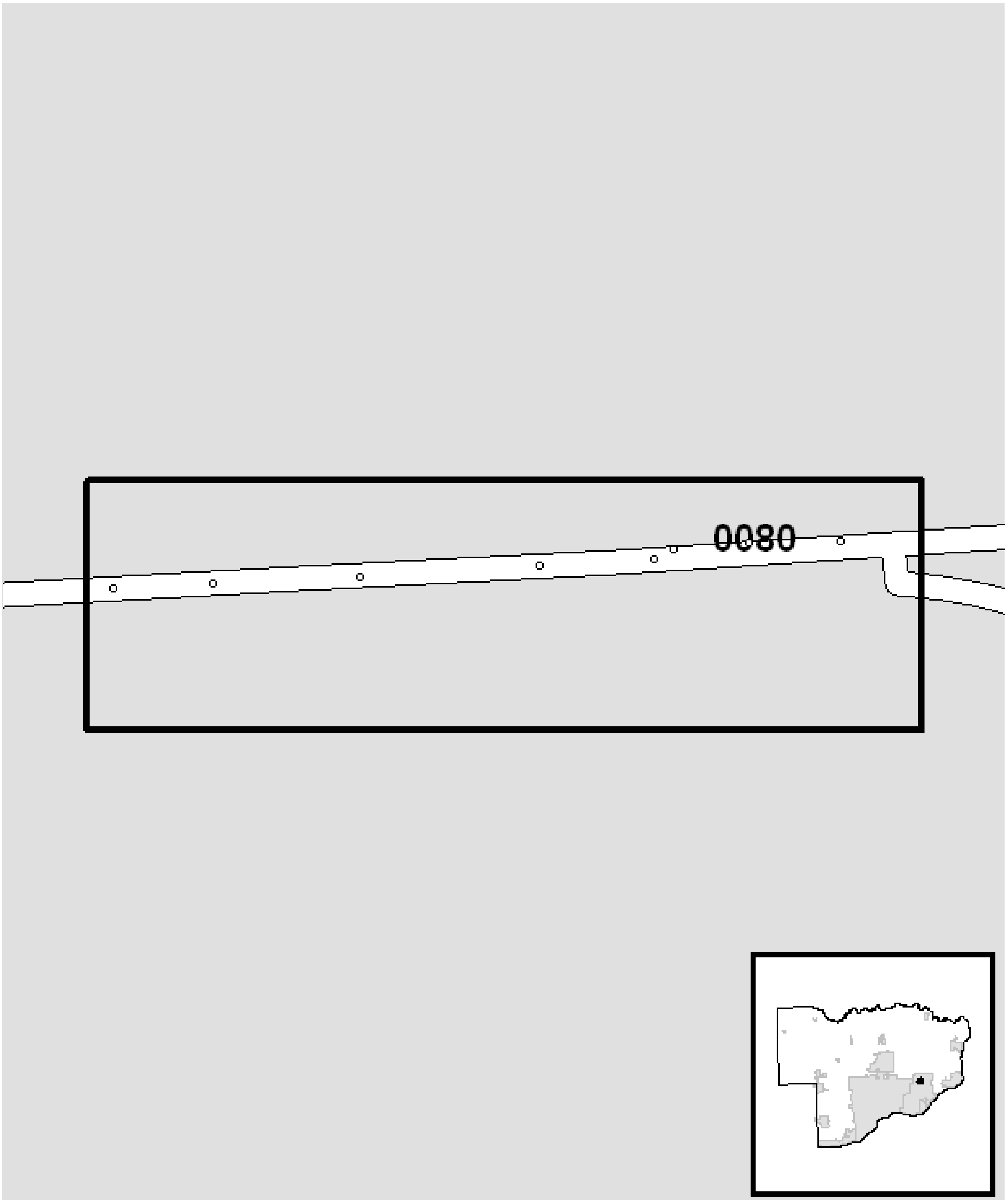
Appendix B: 2008-2012 Crash Data

Location Map

I-80/Middle Road

Incidents: 8

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: I-80 (1)

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2008483152 11/11/2008 07:00
County: 82 **City:** Bettendorf

I-80 WB

Major Cause: Animal

Roadway Type: Not reported

Severity:	PDO	**Manner of Crash:**	not reported		
Fatalities:	0	**Surface Conditions:**	not reported		
Major Injuries:	0	**Light Conditions:**	not reported		
Minor Injuries:	0	**Weather Conditions:**	not reported		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$4500	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	not reported	0	0
Veh Action:	not reported	0	0
Configuration:	Not reported	0	0
Driver Age:	33	0	0
Driver Gender:	M		
Driver Cond:	not reported	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2008473559 11/15/2008 07:51
County: 82 **City:** Bettendorf

NB/EB Interstate 0080 measuring 0.8 Miles East from Interstate 0080 (Milepost 300)

Major Cause: Followed too close

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Rear-end		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Cloudy		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$3000	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	East	0
Veh Action:	Changing lanes	Essentially straight	0
Configuration:	Sport utility vehicle	Passenger car	0
Driver Age:	25	57	0
Driver Gender:	M	F	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	Followed too close	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

2009545128 12/22/2009 20:38 I-80 EB MM 300.8
County: 82 **City:** Bettendorf

Major Cause: Ran off road - left
Roadway Type: Non-intersection: No special feature

Severity:	Fatal	**Manner of Crash:**	Rear-end
Fatalities:	1	**Surface Conditions:**	Wet
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	2	**Weather Conditions:**	Rain
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$20000

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	East	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Passenger car	4-tire light truck	0
Driver Age:	47	43	0
Driver Gender:	F	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	not reported	Other improper action	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

2011659414 11/26/2011 04:28 SB/WB Interstate 0080 measuring 4494 Feet East from Interstate 0080 (Milepost 300)
County: 82 **City:** Bettendorf

Major Cause: Ran off road - left
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	0	**Weather Conditions:**	Cloudy
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$16000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	21	0	0
Driver Gender:	F		
Driver Cond:	Asleep/fatigued/etc.	0	0
Drivr Contr 1:	Fatigued/Asleep	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Guardrail	0	0

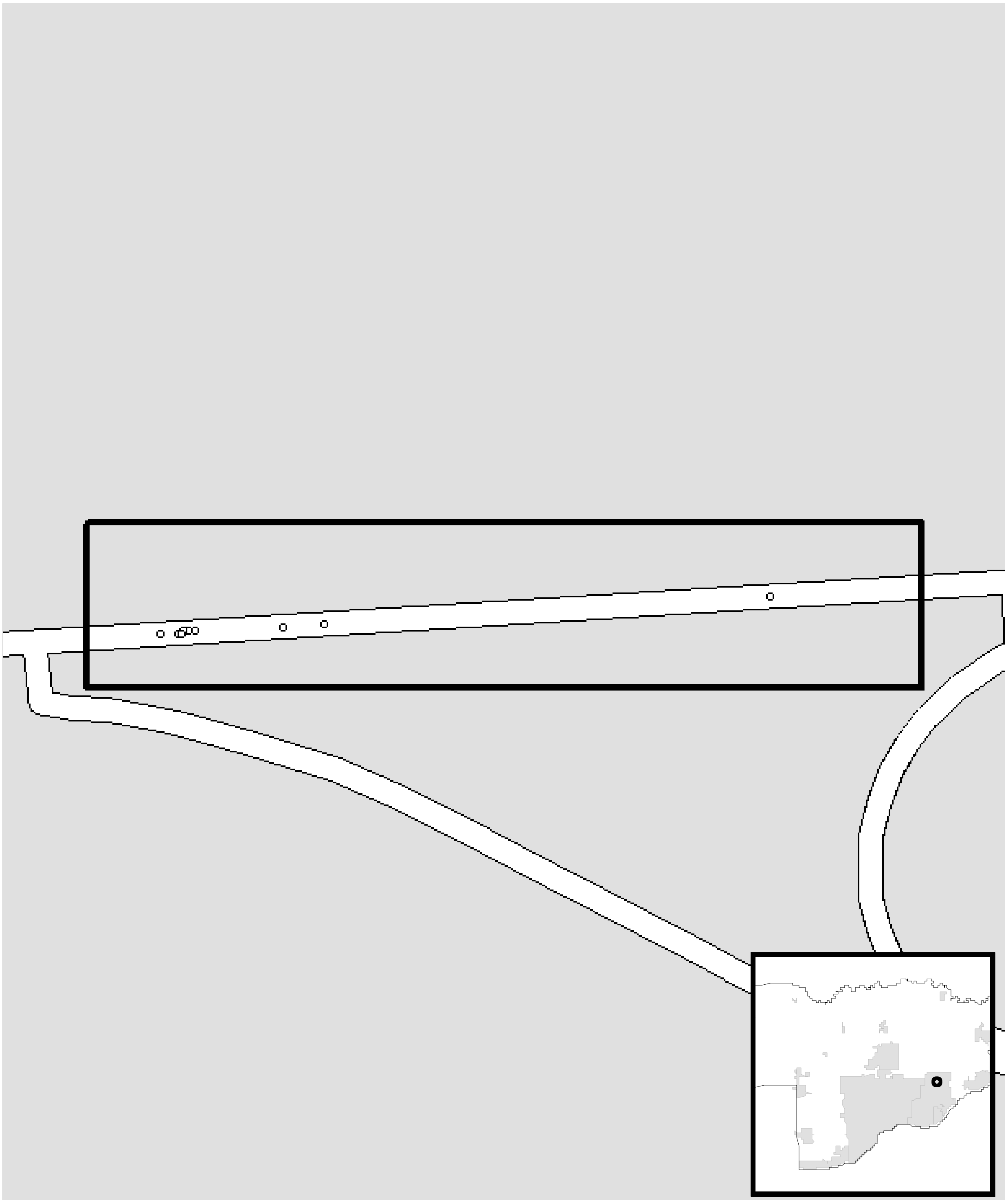
Iowa Department of Transportation

Location Map

I-80/Middle Road

Incidents: 11

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: I-80(2)

2008452994 07/11/2008 02:50
County: 82 **City:** Bettendorf

Interstate 0080 (Milepost 301) measuring 0.01 Miles East from Interstate 0080 (Milepost 301)

Major Cause: Operating in erratic/reckless/careless/aggressive manner

Roadway Type: Non-intersection: Bridge/overpass/underpass

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted		
Minor Injuries:	0	**Weather Conditions:**	Clear		
Possible Injuries:	0	**Drug/Alc Involved:**	Alcohol: Statutory		
Unknown Injuries:	0	**Property Damage:**	$3000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	34	0	0
Driver Gender:	F		
Driver Cond:	Infl by alc/drugs/meds	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	Erratic/reckless/aggrssv	0	0
Fixed Object:	Guardrail	0	0

2008481655 12/15/2008 10:49
County: 82 **City:** Bettendorf

NB/EB Interstate 0080 (Milepost 301)

Major Cause: unknown

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Ice		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Clear		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$1000	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	East	0
Veh Action:	Changing lanes	Essentially straight	0
Configuration:	Tractor/semi-trailer	4-tire light truck	0
Driver Age:	51	41	0
Driver Gender:	M	F	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	unknown	unknown	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2009487994 01/10/2009 11:10 NB/EB Interstate 0080 (Milepost 301)

County: 82 **City:** Bettendorf

Major Cause: Over correcting/over steering

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Ice		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Snow		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$2000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Tractor/semi-trailer	0	0
Driver Age:	26	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	Over correcting/steering	0	0
Fixed Object:	none	0	0

2009519047 07/26/2009 05:15 E/ I-80@301 MM

County: 82 **City:** Bettendorf

Major Cause: Other: No improper action

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Dawn		
Minor Injuries:	0	**Weather Conditions:**	Clear		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$3500	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	88	0	0
Configuration:	Passenger car	0	0
Driver Age:	unknown	0	0
Driver Gender:	NR		
Driver Cond:	Normal	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Other fixed object	0	0

2009534277 10/29/2009 06:01 NB/EB Interstate 0080 (Milepost 301)
County: 82 **City:** Bettendorf

Major Cause: Swerving/evasive action
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	0	**Weather Conditions:**	Partly cloudy
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$3000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	4-tire light truck	0	0
Driver Age:	44	0	0
Driver Gender:	F		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	Swerved to avoid	0	0
Fixed Object:	none	0	0

2010580685 06/26/2010 20:05 301 MILE-MARKER ON I-80 WB
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Not reported

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	not reported
Major Injuries:	0	**Light Conditions:**	not reported
Minor Injuries:	0	**Weather Conditions:**	not reported
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$2000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	not reported	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	21	0	0
Driver Gender:	F		
Driver Cond:	not reported	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

Iowa Department of Transportation

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2010591614 09/14/2010 20:40 I80 WB MM 301
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Not reported

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	not reported		
Major Injuries:	0	**Light Conditions:**	not reported		
Minor Injuries:	0	**Weather Conditions:**	not reported		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$3000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	not reported	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Tractor/semi-trailer	0	0
Driver Age:	48	0	0
Driver Gender:	M		
Driver Cond:	not reported	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2010607519 12/16/2010 18:35 SB/WB Interstate 0080 (Milepost 301)
County: 82 **City:** Bettendorf

Major Cause: Swerving/evasive action
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Sideswipe, same direction		
Fatalities:	0	**Surface Conditions:**	Other		
Major Injuries:	0	**Light Conditions:**	Dark - roadway lighted		
Minor Injuries:	0	**Weather Conditions:**	Snow		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$2500	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	West	0
Veh Action:	Essentially straight	unknown	0
Configuration:	Passenger car	Tractor/semi-trailer	0
Driver Age:	21	unknown	0
Driver Gender:	M	NR	
Driver Cond:	Normal	not reported	0
Drivr Contr 1:	none	unknown	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2011657497 11/10/2011 01:27 SB/WB INTERSTATE 0080 (301MM)
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Not reported

Severity:	PDO	**Manner of Crash:**	not reported		
Fatalities:	0	**Surface Conditions:**	not reported		
Major Injuries:	0	**Light Conditions:**	not reported		
Minor Injuries:	0	**Weather Conditions:**	not reported		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$2000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	38	0	0
Driver Gender:	M		
Driver Cond:	not reported	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2012674821 02/14/2012 00:59 SB/WB Interstate 0080 (Milepost 301)
County: 82 **City:** Bettendorf

Major Cause: Driving too fast for conditions
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Snow		
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted		
Minor Injuries:	0	**Weather Conditions:**	Snow		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$5500	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	4-tire light truck	0	0
Driver Age:	30	0	0
Driver Gender:	F		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Too fast for conditions	0	0
Drivr Contr 2:	Lost control	0	0
Fixed Object:	Other fixed object	0	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2012709428 10/26/2012 08:51 SB/WB Interstate 0080 (Milepost 301)

County: 82 **City:** Bettendorf

Major Cause: Lost control

Roadway Type: Non-intersection: No special feature

Severity: PDO **Manner of Crash:** Sideswipe, same direction

Fatalities: 0 **Surface Conditions:** Dry

Major Injuries: 0 **Light Conditions:** Daylight

Minor Injuries: 0 **Weather Conditions:** Clear

Possible Injuries: 0 **Drug/Alc Involved:** none indicated

Unknown Injuries: 0 **Property Damage:** $1750 **Number of Vehicles:** 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	West	0
Veh Action:	88	Essentially straight	0
Configuration:	4-tire light truck	Tractor/semi-trailer	0
Driver Age:	44	43	0
Driver Gender:	M	M	
Driver Cond:	Normal	unknown	0
Drivr Contr 1:	none	Lost control	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

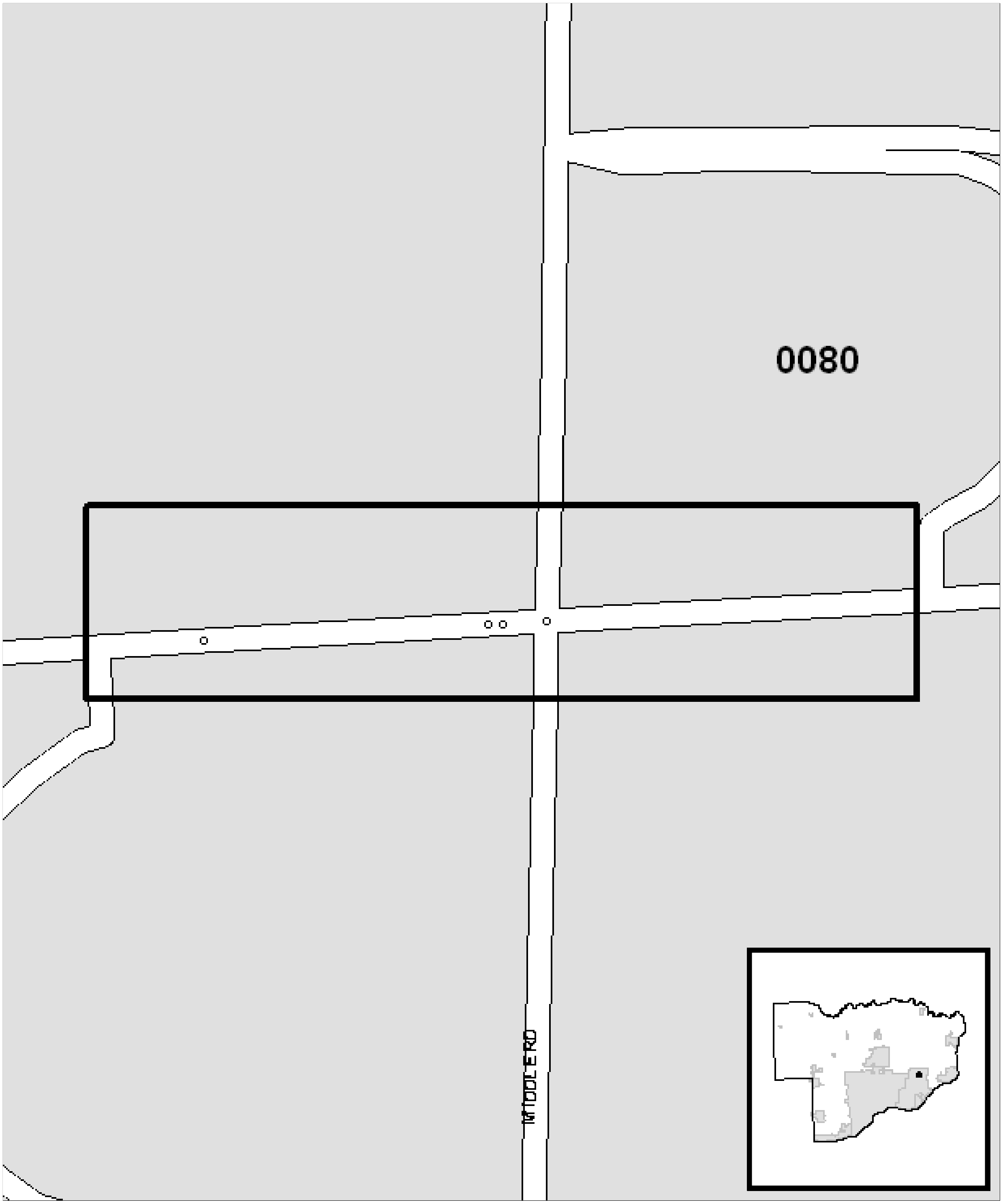
Iowa Department of Transportation

Location Map

I-80/Middle Road

Incidents: 5

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: I-80(3) and Middle Road Under I-80

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2009514135 06/29/2009 23:48
County: 82 **City:** Bettendorf

NB/EB Interstate 0080 measuring 51 Feet West from Interstate 0080 and MIDDLE RD

Major Cause: Ran off road - left

Roadway Type: Non-intersection: Bridge/overpass/underpass

Severity:	Minor	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	1	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$17563

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Sport utility vehicle	0	0
Driver Age:	60	0	0
Driver Gender:	M		
Driver Cond:	Asleep/fatigued/etc.	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Bridge/bridge	0	0

2011614581 01/18/2011 07:04
County: 82 **City:** Bettendorf

MIDDLE RD underpass of Interstate 0080

Major Cause: Driving too fast for conditions

Roadway Type: Non-intersection: Bridge/overpass/underpass

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Ice
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	0	**Weather Conditions:**	Mist
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$3401

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	4-tire light truck	0	0
Driver Age:	29	0	0
Driver Gender:	F		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Too fast for conditions	0	0
Drivr Contr 2:	Lost control	0	0
Fixed Object:	Bridge/bridge	0	0

Iowa Department of Transportation

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2012671491 01/20/2012 14:15 I80 WB MM 301
County: 82 **City:** Bettendorf

Major Cause: Ran off road - right
Roadway Type: Non-intersection: No special feature

Severity:	Minor	**Manner of Crash:**	Rear-end
Fatalities:	0	**Surface Conditions:**	Snow
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	1	**Weather Conditions:**	Snow
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$14000

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	West	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Sport utility vehicle	Tractor/semi-trailer	0
Driver Age:	25	53	0
Driver Gender:	M	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	Lost control	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

2012692393 06/27/2012 09:28 NB/EB INTERSTATE 0080, 301.4 MM
County: 82 **City:** Bettendorf

Major Cause: Ran off road - left
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	0	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$3500

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Changing lanes	0	0
Configuration:	Passenger car	0	0
Driver Age:	58	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Guardrail	0	0

Iowa Department of Transportation

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2012692599 06/28/2012 15:09
County: 82 **City:** Bettendorf

EB INTERSTATE 80 OVERPASS OF MIDDLE RD

Major Cause: Ran off road - right

Roadway Type: Non-intersection: Bridge/overpass/underpass

Severity:	Minor	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	1	**Weather Conditions:**	Clear		
Possible Injuries:	0	**Drug/Alc Involved:**	Under influence of Alc/Drugs/Meds		
Unknown Injuries:	0	**Property Damage:**	$5502	**Number of Vehicles:**	1

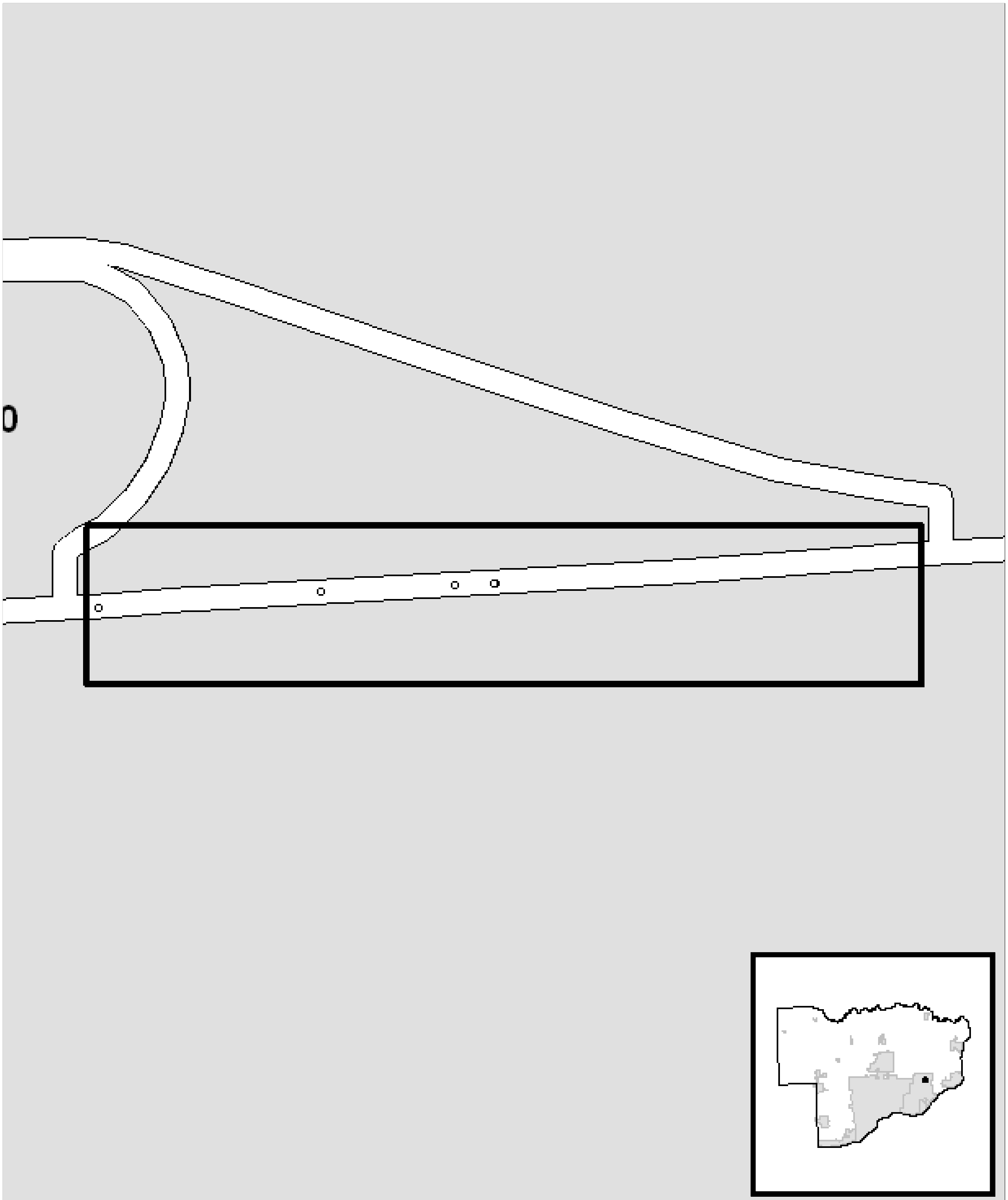
	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Van or mini-van	0	0
Driver Age:	52	0	0
Driver Gender:	F		
Driver Cond:	Infl by alc/drugs/meds	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Bridge/bridge	0	0

Incidents: 5

Location Map

I-80/Middle Road

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: I-80(4)

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2008419388 01/21/2008 16:13
County: 82 **City:** Bettendorf

NB/EB Interstate 0080 measuring 0.5 Miles East from Interstate 0080 (Milepost 301)

Major Cause: Crossed centerline

Roadway Type: Non-intersection: No special feature

Severity:	Major	**Manner of Crash:**	Head-on
Fatalities:	0	**Surface Conditions:**	Snow
Major Injuries:	1	**Light Conditions:**	Dark - roadway lighted
Minor Injuries:	0	**Weather Conditions:**	Snow
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$25311

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	East	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Tractor/semi-trailer	Tractor/semi-trailer	0
Driver Age:	61	66	0
Driver Gender:	M	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	Crossed centerline	none	0
Drivr Contr 2:	Lost control	not reported	0
Fixed Object:	none	none	0

2008420464 01/21/2008 16:13
County: 82 **City:** Bettendorf

NB/EB Interstate 0080 measuring 0.5 Miles East from Interstate 0080 (Milepost 301)

Major Cause: Swerving/evasive action

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Snow
Major Injuries:	0	**Light Conditions:**	Dark - roadway lighted
Minor Injuries:	0	**Weather Conditions:**	Snow
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$7000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	40	0	0
Driver Gender:	F		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Swerved to avoid	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Guardrail	0	0

Iowa Department of Transportation

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2010581503 07/08/2010 21:31
County: 82 **City:** Bettendorf

Interstate 0080 measuring 500 Feet East from MIDDLE RD and Interstate 0080

Major Cause: Animal

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted		
Minor Injuries:	0	**Weather Conditions:**	Partly cloudy		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$5000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Sport utility vehicle	0	0
Driver Age:	57	0	0
Driver Gender:	F		
Driver Cond:	Normal	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2010596736 10/16/2010 06:30
County: 82 **City:** Bettendorf

INTERSTATE 80 WESTBOUND AT MIDDLE RD

Major Cause: Animal

Roadway Type: Not reported

Severity:	PDO	**Manner of Crash:**	not reported		
Fatalities:	0	**Surface Conditions:**	not reported		
Major Injuries:	0	**Light Conditions:**	not reported		
Minor Injuries:	0	**Weather Conditions:**	not reported		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$5000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	not reported	0	0
Veh Action:	not reported	0	0
Configuration:	Passenger car	0	0
Driver Age:	65	0	0
Driver Gender:	F		
Driver Cond:	not reported	0	0
Drivr Contr 1:	unknown	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2011663966 12/09/2011 03:47 SB/WB Interstate 0080
County: 82 **City:** Bettendorf

Major Cause: Driving too fast for conditions
Roadway Type: Non-intersection: No special feature

Severity:	Minor	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Ice		
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted		
Minor Injuries:	1	**Weather Conditions:**	Snow		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$8000	**Number of Vehicles:**	1

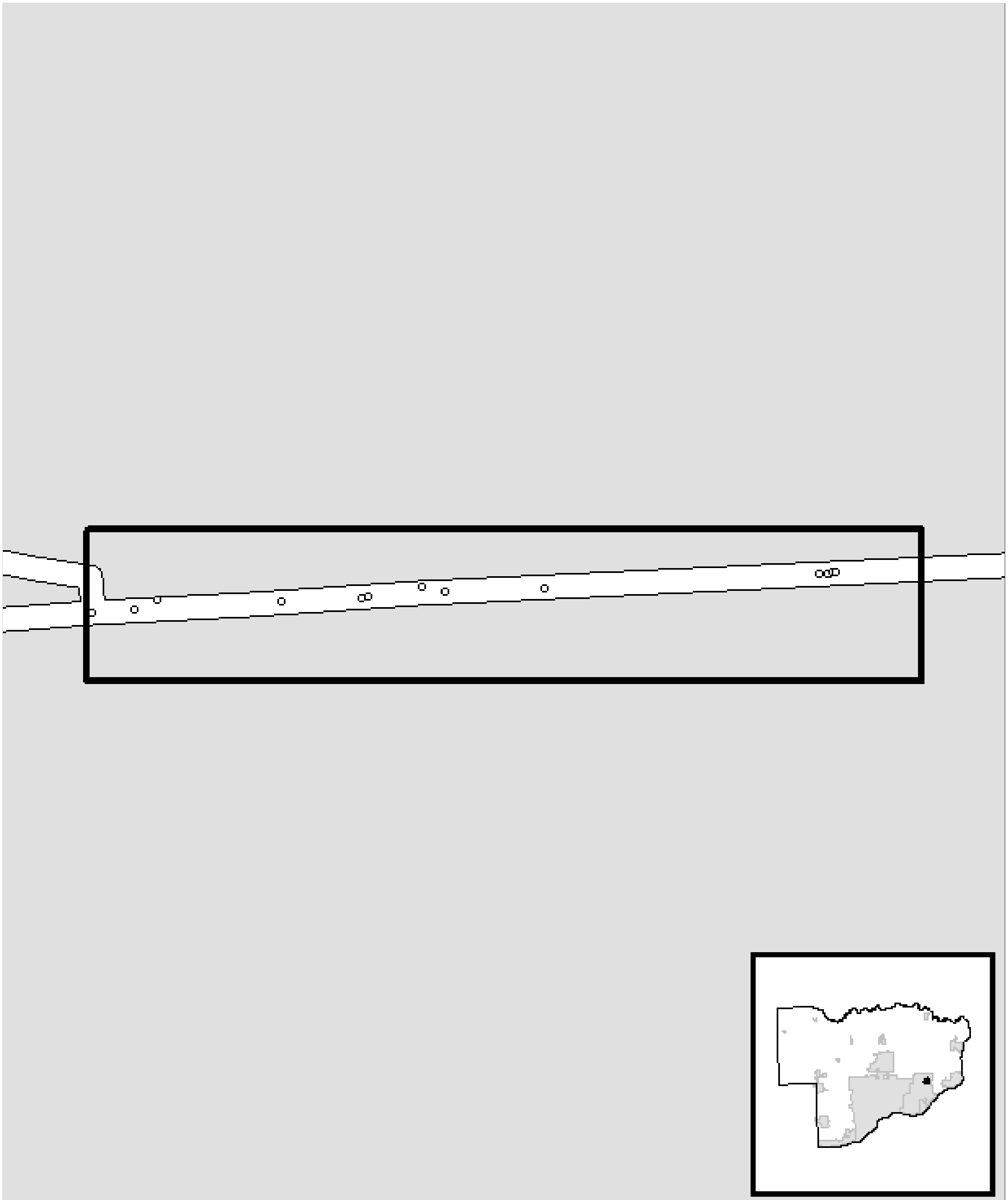
	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	4-tire light truck	0	0
Driver Age:	41	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Too fast for conditions	0	0
Drivr Contr 2:	Lost control	0	0
Fixed Object:	Ditch/embankment	0	0

Location Map

I-80/Middle Road

Incidents: 20

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: I-80(5)

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2008424570 02/01/2008 03:15 WB INTERSTATE 80 302 MILE MARKER
County: 82 **City:** Bettendorf

Major Cause: Swerving/evasive action
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Ice
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	0	**Weather Conditions:**	Blowing sand/soil/dirt/snow
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$40000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Changing lanes	0	0
Configuration:	Tractor/semi-trailer	0	0
Driver Age:	25	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2008469164 10/29/2008 19:15 SB/WB Interstate 0080 (Milepost 302)
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Not reported

Severity:	PDO	**Manner of Crash:**	not reported
Fatalities:	0	**Surface Conditions:**	not reported
Major Injuries:	0	**Light Conditions:**	not reported
Minor Injuries:	0	**Weather Conditions:**	not reported
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$3000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	not reported	0	0
Veh Action:	not reported	0	0
Configuration:	Not reported	0	0
Driver Age:	64	0	0
Driver Gender:	NR		
Driver Cond:	not reported	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2008470890 10/29/2008 05:54
County: 82 **City:** Bettendorf

Interstate 0080 (Milepost 302)

Major Cause: Animal

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	0	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$1500

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Tractor/semi-trailer	0	0
Driver Age:	47	0	0
Driver Gender:	NR		
Driver Cond:	Normal	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2008479093 12/08/2008 09:42
County: 82 **City:** Bettendorf

SB/WB Interstate 0080 measuring 0.75 Miles East from Interstate 0080 (Milepost 301)

Major Cause: Swerving/evasive action

Roadway Type: Non-intersection: No special feature

Severity:	Minor	**Manner of Crash:**	Head-on
Fatalities:	0	**Surface Conditions:**	Ice
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	1	**Weather Conditions:**	Rain
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$6000

Number of Vehicles: 3

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	not reported	West	West
Veh Action:	unknown	Essentially straight	Essentially straight
Configuration:	unknown	Passenger car	4-tire light truck
Driver Age:	unknown	36	55
Driver Gender:	NR	F	M
Driver Cond:	not reported	Normal	Normal
Drivr Contr 1:	unknown	none	none
Drivr Contr 2:	not reported	not reported	not reported
Fixed Object:	none	none	none

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2008481656 12/13/2008 14:27 SB/WB Interstate 0080
County: 82 **City:** Bettendorf

Major Cause: Ran off road - right
Roadway Type: Intersection: Off-ramp

Severity:	Minor	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	1	**Weather Conditions:**	Partly cloudy		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$35000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Tractor/semi-trailer	0	0
Driver Age:	57	0	0
Driver Gender:	M		
Driver Cond:	Other	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	Other improper action	0	0
Fixed Object:	Ditch/embankment	0	0

2008484487 12/26/2008 00:17 SB/WB Interstate 0080 (Milepost 302)
County: 82 **City:** Bettendorf

Major Cause: Driving too fast for conditions
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Ice		
Major Injuries:	0	**Light Conditions:**	Dark - roadway lighted		
Minor Injuries:	0	**Weather Conditions:**	Sleet/hail/freezing rain		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$4000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Overtaking/passing	0	0
Configuration:	Sport utility vehicle	0	0
Driver Age:	22	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Too fast for conditions	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2009536148 11/06/2009 00:05 SB/WB Interstate 0080 (Milepost 302)
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Non-intersection: No special feature

Severity: PDO **Manner of Crash:** Broadside
Fatalities: 0 **Surface Conditions:** Dry
Major Injuries: 0 **Light Conditions:** Dark - roadway not lighted
Minor Injuries: 0 **Weather Conditions:** Partly cloudy
Possible Injuries: 0 **Drug/Alc Involved:** none indicated
Unknown Injuries: 0 **Property Damage:** $4000 **Number of Vehicles:** 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	44	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2009536143 11/07/2009 19:31 NB/EB Interstate 0080 (Milepost 302)
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Non-intersection: No special feature

Severity: PDO **Manner of Crash:** Non-collision
Fatalities: 0 **Surface Conditions:** Dry
Major Injuries: 0 **Light Conditions:** Dark - roadway lighted
Minor Injuries: 0 **Weather Conditions:** Clear
Possible Injuries: 0 **Drug/Alc Involved:** none indicated
Unknown Injuries: 0 **Property Damage:** $1500 **Number of Vehicles:** 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	53	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2009548189 12/25/2009 14:52 SB/WB Interstate 0080

County: 82 **City:** Bettendorf

Major Cause: Ran off road - right

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Ice
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	0	**Weather Conditions:**	Snow
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$1500

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	44	0	0
Driver Gender:	F		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Sign post	0	0

2010607138 12/15/2010 21:30 SB/WB Interstate 0080

County: 82 **City:** Bettendorf

Major Cause: Swerving/evasive action

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Sideswipe, same direction
Fatalities:	0	**Surface Conditions:**	Snow
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	0	**Weather Conditions:**	Snow
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$4000

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	West	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Passenger car	Tractor/semi-trailer	0
Driver Age:	26	32	0
Driver Gender:	M	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	Lost control	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2011630552 05/15/2011 21:17 SB/WB Interstate 0080 (Milepost 302)
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Not reported

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	not reported
Major Injuries:	0	**Light Conditions:**	not reported
Minor Injuries:	0	**Weather Conditions:**	not reported
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$2000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	not reported	0	0
Veh Action:	Essentially straight	0	0
Configuration:	4-tire light truck	0	0
Driver Age:	38	0	0
Driver Gender:	M		
Driver Cond:	not reported	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2011633819 05/30/2011 15:05 I80 EB 302 MM
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Not reported

Severity:	PDO	**Manner of Crash:**	not reported
Fatalities:	0	**Surface Conditions:**	not reported
Major Injuries:	0	**Light Conditions:**	not reported
Minor Injuries:	0	**Weather Conditions:**	not reported
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$5000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	not reported	0	0
Veh Action:	not reported	0	0
Configuration:	Sport utility vehicle	0	0
Driver Age:	61	0	0
Driver Gender:	F		
Driver Cond:	not reported	0	0
Drivr Contr 1:	unknown	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2011634030 06/03/2011 23:20 SB/WB Interstate 0080 (Milepost 302)
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Not reported

Severity: PDO	**Manner of Crash:** not reported		
Fatalities: 0	**Surface Conditions:** not reported		
Major Injuries: 0	**Light Conditions:** not reported		
Minor Injuries: 0	**Weather Conditions:** not reported		
Possible Injuries: 0	**Drug/Alc Involved:** none indicated		
Unknown Injuries: 0	**Property Damage:** $7000	**Number of Vehicles:** 1	

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	not reported	0	0
Veh Action:	not reported	0	0
Configuration:	Passenger car	0	0
Driver Age:	38	0	0
Driver Gender:	M		
Driver Cond:	not reported	0	0
Drivr Contr 1:	unknown	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

2011635961 06/14/2011 15:30 NB/EB Interstate 0080
County: 82 **City:** Bettendorf

Major Cause: Followed too close
Roadway Type: Non-intersection: No special feature

Severity: PDO	**Manner of Crash:** Rear-end		
Fatalities: 0	**Surface Conditions:** Dry		
Major Injuries: 0	**Light Conditions:** Daylight		
Minor Injuries: 0	**Weather Conditions:** Clear		
Possible Injuries: 0	**Drug/Alc Involved:** none indicated		
Unknown Injuries: 0	**Property Damage:** $20032	**Number of Vehicles:** 2	

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	East	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Tractor/semi-trailer	4-tire light truck	0
Driver Age:	50	29	0
Driver Gender:	F	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	Lost control	none	0
Drivr Contr 2:	Followed too close	not reported	0
Fixed Object:	Guardrail	Guardrail	0

2011663969 12/08/2011 23:55 SB/WB Interstate 0080
County: 82 **City:** Bettendorf

Major Cause: Driving too fast for conditions
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Ice		
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted		
Minor Injuries:	0	**Weather Conditions:**	Snow		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$3000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	4-tire light truck	0	0
Driver Age:	33	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Too fast for conditions	0	0
Drivr Contr 2:	Lost control	0	0
Fixed Object:	Ditch/embankment	0	0

2012668744 01/20/2012 16:18 SB/WB Interstate 0080
County: 82 **City:** Bettendorf

Major Cause: Ran off road - right
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Snow		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Snow		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$3000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	23	0	0
Driver Gender:	F		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Tree	0	0

2012676065 01/20/2012 14:05 Interstate 0080 (Milepost 302)
County: 82 **City:** Bettendorf

Major Cause: Swerving/evasive action
Roadway Type: Non-intersection: No special feature

Severity:	Poss/Unk	**Manner of Crash:**	unknown
Fatalities:	0	**Surface Conditions:**	Ice
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	0	**Weather Conditions:**	Snow
Possible Injuries:	2	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$6000

Number of Vehicles: 4

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	West	West
Veh Action:	Essentially straight	Essentially straight	Essentially straight
Configuration:	Passenger car	4-tire light truck	Passenger car
Driver Age:	37	25	52
Driver Gender:	F	M	F
Driver Cond:	Normal	Normal	Normal
Drivr Contr 1:	Lost control	Lost control	Swerved to avoid
Drivr Contr 2:	not reported	unknown	not reported
Fixed Object:	Ditch/embankment	Ditch/embankment	Guardrail

2012671766 02/07/2012 17:49 INTERSTATE 80 EAST (MILEPOST 302)
County: 82 **City:** Bettendorf

Major Cause: unknown
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Sideswipe, same direction
Fatalities:	0	**Surface Conditions:**	Ice
Major Injuries:	0	**Light Conditions:**	Dusk
Minor Injuries:	0	**Weather Conditions:**	Snow
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$5050

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	East	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	4-tire light truck	Tractor/semi-trailer	0
Driver Age:	65	44	0
Driver Gender:	M	F	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	unknown	unknown	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2012683632 04/26/2012 04:26 Interstate 0080 (Milepost 302)
County: 82 **City:** Bettendorf

Major Cause: Swerving/evasive action
Roadway Type: Non-intersection: Bridge/overpass/underpass

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	0	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$14113

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Truck tractor (bobtail)	0	0
Driver Age:	40	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Guardrail	0	0

2012709546 10/20/2012 20:06 WB INTERSTATE 80 (MILEPOST 302)
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	0	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$5000

Number of Vehicles: 1

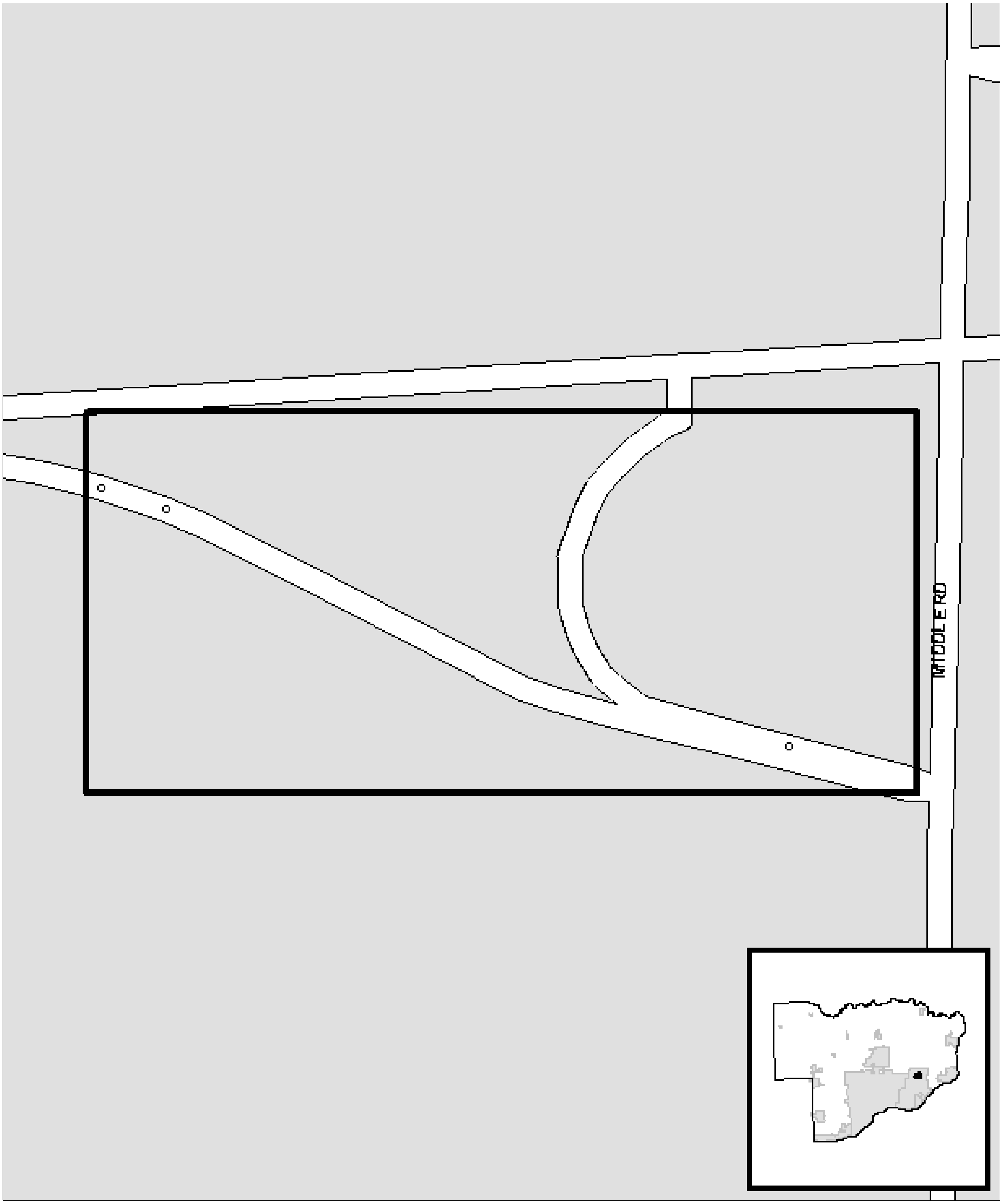
	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	61	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

Location Map

I-80/Middle Road

Incidents: 4

Report Version 1.1 Mar 2005



Analyst: J. Wiegand	**Notes:** I-80 (EB Ramps)

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2009500126 03/08/2009 08:59 Interstate 0080

County: 82 **City:** Bettendorf

Major Cause: Ran off road - right

Roadway Type: Intersection: Off-ramp diverge area

Severity:	Poss/Unk	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Wet		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Rain		
Possible Injuries:	1	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$1100	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Leaving traffic lane	0	0
Configuration:	Passenger car	0	0
Driver Age:	18	0	0
Driver Gender:	F		
Driver Cond:	unknown	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Sign post	0	0

2010592644 09/25/2010 15:03 Interstate 0080 measuring 300 Feet West from MIDDLE RD and Interstate 0080

County: 82 **City:** Bettendorf

Major Cause: Over correcting/over steering

Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Sideswipe, same direction		
Fatalities:	0	**Surface Conditions:**	Wet		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Rain		
Possible Injuries:	0	**Drug/Alc Involved:**	Alcohol: Statutory		
Unknown Injuries:	0	**Property Damage:**	$8000	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	West	0
Veh Action:	Overtaking/passing	Essentially straight	0
Configuration:	Sport utility vehicle	Motor home/RV	0
Driver Age:	28	59	0
Driver Gender:	M	M	
Driver Cond:	Infl by alc/drugs/meds	Normal	0
Drivr Contr 1:	Lost control	none	0
Drivr Contr 2:	Over correcting/steering	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2012671445 01/28/2012 00:40 Interstate 0080
County: 82 **City:** Bettendorf

Major Cause: Driving too fast for conditions
Roadway Type: Intersection: Off-ramp

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Snow
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	0	**Weather Conditions:**	Snow
Possible Injuries:	0	**Drug/Alc Involved:**	Under influence of Alc/Drugs/Meds
Unknown Injuries:	0	**Property Damage:**	$3000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Van or mini-van	0	0
Driver Age:	41	0	0
Driver Gender:	M		
Driver Cond:	Infl by alc/drugs/meds	0	0
Drivr Contr 1:	Too fast for conditions	0	0
Drivr Contr 2:	Lost control	0	0
Fixed Object:	Tree	0	0

2012713601 11/01/2012 05:07 Interstate 0080
County: 82 **City:** Bettendorf

Major Cause: Animal
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Dark - roadway not lighted
Minor Injuries:	0	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$4000

Number of Vehicles: 1

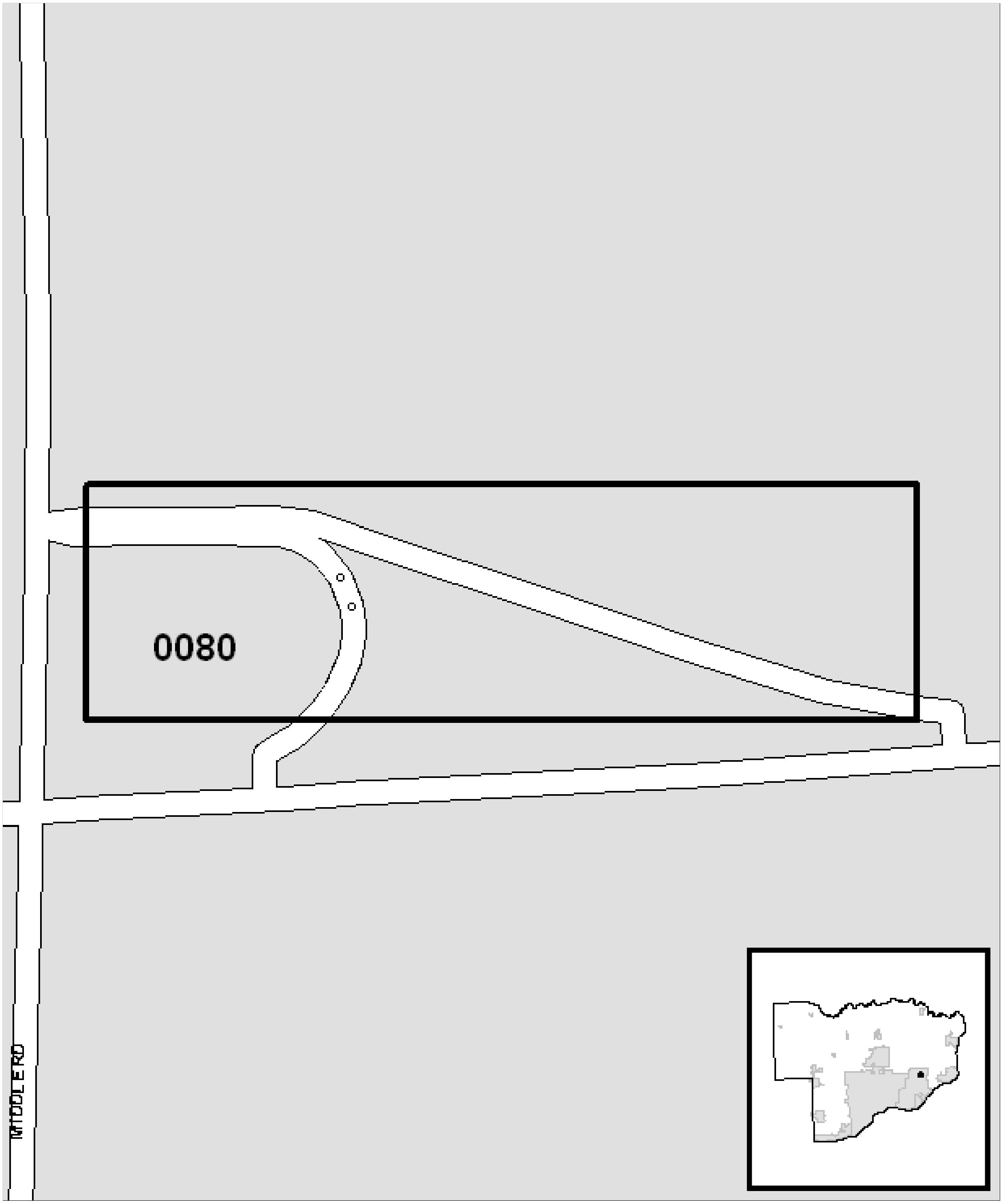
	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	50	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

Location Map

I-80/Middle Road

Incidents: 2

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: I-80 (WB Ramps)

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2009507620 05/13/2009 09:20 Interstate 0080

County: 82 **City:** Bettendorf

Major Cause: Downhill runaway

Roadway Type: Intersection: On-ramp

Severity:	Poss/Unk	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Wet		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Rain		
Possible Injuries:	1	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$100	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	24	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Lost control	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	Ditch/embankment	0	0

2011647085 09/12/2011 21:17 MIDDLE RD ON RAMP TO I-80 WESTBOUND

County: 82 **City:** Bettendorf

Major Cause: Driving too fast for conditions

Roadway Type: Intersection: On-ramp

Severity:	PDO	**Manner of Crash:**	Non-collision		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Dark - roadway lighted		
Minor Injuries:	0	**Weather Conditions:**	Clear		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$8000	**Number of Vehicles:**	1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	0	0
Veh Action:	Entering (merging)	0	0
Configuration:	Sport utility vehicle	0	0
Driver Age:	34	0	0
Driver Gender:	M		
Driver Cond:	Normal	0	0
Drivr Contr 1:	Too fast for conditions	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

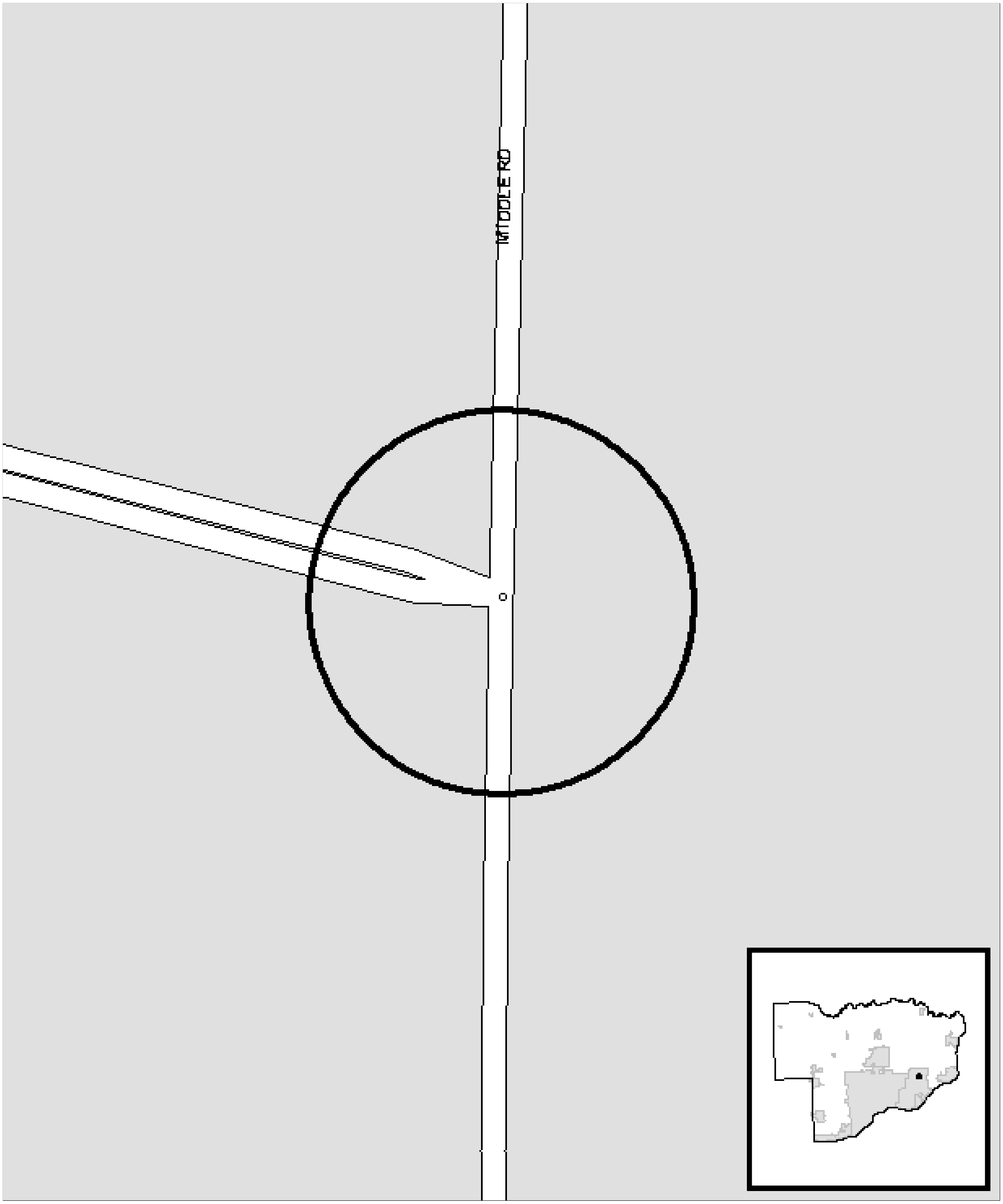
Iowa Department of Transportation

Location Map

I-80/Middle Road

Incidents: 2

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: I-80 (EB RTI)

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2009493055 02/12/2009 08:03 MIDDLE RD and Interstate 0080
County: 82 **City:** Bettendorf

Major Cause: Other improper action
Roadway Type: Intersection: T - intersection

Severity: PDO **Manner of Crash:** Rear-end
Fatalities: 0 **Surface Conditions:** Dry
Major Injuries: 0 **Light Conditions:** Daylight
Minor Injuries: 0 **Weather Conditions:** Clear
Possible Injuries: 0 **Drug/Alc Involved:** none indicated
Unknown Injuries: 0 **Property Damage:** $4500 **Number of Vehicles:** 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	East	0
Veh Action:	Turning right	Turning right	0
Configuration:	Passenger car	Passenger car	0
Driver Age:	27	56	0
Driver Gender:	F	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	none	Other improper action	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

2010582721 07/15/2010 10:06 MIDDLE RD and Interstate 0080
County: 82 **City:** Bettendorf

Major Cause: Lost control
Roadway Type: Intersection: Off-ramp

Severity: PDO **Manner of Crash:** Rear-end
Fatalities: 0 **Surface Conditions:** Dry
Major Injuries: 0 **Light Conditions:** Daylight
Minor Injuries: 0 **Weather Conditions:** Clear
Possible Injuries: 0 **Drug/Alc Involved:** none indicated
Unknown Injuries: 0 **Property Damage:** $1600 **Number of Vehicles:** 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	North	North	0
Veh Action:	Stopped for sign/signal	Stopped for sign/signal	0
Configuration:	Passenger car	Passenger car	0
Driver Age:	19	56	0
Driver Gender:	M	F	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	Lost control	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

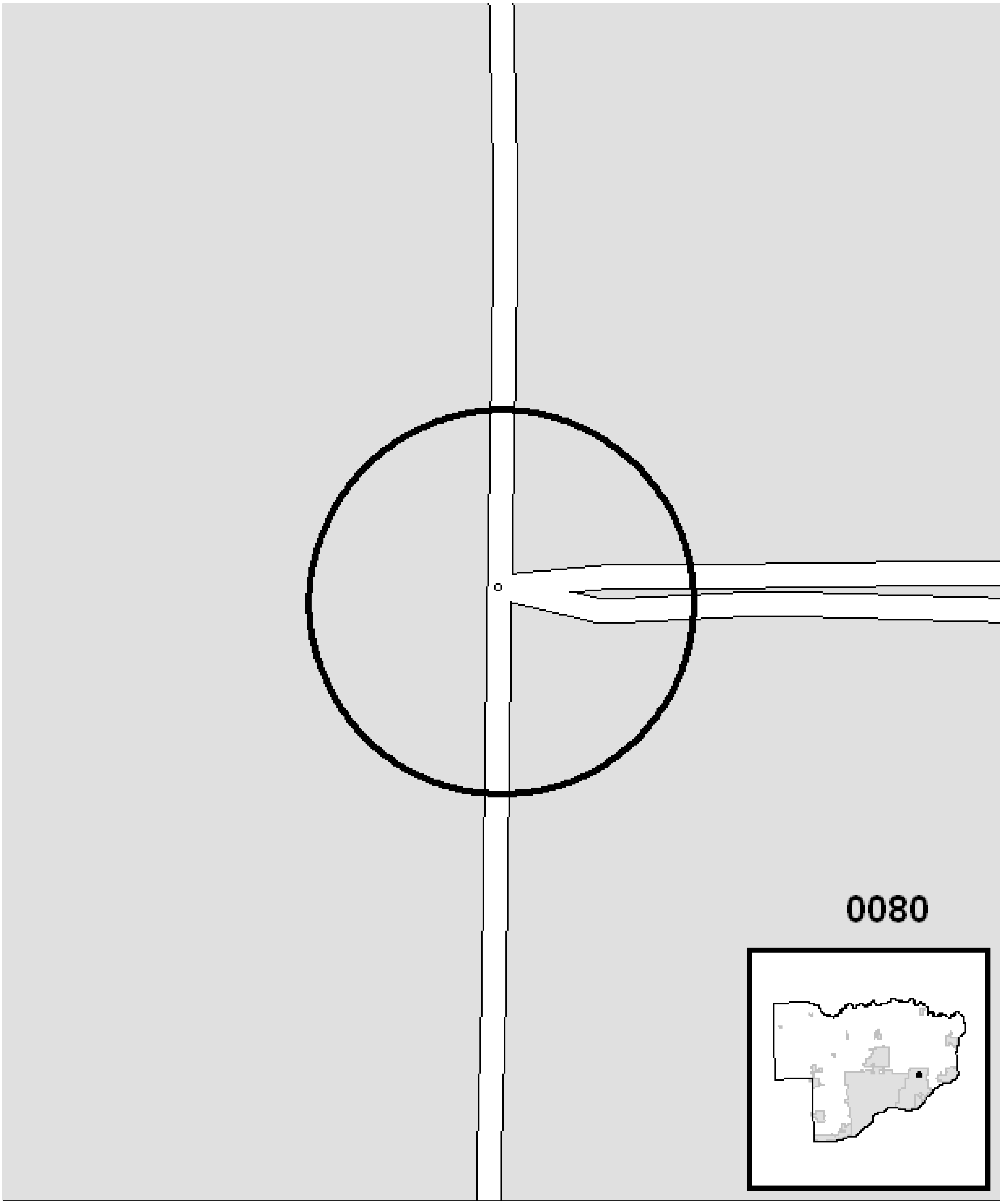
Iowa Department of Transportation

Location Map

I-80/Middle Road

Incidents: 1

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: I-80 (WB RTI)

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2011614828 01/25/2011 07:59 Interstate 0080 and MIDDLE RD

County: 82 **City:** Bettendorf

Major Cause: FTY from stop sign

Roadway Type: Intersection: T - intersection

Severity:	PDO	**Manner of Crash:**	Broadside		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Cloudy		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$6000	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	South	West	0
Veh Action:	Essentially straight	Turning left	0
Configuration:	4-tire light truck	4-tire light truck	0
Driver Age:	17	49	0
Driver Gender:	M	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	none	FTY from stop sign	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

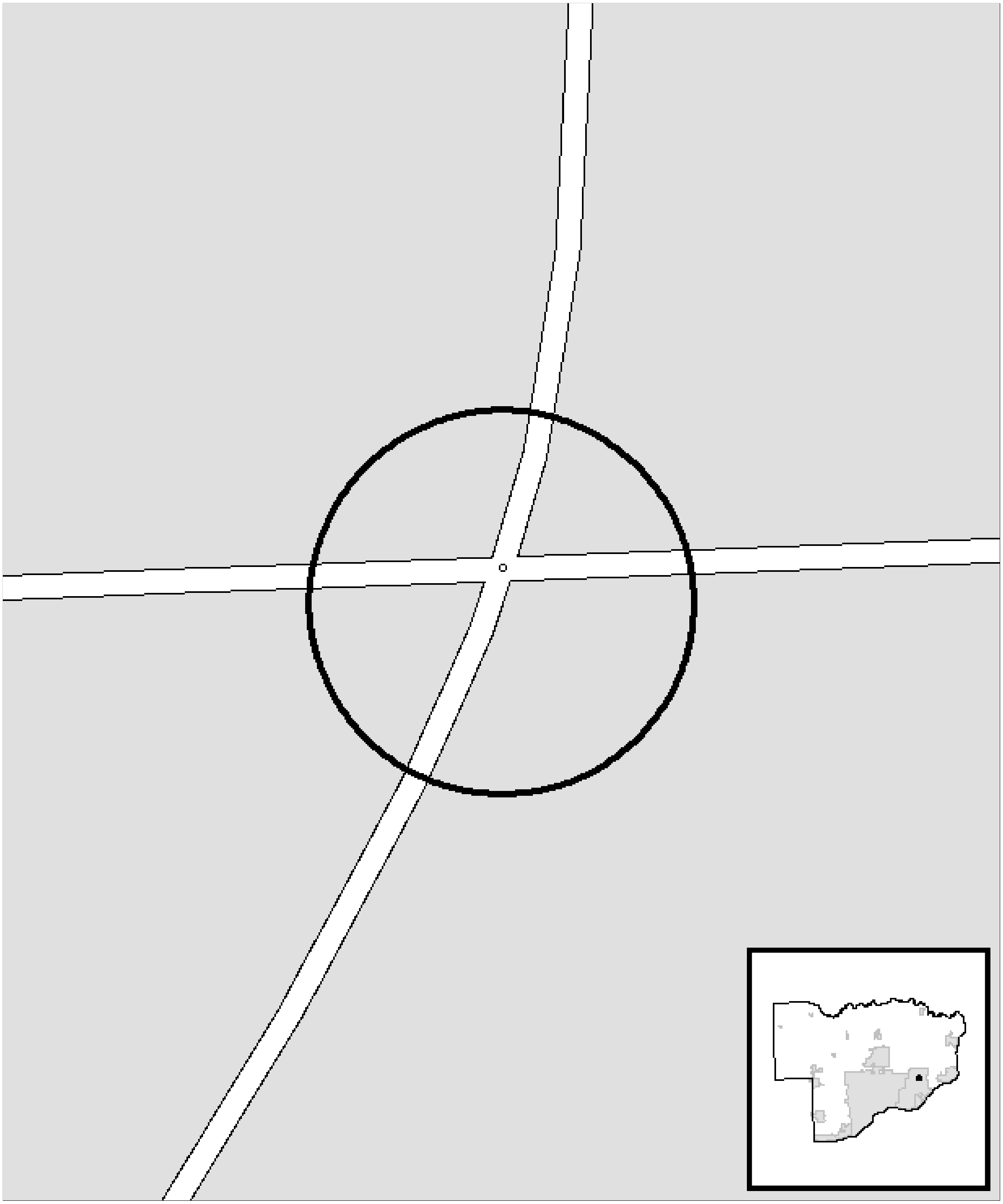
Iowa Department of Transportation

Location Map

I-80/Middle Road

Incidents: 12

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: Middle Road and Forest Grove Drive Intersection

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2008422834 01/31/2008 15:55 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: Swerving/evasive action
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Head-on
Fatalities:	0	**Surface Conditions:**	Snow
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	0	**Weather Conditions:**	Snow
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$6500

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	North	South	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	4-tire light truck	Passenger car	0
Driver Age:	36	52	0
Driver Gender:	M	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	none	Lost control	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

2008460085 09/05/2008 15:03 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: FTY from stop sign
Roadway Type: Intersection: Four-way intersection

Severity:	PDO	**Manner of Crash:**	Broadside
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	0	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$2200

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Passenger car	4-tire light truck	0
Driver Age:	58	17	0
Driver Gender:	F	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	FTY from stop sign	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2008466195 10/15/2008 12:48 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: FTY from stop sign
Roadway Type: Intersection: Four-way intersection

Severity:	PDO	**Manner of Crash:**	Broadside		
Fatalities:	0	**Surface Conditions:**	Wet		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Rain		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$7000	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	4-tire light truck	Passenger car	0
Driver Age:	62	55	0
Driver Gender:	M	F	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	FTY from stop sign	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

2009506480 05/10/2009 17:42 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: Made improper turn
Roadway Type: Intersection: Four-way intersection

Severity:	PDO	**Manner of Crash:**	Sideswipe, same direction		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Clear		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$3500	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	South	South	0
Veh Action:	Turning right	Essentially straight	0
Configuration:	Passenger car	Sport utility vehicle	0
Driver Age:	23	42	0
Driver Gender:	F	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	Made improper turn	none	0
Drivr Contr 2:	Distracted by passenger	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2009508661 05/25/2009 17:34 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: FTY from stop sign
Roadway Type: Intersection: Four-way intersection

Severity:	Minor	**Manner of Crash:**	Broadside		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	1	**Weather Conditions:**	Cloudy		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$2700	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Passenger car	Passenger car	0
Driver Age:	19	62	0
Driver Gender:	F	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	FTY from stop sign	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

2009519111 07/31/2009 16:07 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: FTY from stop sign
Roadway Type: Intersection: Four-way intersection

Severity:	PDO	**Manner of Crash:**	Broadside		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Clear		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$3000	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Passenger car	Passenger car	0
Driver Age:	79	26	0
Driver Gender:	M	F	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	FTY from stop sign	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2009531088 10/13/2009 12:24 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: FTY from stop sign
Roadway Type: Intersection: Four-way intersection

Severity:	Poss/Unk	**Manner of Crash:**	Broadside		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Daylight		
Minor Injuries:	0	**Weather Conditions:**	Clear		
Possible Injuries:	1	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$10000	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Van or mini-van	Sport utility vehicle	0
Driver Age:	48	27	0
Driver Gender:	F	F	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	FTY from stop sign	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

2010550625 01/02/2010 19:15 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: Ran stop sign
Roadway Type: Intersection: Four-way intersection

Severity:	PDO	**Manner of Crash:**	Broadside		
Fatalities:	0	**Surface Conditions:**	Dry		
Major Injuries:	0	**Light Conditions:**	Dark - roadway lighted		
Minor Injuries:	0	**Weather Conditions:**	Clear		
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated		
Unknown Injuries:	0	**Property Damage:**	$7000	**Number of Vehicles:**	2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	4-tire light truck	Sport utility vehicle	0
Driver Age:	18	66	0
Driver Gender:	M	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	Ran stop sign	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2010568642 04/15/2010 11:41 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: Ran stop sign
Roadway Type: Intersection: Four-way intersection

Severity:	Minor	**Manner of Crash:**	Broadside
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	2	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	Alcohol: Statutory
Unknown Injuries:	0	**Property Damage:**	$14000

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Sport utility vehicle	Passenger car	0
Driver Age:	38	74	0
Driver Gender:	F	F	
Driver Cond:	Infl by alc/drugs/meds	Normal	0
Drivr Contr 1:	Ran stop sign	none	0
Drivr Contr 2:	Other improper action	not reported	0
Fixed Object:	Pole: utility/light/etc	none	0

2010598145 10/23/2010 14:56 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: FTY from stop sign
Roadway Type: Intersection: Four-way intersection

Severity:	PDO	**Manner of Crash:**	Broadside
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	0	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$6000

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	East	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Sport utility vehicle	Passenger car	0
Driver Age:	21	46	0
Driver Gender:	F	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	FTY from stop sign	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2011653285 10/23/2011 13:13 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: FTY from stop sign
Roadway Type: Intersection: Four-way intersection

Severity:	Poss/Unk	**Manner of Crash:**	Broadside
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	0	**Weather Conditions:**	Clear
Possible Injuries:	1	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$8500

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	West	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Passenger car	Motorcycle	0
Driver Age:	54	52	0
Driver Gender:	M	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	FTY from stop sign	none	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

2012718108 12/21/2012 15:51 FOREST GROVE DR and MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: Crossed centerline
Roadway Type: Non-intersection: No special feature

Severity:	PDO	**Manner of Crash:**	Head-on
Fatalities:	0	**Surface Conditions:**	Slush
Major Injuries:	0	**Light Conditions:**	Daylight
Minor Injuries:	0	**Weather Conditions:**	Clear
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$6000

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	South	North	0
Veh Action:	Essentially straight	Essentially straight	0
Configuration:	Sport utility vehicle	Passenger car	0
Driver Age:	60	15	0
Driver Gender:	M	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	none	Crossed centerline	0
Drivr Contr 2:	not reported	Lost control	0
Fixed Object:	none	none	0

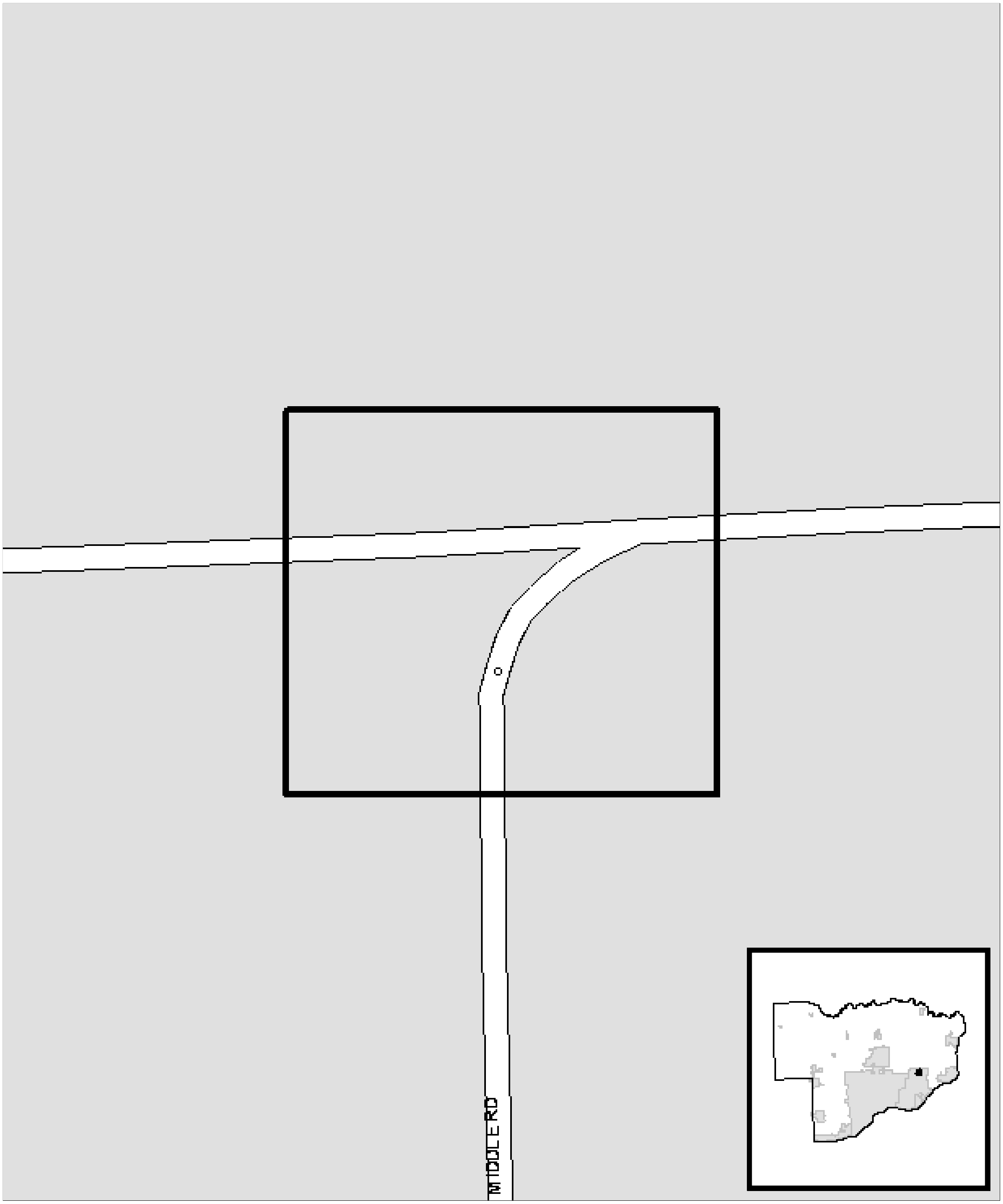
Iowa Department of Transportation

Location Map

I-80/Middle Road

Incidents: 1

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: Middle Road and Indiana Ave Intersection

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2012701971 09/06/2012 08:01
County: 82 **City:** Bettendorf

MIDDLE RD AT THE LEFT TURN AREA TO INDIANA AVE.

Major Cause: FTY making left turn

Roadway Type: Intersection: Y - intersection

Severity: PDO
Fatalities: 0
Major Injuries: 0
Minor Injuries: 0
Possible Injuries: 0
Unknown Injuries: 0

Manner of Crash: Angle, oncoming left turn
Surface Conditions: Dry
Light Conditions: Daylight
Weather Conditions: Clear
Drug/Alc Involved: none indicated
Property Damage: $11500

Number of Vehicles: 2

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	South	North	0
Veh Action:	Essentially straight	Turning left	0
Configuration:	Passenger car	Sport utility vehicle	0
Driver Age:	19	48	0
Driver Gender:	F	M	
Driver Cond:	Normal	Normal	0
Drivr Contr 1:	none	FTY making left turn	0
Drivr Contr 2:	not reported	not reported	0
Fixed Object:	none	none	0

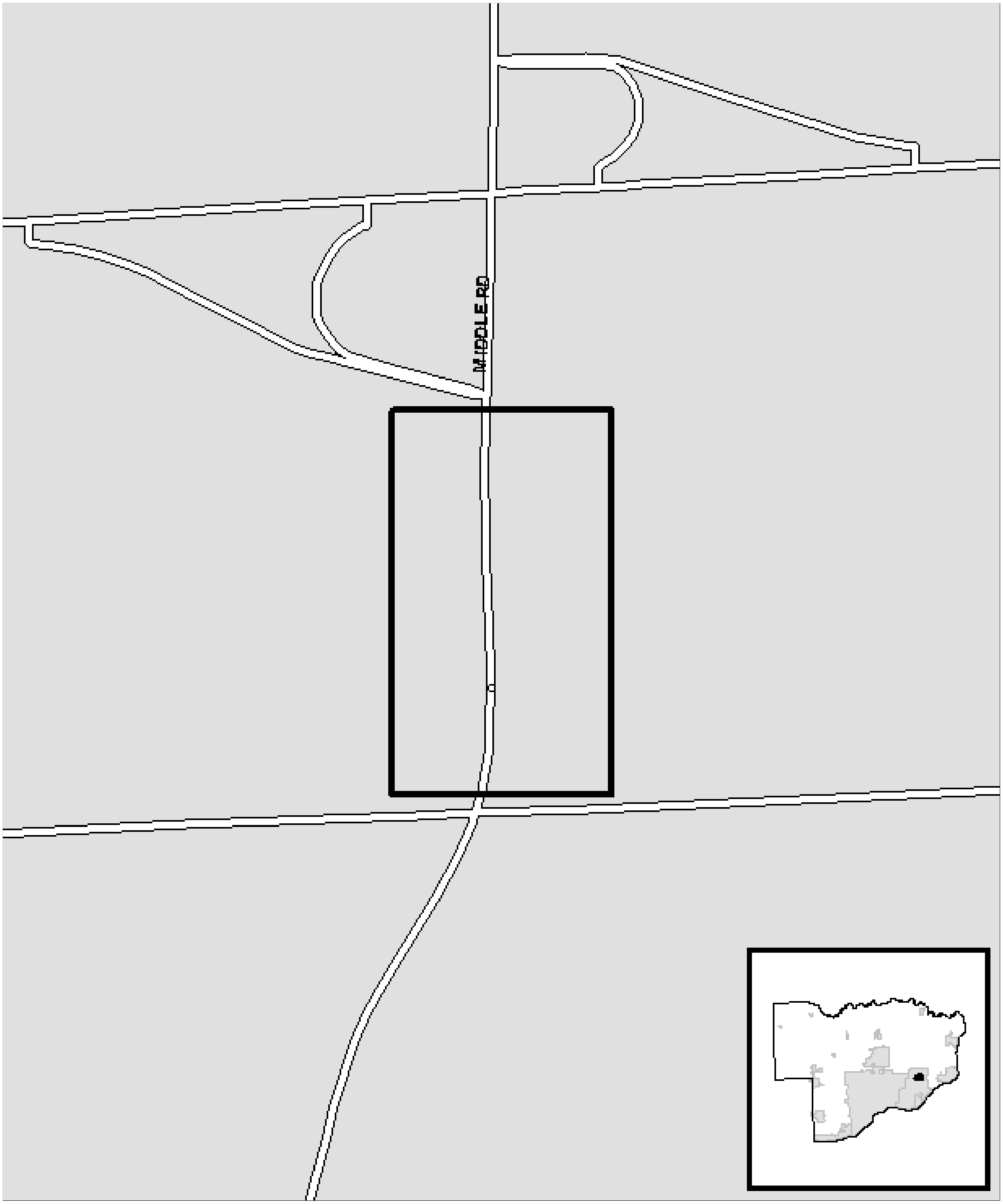
Iowa Department of Transportation

Location Map

I-80/Middle Road

Incidents: 1

Report Version 1.1 Mar 2005



Analyst: J. Wiegand

Notes: Middle Road Segments

Crash Detail Report

I-80/Middle Road

Report Version 1.3 Aug 2006

2011660793 11/30/2011 22:54 MIDDLE RD
County: 82 **City:** Bettendorf

Major Cause: Animal

Roadway Type: Intersection: T - intersection

Severity:	PDO	**Manner of Crash:**	Non-collision
Fatalities:	0	**Surface Conditions:**	Dry
Major Injuries:	0	**Light Conditions:**	Dark - roadway lighted
Minor Injuries:	0	**Weather Conditions:**	Partly cloudy
Possible Injuries:	0	**Drug/Alc Involved:**	none indicated
Unknown Injuries:	0	**Property Damage:**	$6000

Number of Vehicles: 1

	Unit 1	Unit 2	Unit 3
Init Trav Dir:	South	0	0
Veh Action:	Essentially straight	0	0
Configuration:	Passenger car	0	0
Driver Age:	49	0	0
Driver Gender:	F		
Driver Cond:	Normal	0	0
Drivr Contr 1:	none	0	0
Drivr Contr 2:	not reported	0	0
Fixed Object:	none	0	0

Intersection or Spot Benefit / Cost Safety Analysis

Rev. 7/10

Iowa DOT Office of Traffic & Safety

County: Scott | Prepared by: lon Wiegand, HR Gree | Date Prepared: Jan 23, 2014

Intersection: I-80 and Middle Road Interchange

Improvement

Proposed Improvement(s):

	Estimated Improvement Cost, **EC**		Est. Improvement Life, years, **Y**
	Other Annual Cost (after initial year), **AC**		Crash Reduction Factor (integer), **CRF**
$ -	Present Value Other Annual Costs, **OC**	4.0%	Discount Rate (time value of $), **INT**
		$ -	Present Value Cost, **COST** = EC + OC

$$OC = \frac{AC}{INT}\left(1 - \frac{1}{(1+INT)^{Y}}\right)$$

Traffic Volume Data

Source: DOT Traffic Data | 2008 Date of traffic count

Daily Entering Vehicles by Approach (or AADT / 2)

1,125 ; 14,700 ; 14,450 ; 2,430

11,937,325	Current Annual Entering Veh., **AEV** = DEV * 365
32,705	veh / day, Final Year DEV, **FDEV**
-	MEV, Total Million Entering Veh. Over life of Project, **TMEV**
	Projected Traffic Growth (0%-10%), **G**
32,705	Current Daily Entering Vehicles, **DEV**

$$TMEV = \frac{AEV}{-G}\left(1 - \left(\frac{1+G}{1}\right)^{Y}\right) \Big/ 10^{6}$$

Crash Data

2008 First full year --> 2012 Last full year | 5.0 years, Time Period, **T**

Additional months | values as of Dec. 2007

1	Fatal Crashes	x	Fatalities @	$3,500,000	#VALUE!
		x	Major Injuries @	$240,000	#VALUE!
10	Injury Crashes	x	Minor Injuries @	$48,000	#VALUE!
		x	Possible Injuries @	$25,000	#VALUE!
43	Property Damage Only		(assumed cost per crash)	$2,700	$ 145,800
		-OR-	enter all Property Costs of all crashes:		$ -
54	Total Crashes, **TA**			Total $ Loss, **LOSS**	#VALUE!

10.80	Current Crashes / Year, **AA** = TA / T
#VALUE!	Cost per Crash, **AVC** = LOSS / TA
-	Total Expected Crashes, **TECR** = CR x TMEV
-	Crashes Avoided First Year **AAR** = AA x CRF / 100
#VALUE!	Crash Costs Avoided in First Year, AAR x AVC
-	Total Avoided Crashes, TECR x CRF/ 100

0.90 Crashes / MEV, Crash Rate, **CR**
CR = TA x 10^6 / (DEV x 365 x T)

#VALUE! Present Value of Avoided Crashes, **BENEFIT**

$$BEN. = \frac{AVC \times AAR}{(INT - G)}\left(1 - \left(\frac{1+G}{1+INT}\right)^{Y}\right)$$

Benefit / Cost Ratio

Benefit : Cost = #VALUE! : $0 = - : 1

Appendix C: 2040 Traffic Forecast Technical Memorandum

Appendix C: 2040 Traffic Forecast Technical Memorandum

MEMO

To: Project Stakeholders

From: Andy Swisher, PE, PTOE

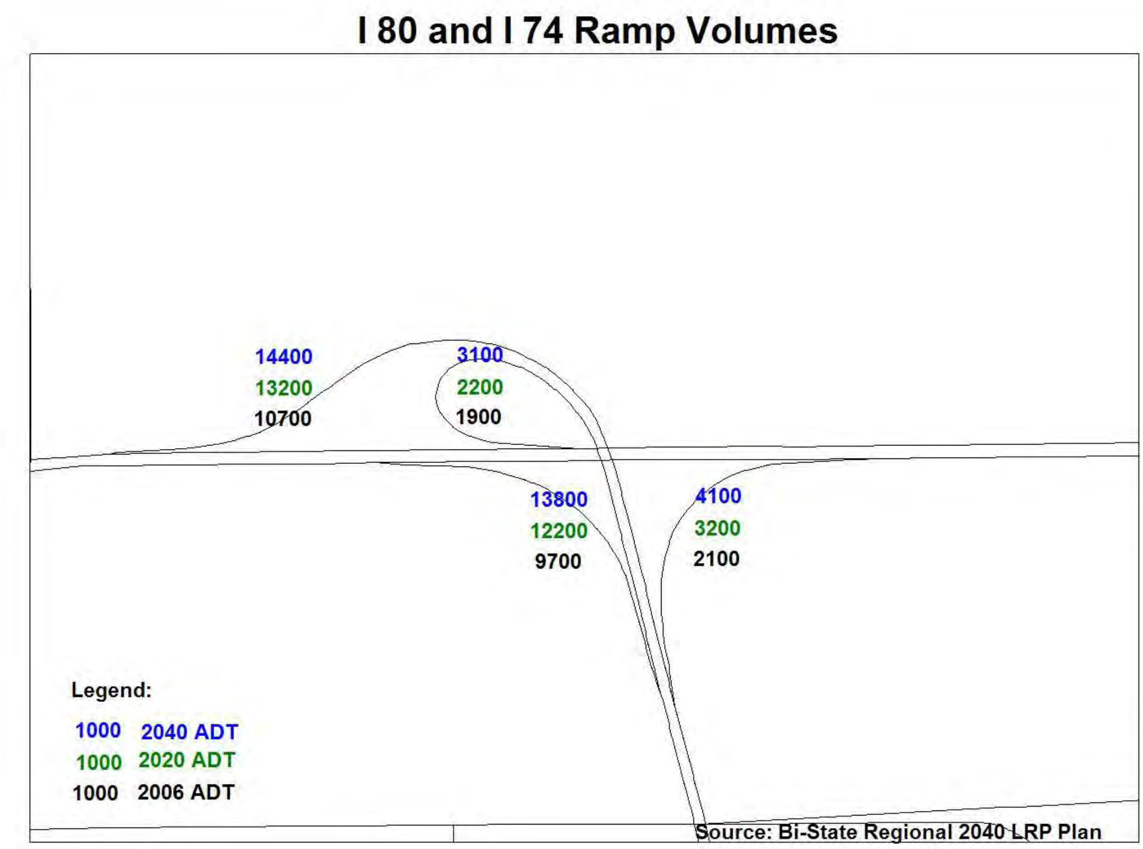
Subject: Traffic Forecast Technical Memorandum
I-80/Middle Road IJR

Date: January 28, 2014

This memo serves to document the traffic forecasting procedures used to derive AM and PM peak hour traffic projections for the Interstate 80 (I-80) and Middle Road study area. These forecasts were completed in cooperation with Bi-States Regional Commission and the Iowa Department of Transportation (DOT) for the I-80/Middle Road Interchange Justification Report (IJR) project.

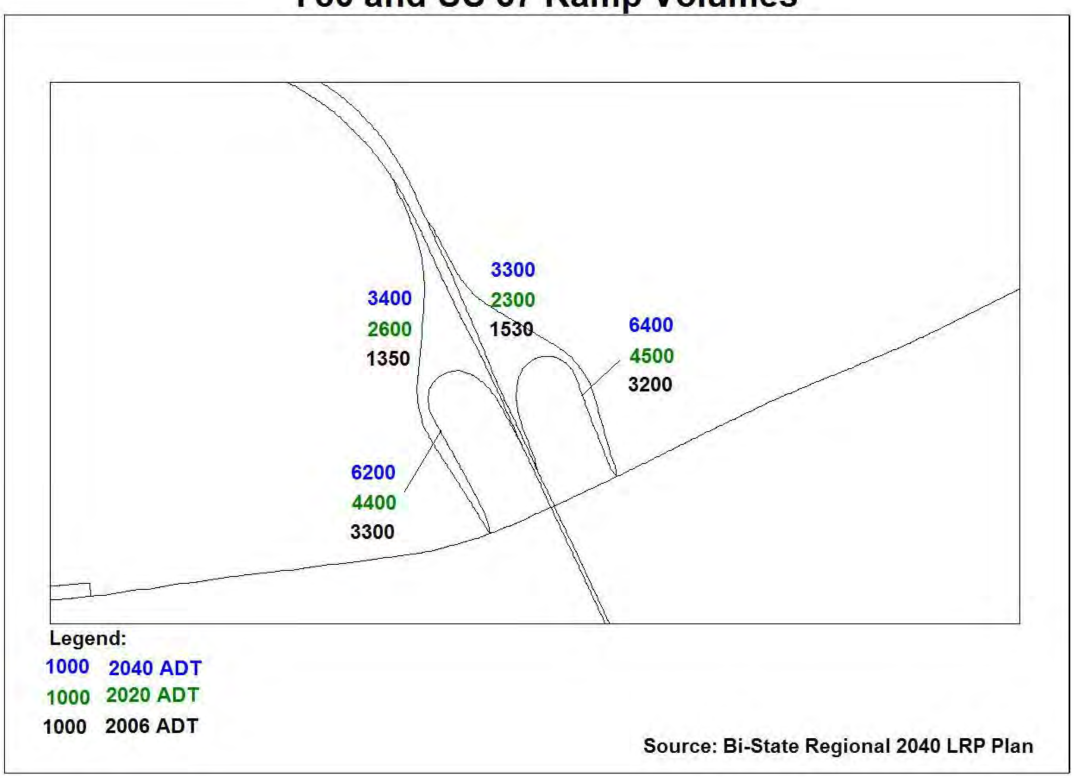
<u>Travel Demand Model</u>

Output from the Quad Cities region travel demand model was obtained from Bi-States. This output included 2006 base year, 2020 projection year, and 2040 projection year average daily traffic. The output was post-processed by Bi-States prior to providing it for the project. The data provided is shown in the following images.

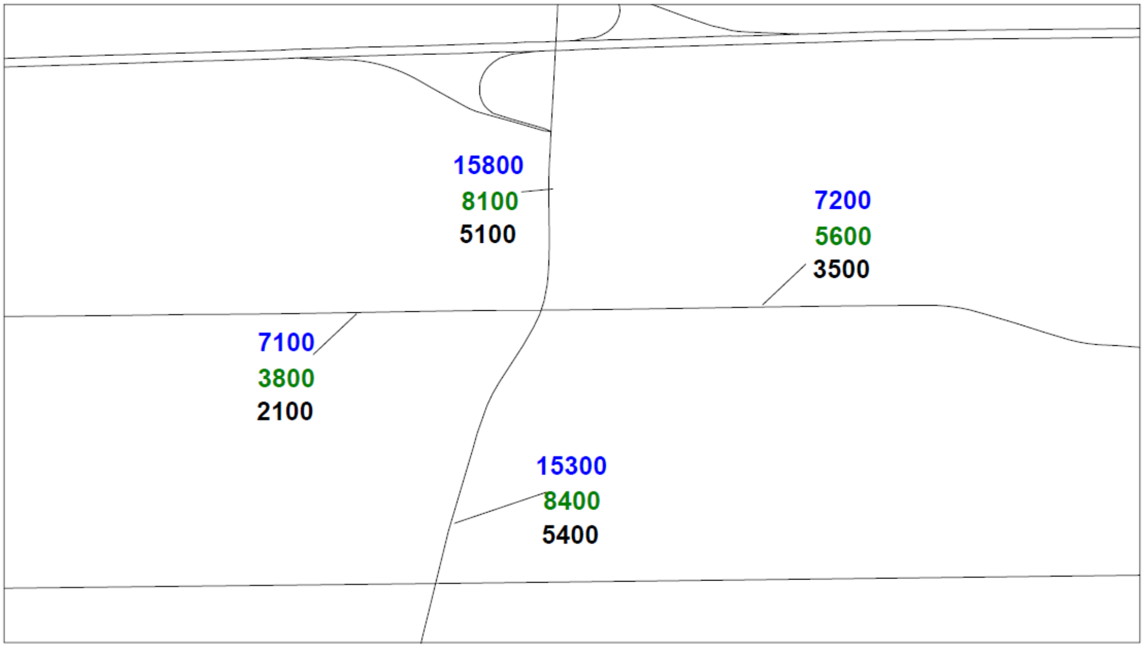


I 80 and Middle Road IJR Project

I 80 and US 67 Ramp Volumes



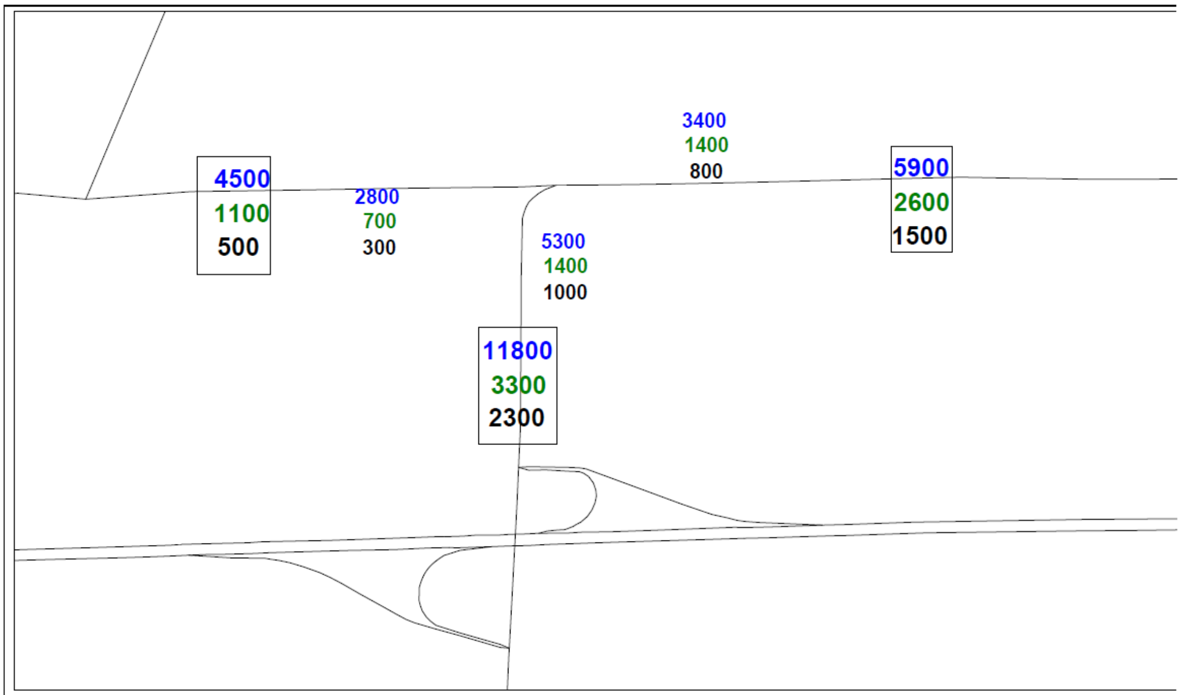
Middle Road and Forest Grove Rd TOTAL Volumes



Legend:
1000 2040 ADT
1000 2020 ADT
1000 2006 ADT

Source: Bi-State Regional 2040 LRP Plan

Middle Rd and Indiana Ave Total and Directional Volumes



Legend:
1000 2040 ADT
1000 2020 ADT
1000 2006 ADT

TOTAL Volumes

Source: Bi-State Regional 2040 LRP Plan

Peak Hour Traffic Forecasts

Peak hour traffic forecasts were derived using methodologies consistent with NCHRP Report 255. Turning movement counts were obtained for the I-80/Middle Road ramp terminal intersections as well as the Middle Road/Indiana Avenue and Middle Road/Forest Grove Drive intersections. These turning movement counts were used as the basis for developing the forecasted volumes. The existing turning movement count information is shown in Exhibits 1A and 1B. By comparing the base and forecast year ADT data from the travel demand model, growth rates were determined and peak hour forecasts were determined using an iterative process to balance intersection approach and departure volumes. Finally, the volumes between intersections were balanced. The resulting 2040 traffic forecasts are shown in Exhibits 2A and 2B.

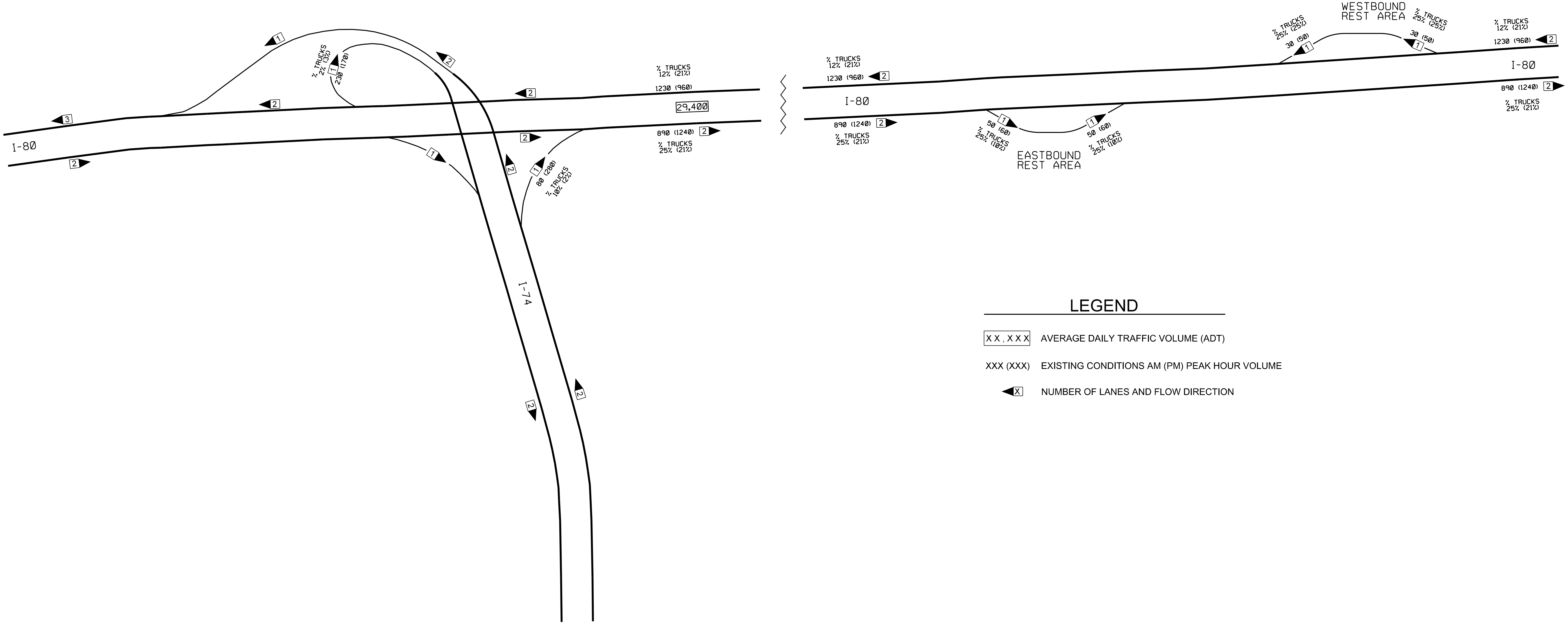
Middle Road Sub Area Analysis Traffic Forecasts

The traffic volumes projected by Bi-States' adopted travel demand model are limited by control totals for growth of the region, as a whole. This works well when developing 20 year horizon traffic volumes. However, many infrastructure investments will have a useful life of 50 years or more. For this reason, sensitivity traffic forecasts are sometimes used to test higher volume traffic scenarios such that infrastructure investments can be designed to accommodate expandability providing added capacity beyond the 20 year horizon traffic forecast.

In the case of the Middle Road study area, the City of Bettendorf identified this area as being critical to the future growth of the City and included a subarea plan for future land use within the City's Comprehensive Plan document. HR Green used the subarea plan future land use to develop socioeconomic factors including number of dwelling units, number of retail employment, and number of other employment. These socioeconomic factors were then provided back to Bi-State for a special run of the travel demand model.

At this point, Bi-State was currently working from the 2035 horizon year forecast model. Bi-State reviewed the revised socioeconomic inputs and incorporated the inputs into the 2035 model for the special model run. Again, since the socioeconomic inputs represent something above and beyond the growth anticipated by 2035, the horizon year (2035 in this case) is not relevant as the data represents something closer to the full build-out of the area which may occur several years beyond.

The output from the special model run was received from Bi-State in the form of GIS shapefiles. A similar process as described previously for the development of the 2040 AM and PM peak hour traffic forecasts was used to complete the Sub Area Analysis Forecasts. The resulting Sub Area AM and PM Peak Hour Forecasts are shown in Exhibits 3A and 3B.



NORTH

NOT TO SCALE

Bettendorf IOWA

Iowa Department of Transportation

2008 EXISTING STUDY AREA AM/PM PEAK HOUR TRAFFIC VOLUMES

I-80 AND MIDDLE ROAD

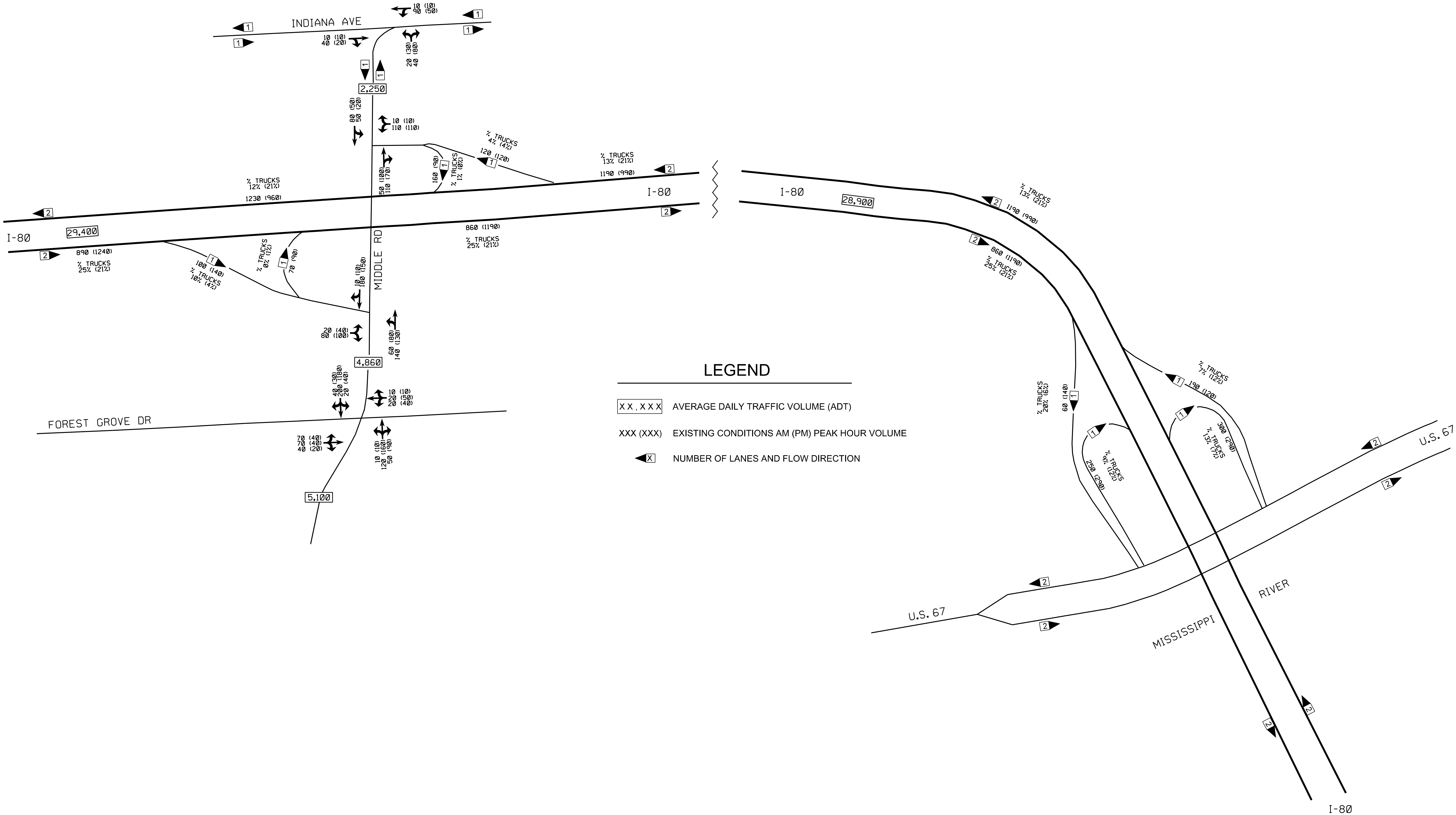
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

EXHIBIT 1

PAGE A

PLOT: $TIME$ $DATE$ FILE: $FILE$



NORTH

NOT TO SCALE

Bettendorf IOWA

Iowa Department of Transportation

2008 EXISTING STUDY AREA AM/PM PEAK HOUR TRAFFIC VOLUMES

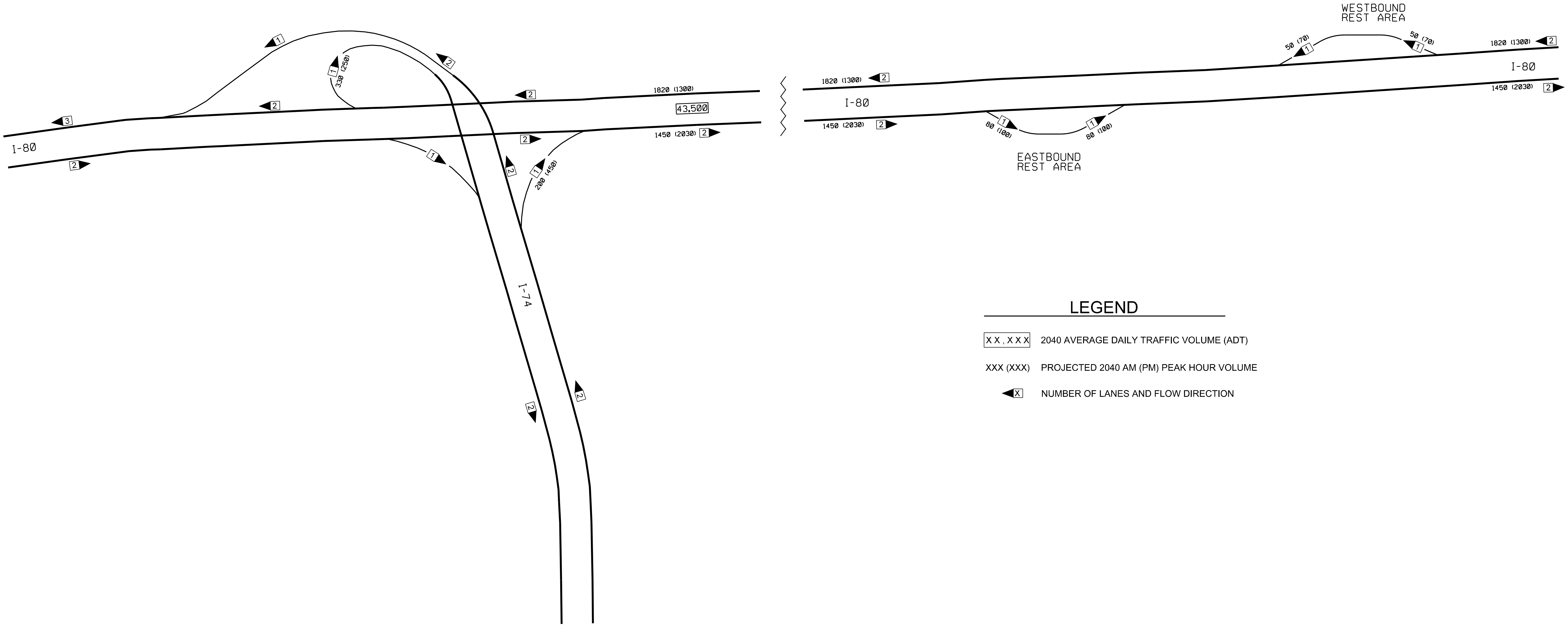
I-80 AND MIDDLE ROAD

BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

EXHIBIT 1

PAGE B



LEGEND

XX,XXX	2040 AVERAGE DAILY TRAFFIC VOLUME (ADT)
XXX (XXX)	PROJECTED 2040 AM (PM) PEAK HOUR VOLUME
◄X	NUMBER OF LANES AND FLOW DIRECTION

NORTH

NOT TO SCALE

Bettendorf IOWA

Iowa Department of Transportation

2040 PLANNING YEAR STUDY AREA AM/PM PEAK HOUR TRAFFIC VOLUMES

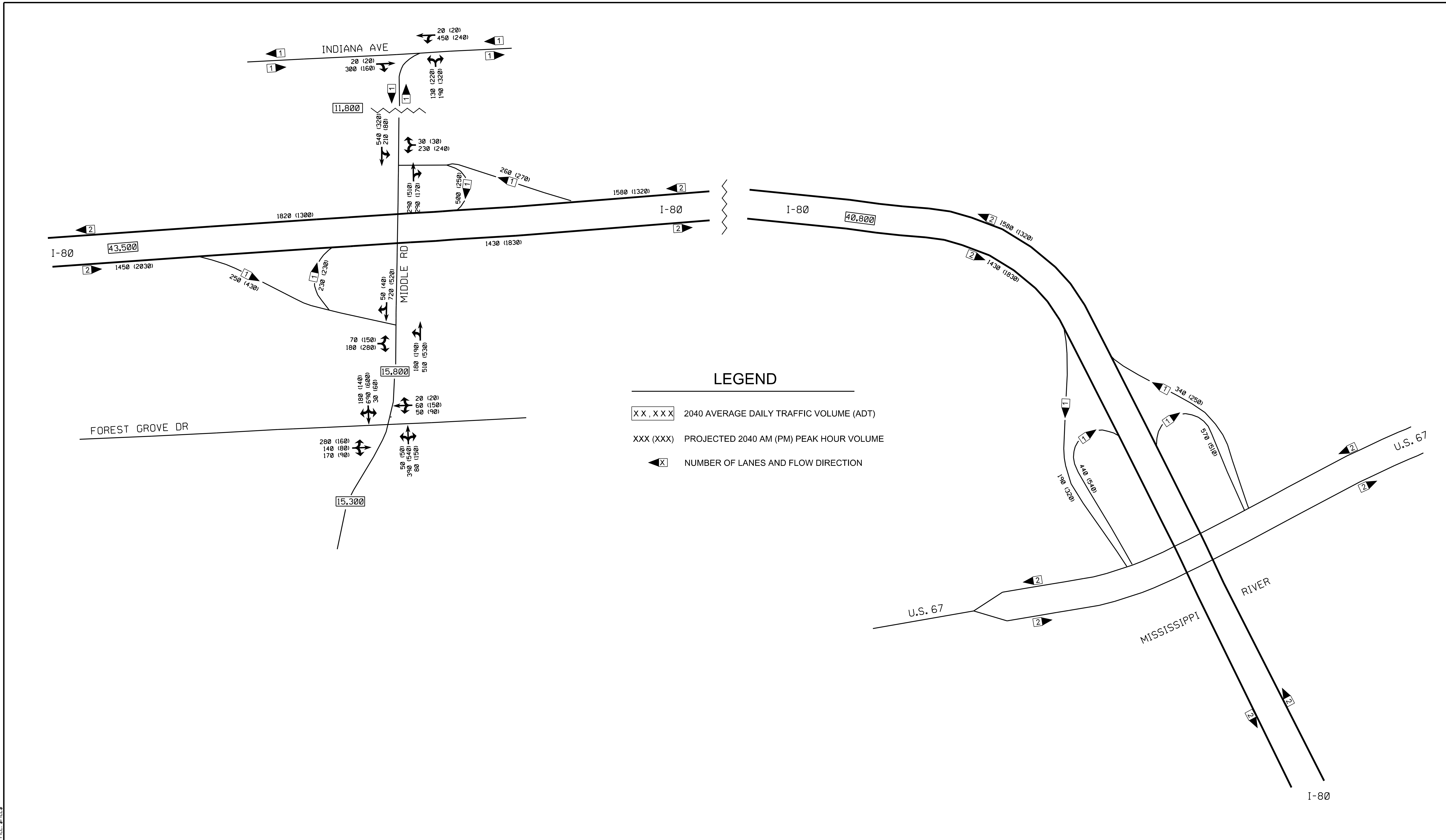
I-80 AND MIDDLE ROAD

BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

EXHIBIT 2

PAGE A



Bettendorf IOWA

Iowa Department of Transportation

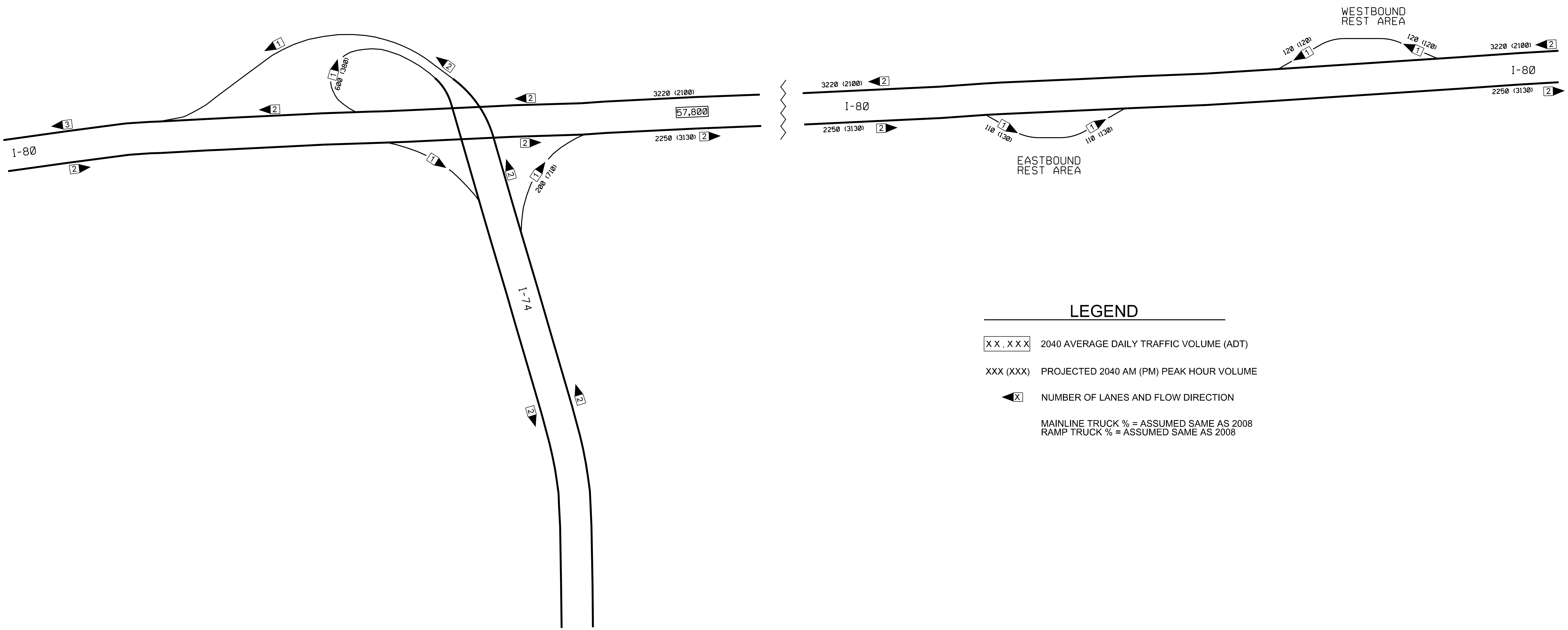
2040 PLANNING YEAR STUDY AREA AM/PM PEAK HOUR TRAFFIC VOLUMES

I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

EXHIBIT 2

PAGE B



PLOT: $TIME$ $DATE$ FILE: $FILE$

Bettendorf IOWA

Iowa Department of Transportation

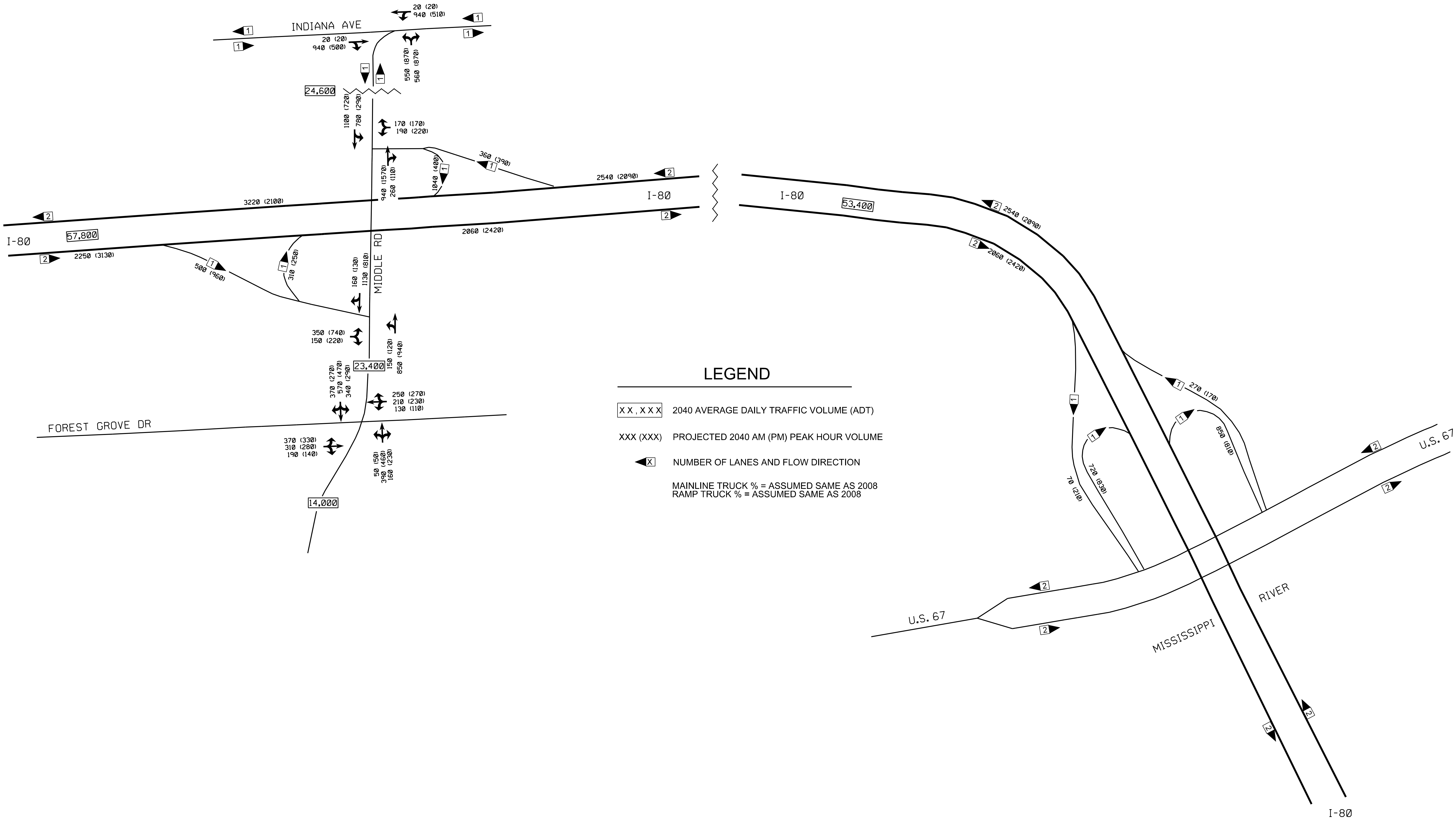
2040 SUB-AREA SCENARIO
AM/PM PEAK HOUR TRAFFIC VOLUMES

I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

EXHIBIT 3

PAGE A



NORTH

NOT TO SCALE

Bettendorf IOWA

Iowa Department of Transportation

2040 SUB-AREA SCENARIO
AM/PM PEAK HOUR TRAFFIC VOLUMES
I-80 AND MIDDLE ROAD
BETTENDORF, SCOTT COUNTY, IOWA

JAN 2014

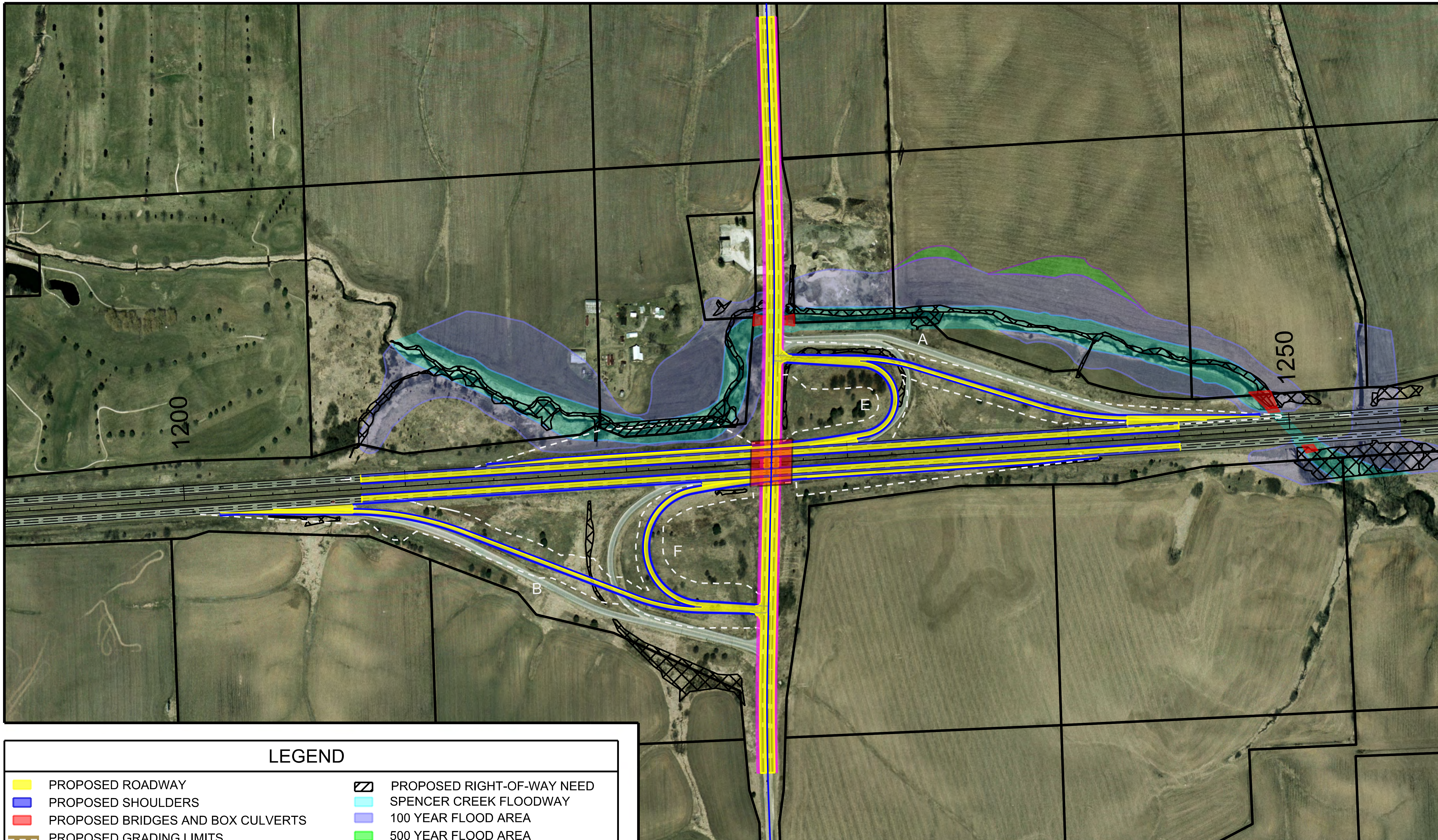
EXHIBIT 3

PAGE B

PLOT: $TIME$ $DATE$ FILE: $FILE$

Appendix D: Concept Drawings

Appendix D: Concept Drawings



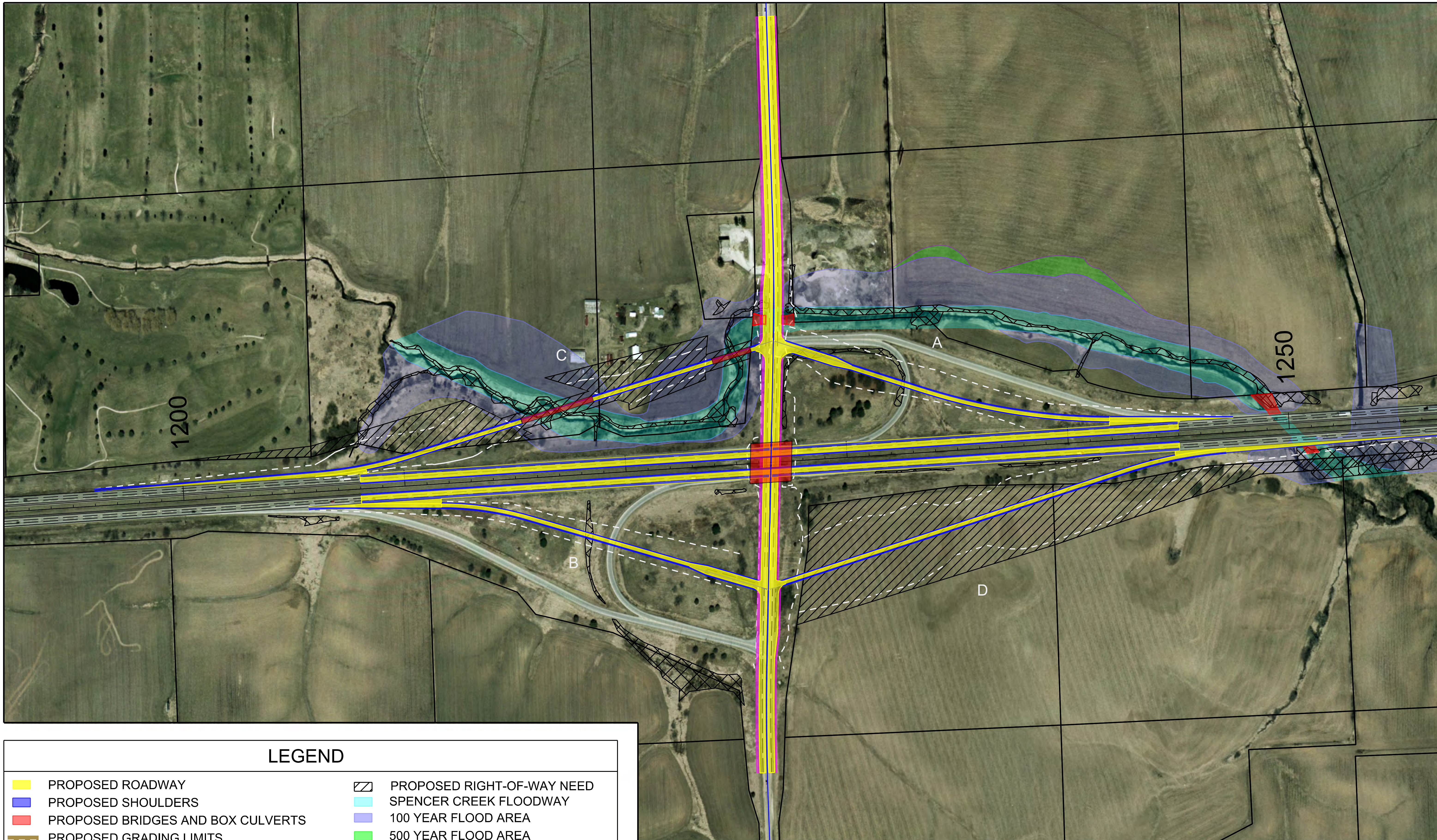
LEGEND

PROPOSED ROADWAY
PROPOSED SHOULDERS
PROPOSED BRIDGES AND BOX CULVERTS
PROPOSED GRADING LIMITS
EXISTING PROPERTY LINES
EXISTING WETLANDS
PROPOSED TRAIL AND SIDEWALK
PROPOSED RIGHT-OF-WAY NEED
SPENCER CREEK FLOODWAY
100 YEAR FLOOD AREA
500 YEAR FLOOD AREA
FUTURE ROADWAY

NORTH
1"=400'

Reconstruct Existing
I-80 and Middle Road
Interchange Justification Report
Bettendorf, Iowa

ALTERNATIVE 1



LEGEND

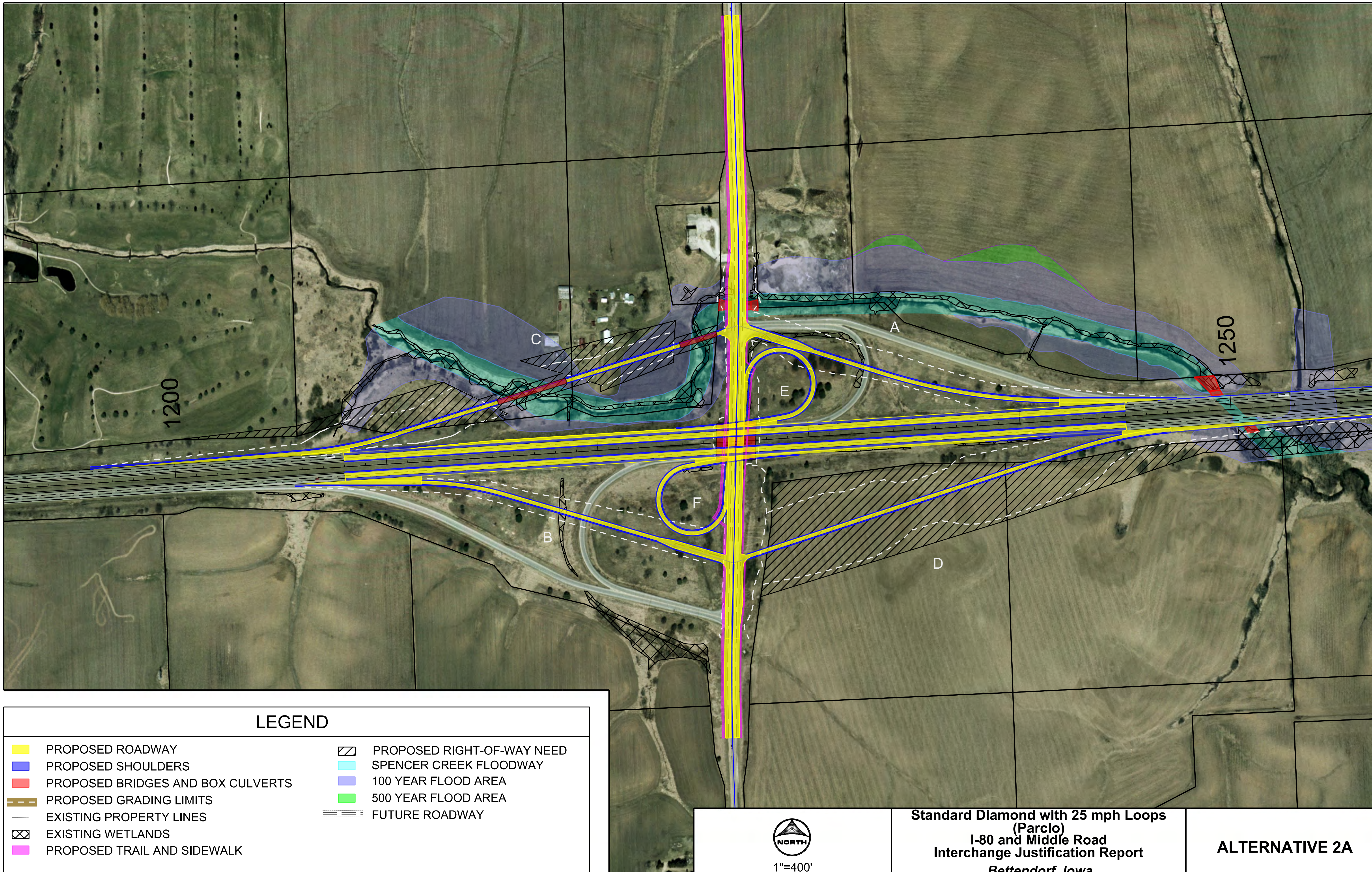
- PROPOSED ROADWAY
- PROPOSED SHOULDERS
- PROPOSED BRIDGES AND BOX CULVERTS
- PROPOSED GRADING LIMITS
- EXISTING PROPERTY LINES
- EXISTING WETLANDS
- PROPOSED TRAIL AND SIDEWALK
- PROPOSED RIGHT-OF-WAY NEED
- SPENCER CREEK FLOODWAY
- 100 YEAR FLOOD AREA
- 500 YEAR FLOOD AREA
- FUTURE ROADWAY

NORTH
1"=400'

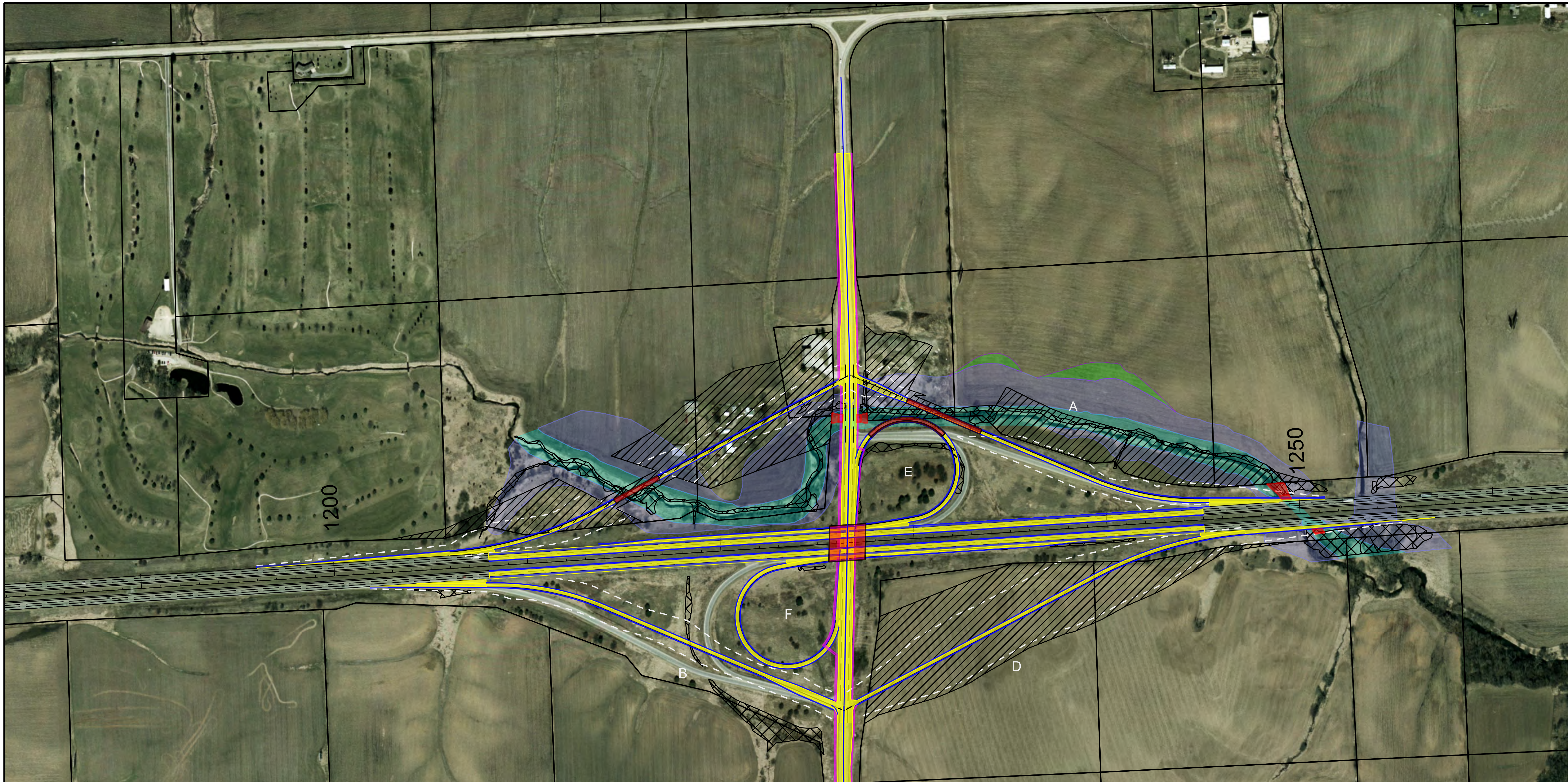
Standard Diamond

I-80 and Middle Road
Interchange Justification Report
Bettendorf, Iowa

ALTERNATIVE 2



C
A
E
F
B
D
1200
1250
LEGEND
PROPOSED ROADWAY
PROPOSED SHOULDERS
PROPOSED BRIDGES AND BOX CULVERTS
PROPOSED GRADING LIMITS
EXISTING PROPERTY LINES
EXISTING WETLANDS
PROPOSED TRAIL AND SIDEWALK
PROPOSED RIGHT-OF-WAY NEED
SPENCER CREEK FLOODWAY
100 YEAR FLOOD AREA
500 YEAR FLOOD AREA
FUTURE ROADWAY
NORTH
1"=400'
Standard Diamond with 25 mph Loops (Parclo)
I-80 and Middle Road
Interchange Justification Report
Bettendorf, Iowa
ALTERNATIVE 2A



LEGEND

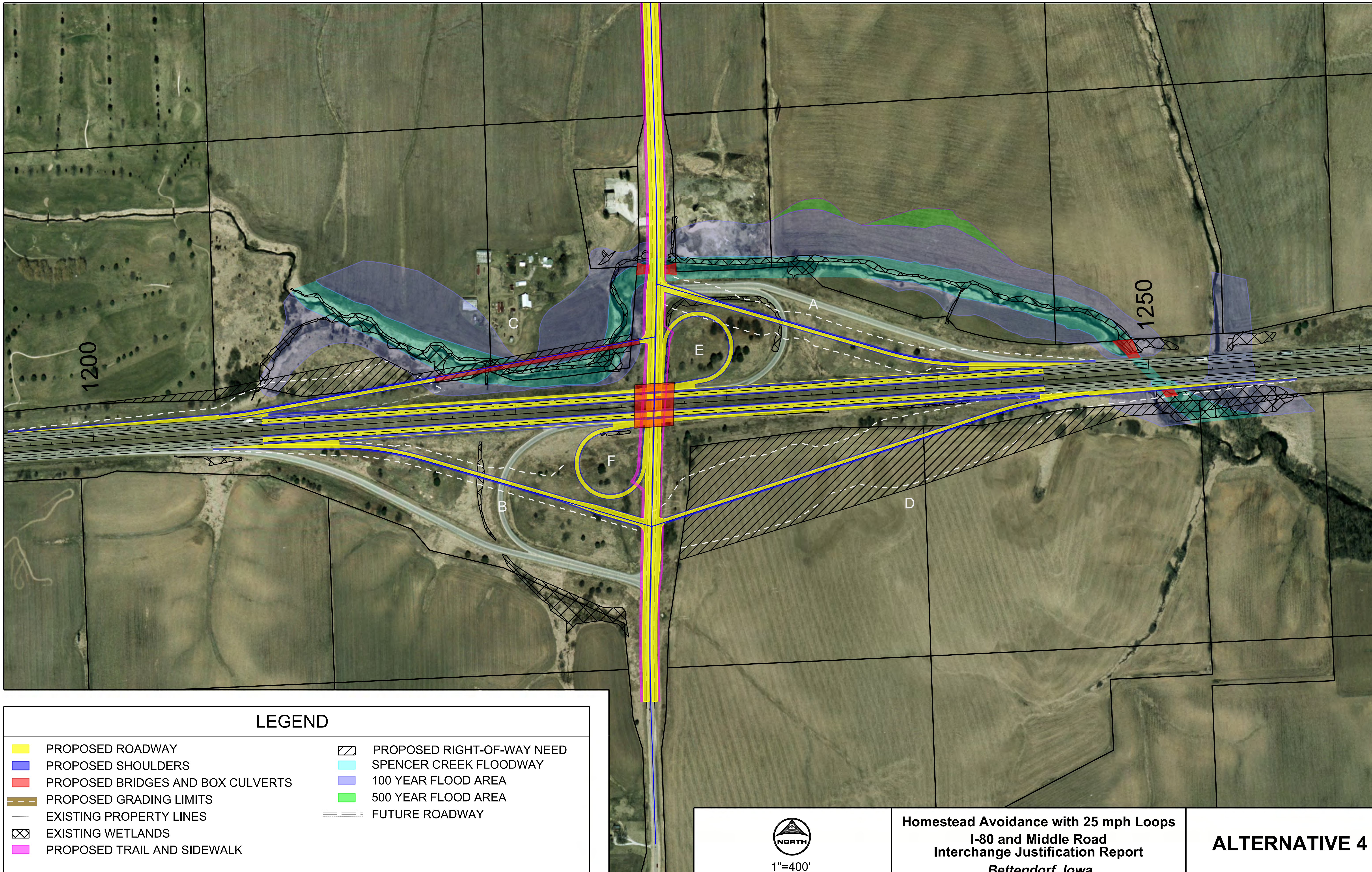
- PROPOSED ROADWAY
- PROPOSED SHOULDERS
- PROPOSED BRIDGES AND BOX CULVERTS
- PROPOSED GRADING LIMITS
- EXISTING PROPERTY LINES
- EXISTING WETLANDS
- PROPOSED TRAIL AND SIDEWALK
- PROPOSED RIGHT-OF-WAY NEED
- SPENCER CREEK FLOODWAY
- 100 YEAR FLOOD AREA
- 500 YEAR FLOOD AREA
- FUTURE ROADWAY

NORTH

1"=500'

Standard Diamond with 30 mph Loops (Parclo)
I-80 and Middle Road
Interchange Justification Report
Bettendorf, Iowa

ALTERNATIVE 3



LEGEND

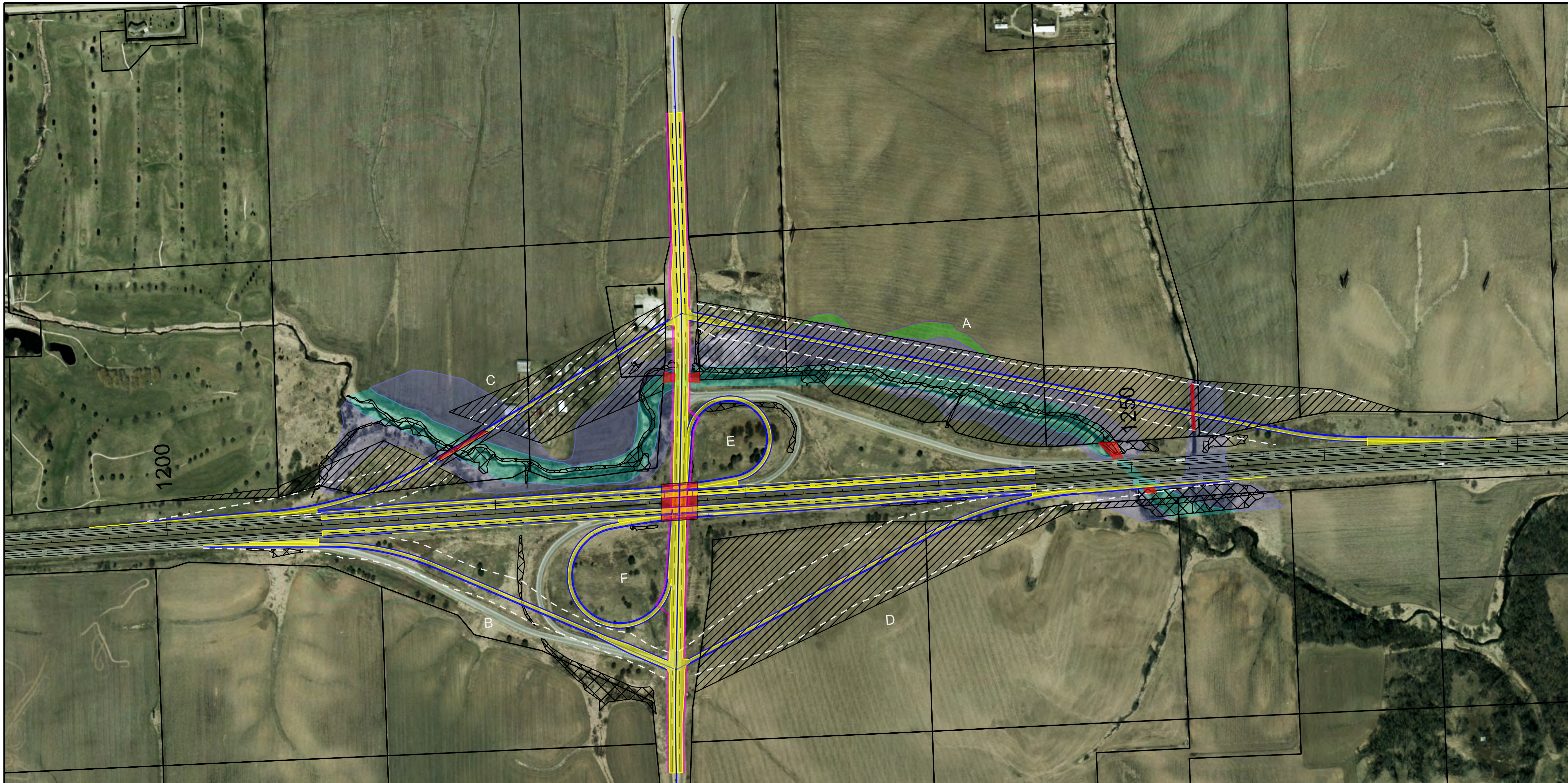
- PROPOSED ROADWAY
- PROPOSED SHOULDERS
- PROPOSED BRIDGES AND BOX CULVERTS
- PROPOSED GRADING LIMITS
- EXISTING PROPERTY LINES
- EXISTING WETLANDS
- PROPOSED TRAIL AND SIDEWALK
- PROPOSED RIGHT-OF-WAY NEED
- SPENCER CREEK FLOODWAY
- 100 YEAR FLOOD AREA
- 500 YEAR FLOOD AREA
- FUTURE ROADWAY

NORTH

1"=400'

Homestead Avoidance with 25 mph Loops
I-80 and Middle Road
Interchange Justification Report
Bettendorf, Iowa

ALTERNATIVE 4



LEGEND

- PROPOSED ROADWAY
- PROPOSED SHOULDERS
- PROPOSED BRIDGES AND BOX CULVERTS
- PROPOSED GRADING LIMITS
- EXISTING PROPERTY LINES
- EXISTING WETLANDS
- PROPOSED TRAIL AND SIDEWALK
- PROPOSED RIGHT-OF-WAY NEED
- SPENCER CREEK FLOODWAY
- 100 YEAR FLOOD AREA
- 500 YEAR FLOOD AREA
- FUTURE ROADWAY

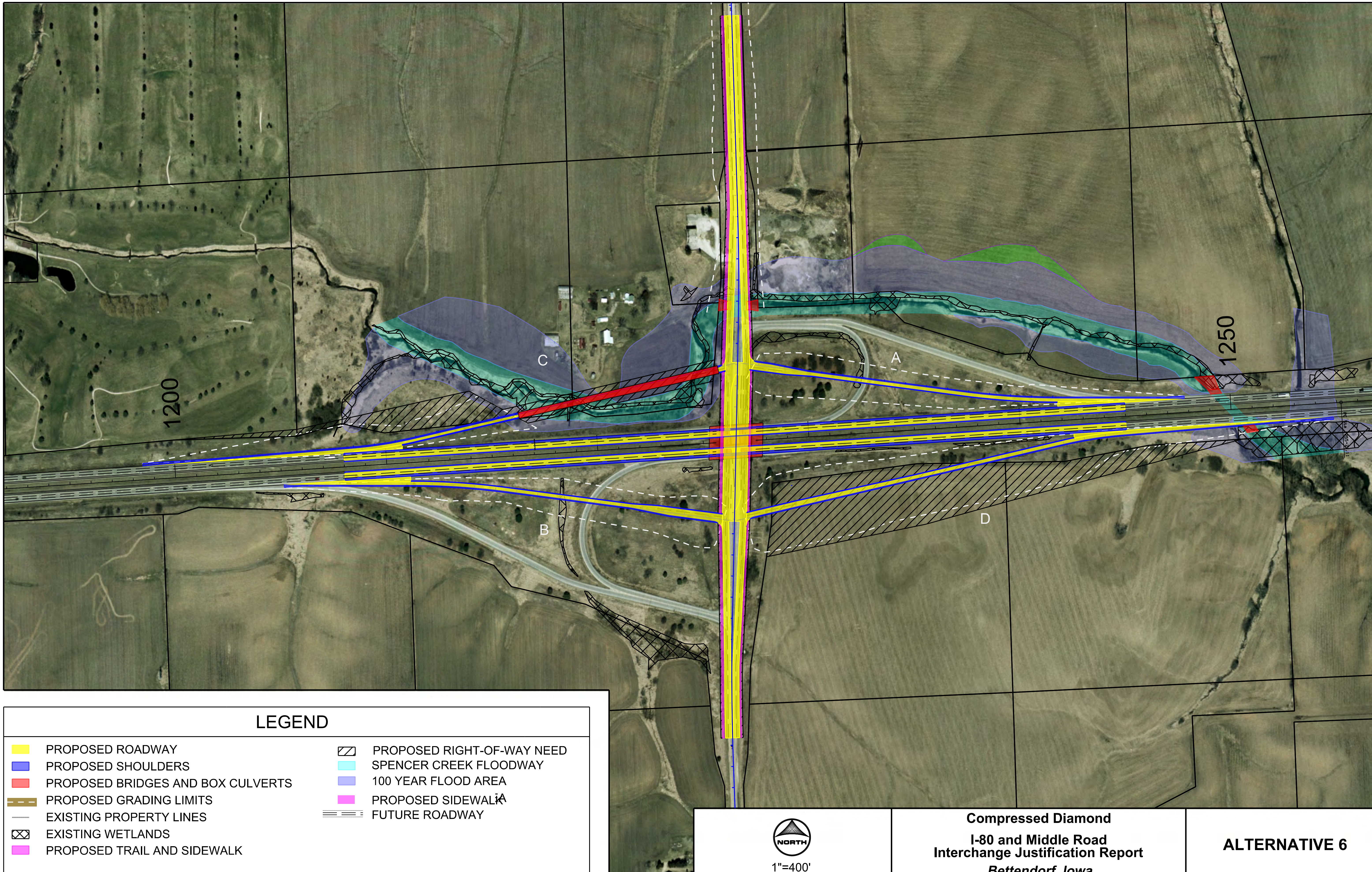
NORTH

1"=500'

Creek Avoidance

I-80 and Middle Road
Interchange Justification Report
Bettendorf, Iowa

ALTERNATIVE 5



LEGEND

- PROPOSED ROADWAY
- PROPOSED SHOULDERS
- PROPOSED BRIDGES AND BOX CULVERTS
- PROPOSED GRADING LIMITS
- EXISTING PROPERTY LINES
- EXISTING WETLANDS
- PROPOSED TRAIL AND SIDEWALK
- PROPOSED RIGHT-OF-WAY NEED
- SPENCER CREEK FLOODWAY
- 100 YEAR FLOOD AREA
- PROPOSED SIDEWALK
- FUTURE ROADWAY

NORTH

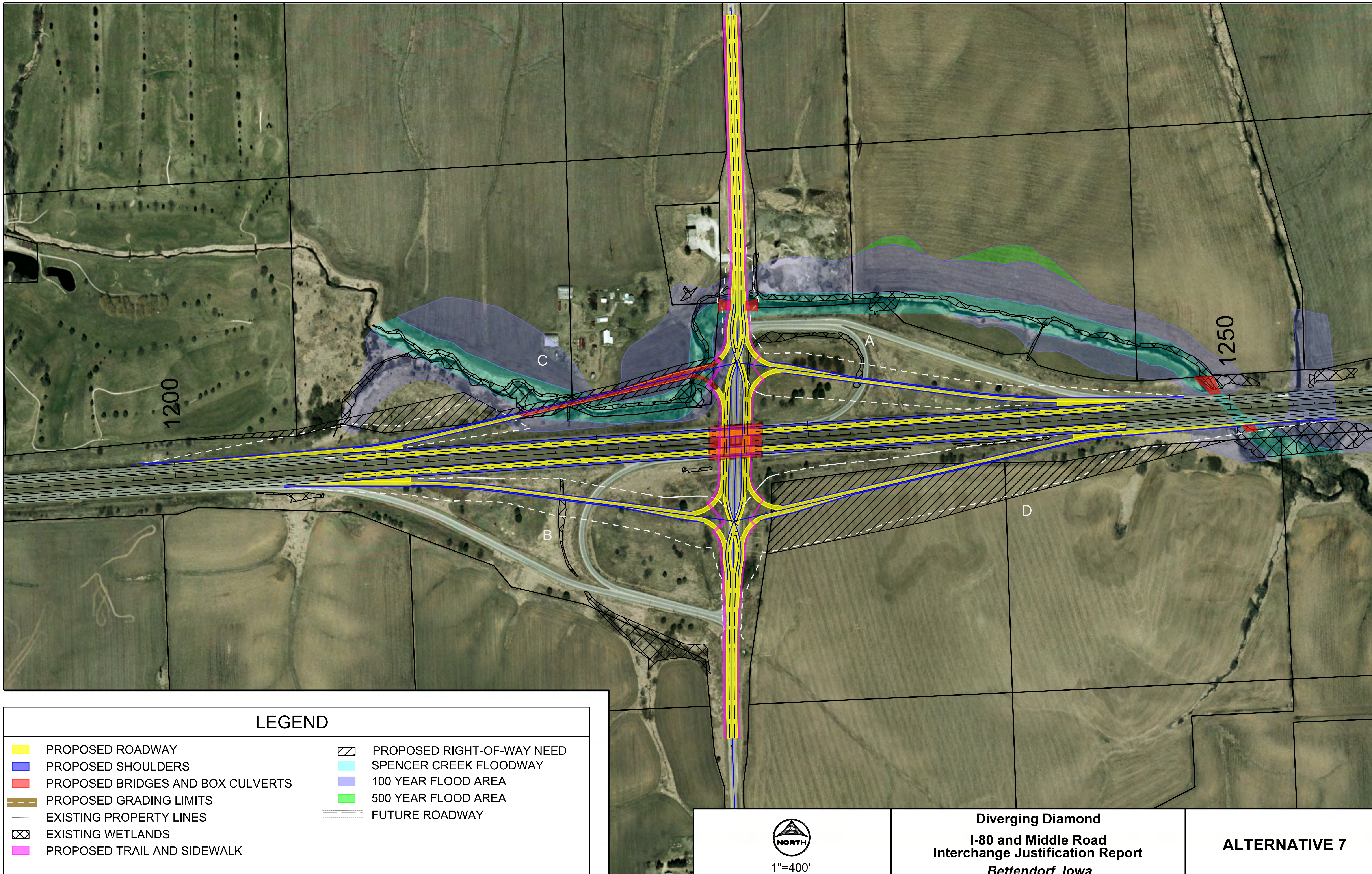
1"=400'

Compressed Diamond

I-80 and Middle Road Interchange Justification Report

Bettendorf, Iowa

ALTERNATIVE 6



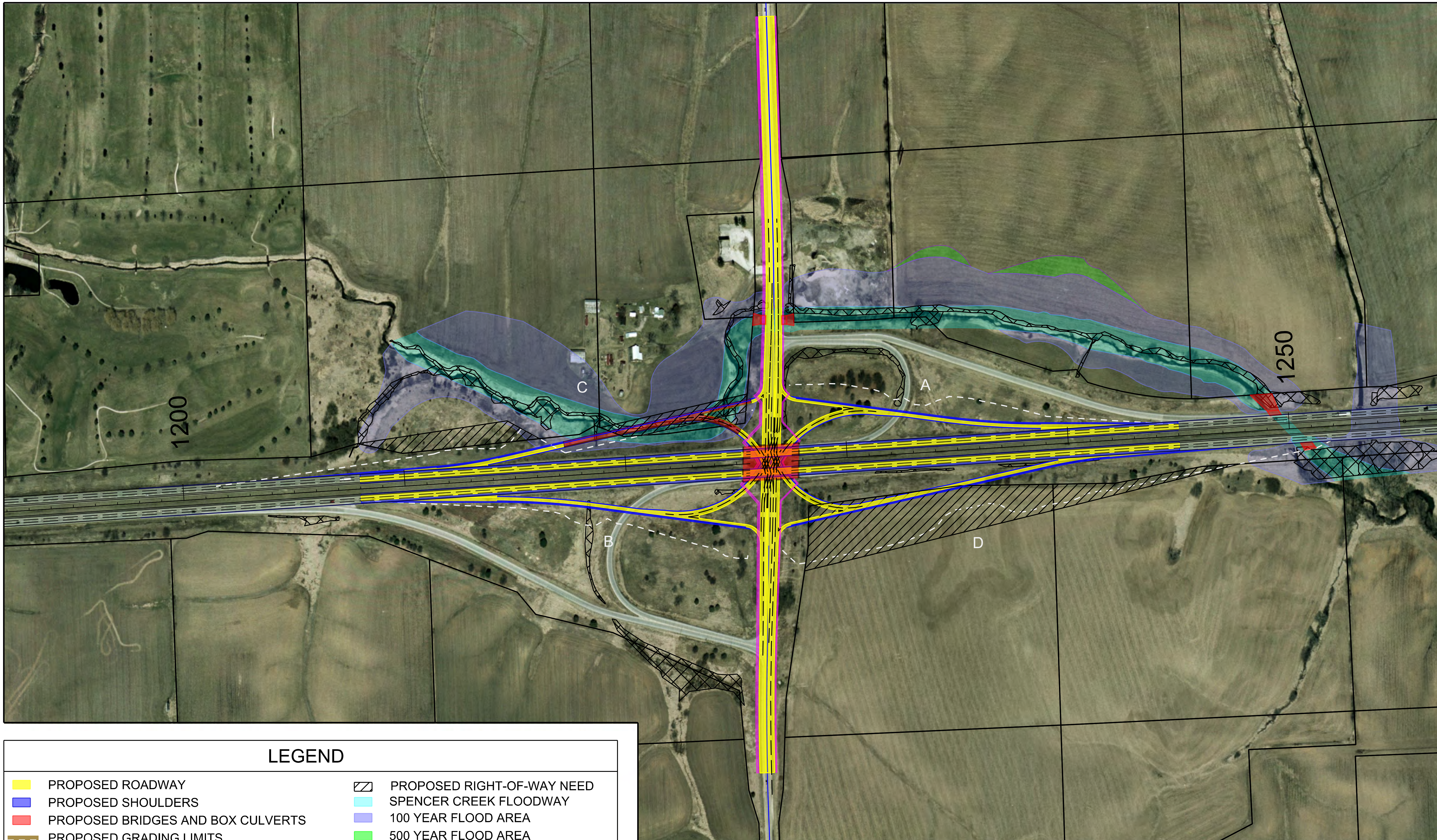
LEGEND

- PROPOSED ROADWAY
- PROPOSED SHOULDERS
- PROPOSED BRIDGES AND BOX CULVERTS
- PROPOSED GRADING LIMITS
- EXISTING PROPERTY LINES
- EXISTING WETLANDS
- PROPOSED TRAIL AND SIDEWALK
- PROPOSED RIGHT-OF-WAY NEED
- SPENCER CREEK FLOODWAY
- 100 YEAR FLOOD AREA
- 500 YEAR FLOOD AREA
- FUTURE ROADWAY

Diverging Diamond

I-80 and Middle Road
Interchange Justification Report
Bettendorf, Iowa

ALTERNATIVE 7



LEGEND

- PROPOSED ROADWAY
- PROPOSED SHOULDERS
- PROPOSED BRIDGES AND BOX CULVERTS
- PROPOSED GRADING LIMITS
- EXISTING PROPERTY LINES
- EXISTING WETLANDS
- PROPOSED TRAIL AND SIDEWALK
- PROPOSED RIGHT-OF-WAY NEED
- SPENCER CREEK FLOODWAY
- 100 YEAR FLOOD AREA
- 500 YEAR FLOOD AREA
- FUTURE ROADWAY

NORTH

1"=400'

Single Point Urban Interchange

I-80 and Middle Road
Interchange Justification Report
Bettendorf, Iowa

ALTERNATIVE 8

Appendix E: Opinions of Probable Construction Cost

Appendix E: Opinions of Probable Construction Cost

I-80 / Middle Road Interchange
Bettendorf, Iowa

Planning Level Opinion of Probable Cost
HR Green Company -- March 2014
Alternative 1-Reconstruct Existing

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	32,500	$ 7.00	$ 228,000
2	NEW PAVEMENT				
	Ramps and Loops	SY	17,000	$ 50.00	$ 850,000
	Middle Road	SY	23,000	$ 50.00	$ 1,150,000
	I-80 EB and I-80 WB	SY	20,000	$ 50.00	$ 1,000,000
	Trail/Sidewalk	SY	5,600	$ 40.00	$ 224,000
3	SHOULDERS				
	Paved Shoulders	SY	23,900	$ 45.00	$ 1,076,000
4	TEMPORARY PAVING (For Staging)				
	Arterial Street/Ramps	SY	1,200	$ 45.00	$ 54,000
	Shoulders	SY	800	$ 45.00	$ 36,000
5	STRUCTURES				
	I-80 Mainline Bridge	SF	38,100	$ 115.00	$ 4,382,000
6	EARTHWORK	CY	74,978	$ 8.00	$ 600,000
7	MODIFIED BASE	CY	15,633	$ 35.00	$ 547,000
				Subtotal, Items 1-7	$ 10,147,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 1,218,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 203,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 304,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 507,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 1,218,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 13,597,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$15,907,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 3,976,750
14	ROW ACQUISITION				
	Farmland	AC	0.8	$ 50,000.00	$ 40,000
				Subtotal ROW Costs, Item 14	**$ 40,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 1,992,000
	TOTAL PROJECT COST				**$ 21,920,000**

ASSUMPTIONS

1. Rebuild approximately 1900 feet of Middle Road.
2. Rebuild approximately 3700 feet of I-80 EB and I-80 WB.
3. 4% annual inflation rate for construction costs.
4. Includes earthwork for ramps and loops.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Planning Level Opinion of Probable Cost
HR Green Company -- March 2014
Alternative 2-Standard Diamond

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	32,500	$ 7.00	$ 228,000
2	NEW PAVEMENT				
	Ramps	SY	18,000	$ 50.00	$ 900,000
	Middle Road	SY	23,000	$ 50.00	$ 1,150,000
	I-80 EB and I-80 WB	SY	20,000	$ 50.00	$ 1,000,000
	Trail/Sidewalk	SY	5,500	$ 40.00	$ 220,000
3	SHOULDERS				
	Paved Shoulders	SY	24,300	$ 45.00	$ 1,094,000
4	TEMPORARY PAVING (For Staging)				
	Arterial Street/Ramps	SY	1,300	$ 45.00	$ 59,000
	Shoulders	SY	900	$ 45.00	$ 41,000
5	STRUCTURES				
	I-80 Bridges and Box Culverts	SF	35,000	$ 115.00	$ 4,025,000
	Ramp Bridges	SF	13,500	$ 125.00	$ 1,688,000
6	EARTHWORK	CY	429,654	$ 8.00	$ 3,437,000
7	MODIFIED BASE	CY	14,100	$ 35.00	$ 494,000
				Subtotal, Items 1-7	$ 14,336,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 1,720,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 287,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 430,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 717,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 1,720,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 19,210,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$22,473,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 5,618,250
14	ROW ACQUISITION				
	Farmland	AC	21.8	$ 50,000.00	$ 1,090,000
				Subtotal ROW Costs, Item 14	**$ 1,090,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 2,918,000
	TOTAL PROJECT COST				**$ 32,100,000**

ASSUMPTIONS

1. Rebuild all ramps.
2. Rebuild approximately 1900 feet of Middle Road.
3. Rebuild approximately 3700 feet of I-80 EB and I-80 WB.
4. 4% annual inflation rate for construction costs.
5. Includes earthwork for ramps.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Planning Level Opinion of Probable Cost
HR Green Company -- March 2014
Alternative 2a-Standard Diamond with 25 mph Loops for Expandability

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	32,500	$ 7.00	$ 228,000
2	NEW PAVEMENT				
	Ramps and Loops	SY	23,000	$ 50.00	$ 1,150,000
	Middle Road	SY	23,000	$ 50.00	$ 1,150,000
	I-80 EB and I-80 WB	SY	20,000	$ 50.00	$ 1,000,000
	Trail/Sidewalk	SY	5,600	$ 40.00	$ 224,000
3	SHOULDERS				
	Paved Shoulders	SY	28,000	$ 45.00	$ 1,260,000
4	TEMPORARY PAVING (For Staging)				
	Arterial Street/Ramps	SY	1,300	$ 45.00	$ 59,000
	Shoulders	SY	900	$ 45.00	$ 41,000
5	STRUCTURES				
	I-80 Bridges and Box Culverts	SF	35,000	$ 115.00	$ 4,025,000
	Ramp Bridges	SF	13,500	$ 125.00	$ 1,688,000
6	EARTHWORK	CY	459,447	$ 8.00	$ 3,676,000
7	MODIFIED BASE	CY	17,000	$ 35.00	$ 595,000
				Subtotal, Items 1-7	$ 15,096,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 1,812,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 302,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 453,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 755,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 1,812,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 20,230,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$23,667,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 5,916,750
14	ROW ACQUISITION				
	Farmland	AC	21.8	$ 50,000.00	$ 1,090,000
				Subtotal ROW Costs, Item 14	**$ 1,090,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 3,067,000
	TOTAL PROJECT COST				**$ 33,740,000**

ASSUMPTIONS

1. Rebuild all ramps and loops.
2. Rebuild approximately 1900 feet of Middle Road.
3. Rebuild approximately 3700 feet of I-80 EB and I-80 WB.
4. 4% annual inflation rate for construction costs.
5. Includes earthwork for ramps.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Planning Level Opinion of Probable Cost
HR Green Company -- March 2014
Alternative 3-Standard Diamond with 30 mph Loops for Expandability

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	32,500	$ 7.00	$ 228,000
2	NEW PAVEMENT				
	Ramps and Loops	SY	30,000	$ 50.00	$ 1,500,000
	Middle Road	SY	23,000	$ 50.00	$ 1,150,000
	I-80 EB and I-80 WB	SY	20,000	$ 50.00	$ 1,000,000
	Trail/Sidewalk	SY	5,700	$ 40.00	$ 228,000
3	SHOULDERS				
	Paved Shoulders	SY	30,600	$ 45.00	$ 1,377,000
4	TEMPORARY PAVING (For Staging)				
	Arterial Street/Ramps	SY	7,000	$ 45.00	$ 315,000
	Shoulders	SY	4,400	$ 45.00	$ 198,000
5	STRUCTURES				
	I-80 Bridges and Box Culverts	SF	35,900	$ 115.00	$ 4,129,000
	Ramp Bridges	SF	29,400	$ 125.00	$ 3,675,000
6	EARTHWORK	CY	425,943	$ 8.00	$ 3,408,000
7	MODIFIED BASE	CY	20,200	$ 35.00	$ 707,000
				Subtotal, Items 1-7	$ 17,915,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 2,150,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 358,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 537,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 896,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 2,150,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 24,006,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$28,084,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 7,021,000
14	ROW ACQUISITION				
	Farmland	AC	40.0	$ 50,000.00	$ 2,000,000
				Subtotal ROW Cost, Items 14	**$ 2,000,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 3,711,000
	TOTAL PROJECT COST				**$ 40,820,000**

ASSUMPTIONS

1. Rebuild all ramps and loops.
2. Rebuild approximately 1900 feet of Middle Road.
3. Rebuild approximately 3700 feet of I-80 EB and I-80 WB.
4. 4% annual inflation rate for construction costs.
5. Includes earthwork for ramps.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Planning Level Opinion of Probable Cost
HR Green Company -- March 2014
Alternative 4-Homestead Avoidance with 25 mph Loops for Expandability

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	32,500	$ 7.00	$ 228,000
2	NEW PAVEMENT				
	Ramps and Loops	SY	27,000	$ 50.00	$ 1,350,000
	Middle Road	SY	23,000	$ 50.00	$ 1,150,000
	I-80 EB and I-80 WB	SY	20,000	$ 50.00	$ 1,000,000
	Trail/Sidewalk	SY	5,600	$ 40.00	$ 224,000
3	SHOULDERS				
	Paved Shoulders	SY	27,100	$ 45.00	$ 1,220,000
4	TEMPORARY PAVING (For Staging)				
	Arterial Street/Ramps	SY	1,300	$ 45.00	$ 59,000
	Shoulders	SY	900	$ 45.00	$ 41,000
5	STRUCTURES				
	I-80 Bridges and Box Culverts	SF	39,600	$ 115.00	$ 4,554,000
	Ramp Bridges	SF	25,600	$ 125.00	$ 3,200,000
6	EARTHWORK	CY	452,807	$ 8.00	$ 3,622,000
7	MODIFIED BASE	CY	18,033	$ 35.00	$ 631,000
				Subtotal, Items 1-8	$ 17,279,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 2,073,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 346,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 518,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 864,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 2,073,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 23,153,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$27,086,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 6,771,500
14	ROW ACQUISITION				
	Farmland	AC	18.9	$ 50,000.00	$ 945,000
				Subtotal ROW Costs, Item 14	**$ 945,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 3,480,000
	TOTAL PROJECT COST				**$ 38,280,000**

ASSUMPTIONS

1. Rebuild all ramps and loops.
2. Rebuild approximately 1900 feet of Middle Road.
3. Rebuild approximately 3700 feet of I-80 EB and I-80 WB.
4. 4% annual inflation rate for construction costs.
5. Includes earthwork for ramps.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Planning Level Opinion of Probable Cost
HR Green Company -- March 2014
Alternative 5-Creek Avoidance

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	32,500	$ 7.00	$ 228,000
2	NEW PAVEMENT				
	Ramps and Loops	SY	37,000	$ 50.00	$ 1,850,000
	Middle Road	SY	22,000	$ 50.00	$ 1,100,000
	I-80 EB and I-80 WB	SY	20,000	$ 50.00	$ 1,000,000
	Trail/Sidewalk	SY	5,700	$ 40.00	$ 228,000
3	SHOULDERS				
	Paved Shoulders	SY	36,300	$ 45.00	$ 1,634,000
4	TEMPORARY PAVING (For Staging)				
	Arterial Street/Ramps	SY	4,700	$ 45.00	$ 212,000
	Shoulders	SY	3,000	$ 45.00	$ 135,000
5	STRUCTURES				
	I-80 Bridges and Box Culverts	SF	37,100	$ 115.00	$ 4,267,000
	Ramp Bridges	SF	7,500	$ 125.00	$ 938,000
6	EARTHWORK	CY	500,931	$ 8.00	$ 4,007,000
7	MODIFIED BASE	CY	24,433	$ 35.00	$ 855,000
				Subtotal, Items 1-7	$ 16,454,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 1,974,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 329,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 494,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 823,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 1,974,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 22,048,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$25,794,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 6,448,500
14	ROW ACQUISITION				
	Farmland	AC	56.1	$ 50,000.00	$ 2,805,000
				Subtotal ROW Costs, Item 14	**$ 2,805,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 3,505,000
	TOTAL PROJECT COST				**$ 38,550,000**

ASSUMPTIONS

1. Rebuild all ramps and loops.
2. Rebuild approximately 1900 feet of Middle Road.
3. Rebuild approximately 3700 feet of I-80 EB and I-80 WB.
4. 4% annual inflation rate for construction costs.
5. Includes earthwork for ramps and loops.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Planning Level Opinion of Probable Cost
HR Green Company -- March 2014
Alternative 6-Compressed Diamond

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	32,500	$ 7.00	$ 228,000
2	NEW PAVEMENT				
	Ramps	SY	17,300	$ 50.00	$ 865,000
	Middle Road	SY	27,000	$ 50.00	$ 1,350,000
	I-80 EB and I-80 WB	SY	20,000	$ 50.00	$ 1,000,000
	Trail/Sidewalk	SY	5,600	$ 40.00	$ 224,000
3	SHOULDERS				
	Paved Shoulders	SY	20,900	$ 45.00	$ 941,000
4	TEMPORARY PAVING (For Staging)				
	Arterial Street/Ramps	SY	3,400	$ 45.00	$ 153,000
	Shoulders	SY	2,100	$ 45.00	$ 95,000
5	STRUCTURES				
	I-80 Bridges and Box Culverts	SF	41,700	$ 115.00	$ 4,796,000
	Ramp Bridges	SF	32,200	$ 125.00	$ 4,025,000
6	EARTHWORK	CY	426,695	$ 8.00	$ 3,414,000
7	MODIFIED BASE	CY	12,733	$ 35.00	$ 446,000
				Subtotal, Items 1-7	$ 17,537,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 2,104,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 351,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 526,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 877,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 2,104,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 23,499,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$27,491,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 6,872,750
14	ROW ACQUISITION				
	Farmland	AC	14.1	$ 50,000.00	$ 705,000
				Subtotal ROW Costs, Item 14	**$ 705,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 3,507,000
	TOTAL PROJECT COST				**$ 38,580,000**

ASSUMPTIONS

1. Rebuild all ramps.
2. Rebuild approximately 1900 feet of Middle Road.
3. Rebuild approximately 3700 feet of I-80 EB and I-80 WB.
4. 4% annual inflation rate for construction costs.
5. Includes earthwork for ramps and Middle Road widening.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Planning Level Opinion of Probable Cost
HR Green Company -- March 2014
Alternative 7-Diverging Diamond Interchange, (DDI)

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	32,500	$ 7.00	$ 228,000
2	NEW PAVEMENT				
	Ramps	SY	19,000	$ 50.00	$ 950,000
	Middle Road	SY	21,000	$ 50.00	$ 1,050,000
	I-80 EB and I-80 WB	SY	20,000	$ 50.00	$ 1,000,000
	Trail/Sidewalk	SY	6,000	$ 40.00	$ 240,000
3	SHOULDERS				
	Paved Shoulders	SY	22,800	$ 45.00	$ 1,026,000
4	TEMPORARY PAVING (For Staging)				
	Arterial Street/Ramps	SY	3,400	$ 45.00	$ 153,000
	Shoulders	SY	2,100	$ 45.00	$ 95,000
5	STRUCTURES				
	I-80 Bridges and Box Culverts	SF	41,700	$ 115.00	$ 4,796,000
	Ramp Bridges	SF	32,200	$ 125.00	$ 4,025,000
6	EARTHWORK	CY	426,695	$ 8.00	$ 3,414,000
7	MODIFIED BASE	CY	13,933	$ 35.00	$ 488,000
				Subtotal, Items 1-7	$ 17,465,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 2,096,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 349,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 524,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 873,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 2,096,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 23,403,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$27,379,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 6,844,750
14	ROW ACQUISITION				
	Farmland	AC	13.1	$ 50,000.00	$ 655,000
				Subtotal ROW Costs, Item 14	**$ 655,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 3,488,000
	TOTAL PROJECT COST				**$ 38,370,000**

ASSUMPTIONS

1. Rebuild all ramps.
2. Rebuild approximately 1900 feet of Middle Road.
3. Rebuild approximately 3700 feet of I-80 EB and I-80 WB.
4. 4% annual inflation rate for construction costs.
5. Includes earthwork for ramps and Middle Road widening.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Planning Level Opinion of Probable Cost
HR Green Company -- March 2014
Alternative 8-Single Point Urban Interchange, (SPUI)

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	32,500	$ 7.00	$ 228,000
2	NEW PAVEMENT				
	Ramps	SY	14,000	$ 50.00	$ 700,000
	Middle Road	SY	24,000	$ 50.00	$ 1,200,000
	I-80 EB and I-80 WB	SY	20,000	$ 50.00	$ 1,000,000
	Trail/Sidewalk	SY	7,800	$ 40.00	$ 312,000
3	SHOULDERS				
	Paved Shoulders	SY	21,100	$ 45.00	$ 950,000
4	TEMPORARY PAVING (For Staging)				
	Arterial Street/Ramps	SY	3,400	$ 45.00	$ 153,000
	Shoulders	SY	2,100	$ 45.00	$ 95,000
5	STRUCTURES				
	I-80 Bridges and Box Culverts	SF	41,700	$ 115.00	$ 4,796,000
	Ramp Bridges	SF	25,600	$ 125.00	$ 3,200,000
6	EARTHWORK	CY	426,695	$ 8.00	$ 3,414,000
7	MODIFIED BASE	CY	11,700	$ 35.00	$ 410,000
				Subtotal, Items 1-7	$ 16,458,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 1,975,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 329,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 494,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 823,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 1,975,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 22,054,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$25,801,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 6,450,250
14	ROW ACQUISITION				
	Farmland	AC	8.9	$ 50,000.00	$ 445,000
				Subtotal ROW Costs, Item 14	**$ 445,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 3,270,000
	TOTAL PROJECT COST				**$ 35,970,000**

ASSUMPTIONS

1. Rebuild all ramps.
2. Rebuild approximately 1900 feet of Middle Road.
3. Rebuild approximately 3700 feet of I-80 EB and I-80 WB.
4. 4% annual inflation rate for construction costs.
5. Includes earthwork for ramps and Middle Road widening.

Compressed Diamond Interchange

Opinion of Probable Construction Costs

Segment Breakout

I-80 / Middle Road Interchange
Bettendorf, Iowa

I-80 Planning Level Opinion of Probable Cost
HR Green Company -- January 2014
Alternative 6-Compressed Diamond

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	28,000	$ 7.00	$ 196,000
2	NEW PAVEMENT				
	I-80 EB	SY	10,000	$ 50.00	$ 500,000
	I-80 WB	SY	10,000	$ 50.00	$ 500,000
3	SHOULDERS				
	I-80 EB	SY	4,100	$ 45.00	$ 185,000
	I-80 WB	SY	4,100	$ 45.00	$ 185,000
4	TEMPORARY PAVING (For Staging)				
	CROSSOVERS	SY	2,500	$ 45.00	$ 113,000
5	STRUCTURES				
	I-80 Bridges	SF	41,700	$ 115.00	$ 4,796,000
6	EARTHWORK	CY	200,000	$ 8.00	$ 1,600,000
7	MODIFIED BASE	CY	4,700	$ 35.00	$ 165,000
				Subtotal, Items 1-7	$ 8,240,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 989,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 165,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 247,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 412,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 989,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 11,042,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$12,918,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 3,229,500
14	CONTINGENCY	LS	10% of Items 1-13	N/A	$ 1,615,000
	TOTAL PROJECT COST				**$ 17,760,000**

ASSUMPTIONS

1. 4% annual inflation rate for construction costs.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Middle Road Planning Level Opinion of Probable Cost
HR Green Company -- January 2014
Alternative 6-Compressed Diamond

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	55,000	$ 7.00	$ 385,000
2	NEW PAVEMENT				
	Middle Road	SY	24,600	$ 50.00	$ 1,230,000
	Trail/Sidewalk	SY	5,600	$ 40.00	$ 224,000
3	TEMPORARY PAVING (For Staging)				
	Middle Road	SY	2,500	$ 45.00	$ 113,000
4	EARTHWORK	CY	414,736	$ 8.00	$ 3,318,000
5	MODIFIED BASE	CY	8,200	$ 35.00	$ 287,000
				Subtotal, Items 1-7	$ 5,557,000
	ALLOWANCES:				
6	DRAINAGE	LS	12% of items 1-5	N/A	$ 667,000
7	EROSION CONTROL	LS	2% of items 1-5	N/A	$ 111,000
8	SIGNING/MARKINGS	LS	3% of items 1-5	N/A	$ 167,000
9	TYPICAL UTILITIES	LS	5% of items 1-5	N/A	$ 278,000
10	INCIDENTAL	LS	12% of items 1-5		$ 667,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 7,447,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$8,712,000**
11	ENGINEERING	LS	25% of Items 1-10	N/A	$ 2,178,000
12	CONTINGENCY	LS	10% of Items 1-11	N/A	$ 1,089,000
	TOTAL PROJECT COST				**$ 11,980,000**

ASSUMPTIONS

1. Does not include associated costs of improvements to I-80
2. Rebuild all ramps.
3. Rebuild approximately 3400 feet of Middle Road.
4. 4% annual inflation rate for construction costs.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Ramp A Planning Level Opinion of Probable Cost
HR Green Company -- January 2014
Alternative 6-Compressed Diamond

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	8,125	$ 7.00	$ 57,000
2	NEW PAVEMENT				
	Ramp A	SY	4,000	$ 50.00	$ 200,000
3	SHOULDERS				
	Ramp A	SY	2,100	$ 45.00	$ 95,000
4	TEMPORARY PAVING (For Staging)				
	I-80 Tie-In	SY	800	$ 45.00	$ 36,000
5	EARTHWORK	CY	47,449	$ 8.00	$ 380,000
	Ramp A		47,449		
6	MODIFIED BASE	CY	2,033	$ 35.00	$ 71,000
				Subtotal, Items 1-6	$ 839,000
	ALLOWANCES:				
7	DRAINAGE	LS	12% of items 1-6	N/A	$ 101,000
8	EROSION CONTROL	LS	2% of items 1-6	N/A	$ 17,000
9	SIGNING/MARKINGS	LS	3% of items 1-6	N/A	$ 25,000
10	TYPICAL UTILITIES	LS	5% of items 1-6	N/A	$ 42,000
11	INCIDENTAL	LS	12% of items 1-6	N/A	$ 101,000
				Subtotal Construction Costs, Items 1-11 (Current Year)	**$ 1,125,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-11 (Construction Year)	**$1,317,000**
12	ENGINEERING	LS	25% of Items 1-11	N/A	$ 329,250
13	CONTINGENCY	LS	10% of Items 1-12	N/A	$ 165,000
	TOTAL PROJECT COST				**$ 1,810,000**

ASSUMPTIONS

1. 4% annual inflation rate for construction costs.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Ramp B Planning Level Opinion of Probable Cost
HR Green Company -- January 2014
Alternative 6-Compressed Diamond

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	8,125	$ 7.00	$ 57,000
2	NEW PAVEMENT				
	Ramp B	SY	4,100	$ 50.00	$ 205,000
3	SHOULDERS				
	Ramp B	SY	2,100	$ 45.00	$ 95,000
4	TEMPORARY PAVING (For Staging)				
	I-80 Tie-In	SY	800	$ 45.00	$ 36,000
5	EARTHWORK	CY	36,446	$ 8.00	$ 292,000
	Ramp B		36,446		
6	MODIFIED BASE	CY	2,067	$ 35.00	$ 72,000
				Subtotal, Items 1-6	$ 757,000
	ALLOWANCES:				
7	DRAINAGE	LS	12% of items 1-6	N/A	$ 91,000
8	EROSION CONTROL	LS	2% of items 1-6	N/A	$ 15,000
9	SIGNING/MARKINGS	LS	3% of items 1-6	N/A	$ 23,000
10	TYPICAL UTILITIES	LS	5% of items 1-6	N/A	$ 38,000
11	INCIDENTAL	LS	12% of items 1-6	N/A	$ 91,000
				Subtotal Construction Costs, Items 1-11 (Current Year)	**$ 1,015,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-11 (Construction Year)	**$1,188,000**
12	ENGINEERING	LS	25% of Items 1-11	N/A	$ 297,000
13	CONTINGENCY	LS	10% of Items 1-12	N/A	$ 149,000
	TOTAL PROJECT COST				**$ 1,630,000**

ASSUMPTIONS

1. 4% annual inflation rate for construction costs.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Ramp C Planning Level Opinion of Probable Cost
HR Green Company -- January 2014
Alternative 6-Compressed Diamond

ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	8,125	$ 7.00	$ 57,000
2	NEW PAVEMENT				
	Ramp C	SY	1,700	$ 50.00	$ 85,000
3	SHOULDERS				
	Ramp C	SY	1,600	$ 45.00	$ 72,000
4	TEMPORARY PAVING (For Staging)				
	I-80 Tie-In	SY	1,400	$ 45.00	$ 63,000
5	STRUCTURES				
	Ramp C Bridge	SF	32,200	$ 125.00	$ 4,025,000
6	EARTHWORK	CY	36,233	$ 8.00	$ 290,000
	Ramp C		36,233		
7	MODIFIED BASE	CY	1,100	$ 35.00	$ 39,000
				Subtotal, Items 1-7	$ 4,631,000
	ALLOWANCES:				
8	DRAINAGE	LS	12% of items 1-7	N/A	$ 556,000
9	EROSION CONTROL	LS	2% of items 1-7	N/A	$ 93,000
10	SIGNING/MARKINGS	LS	3% of items 1-7	N/A	$ 139,000
11	TYPICAL UTILITIES	LS	5% of items 1-7	N/A	$ 232,000
12	INCIDENTAL	LS	12% of items 1-7	N/A	$ 556,000
				Subtotal Construction Costs, Items 1-12 (Current Year)	**$ 6,207,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-12 (Construction Year)	**$7,262,000**
13	ENGINEERING	LS	25% of Items 1-12	N/A	$ 1,815,500
14	ROW ACQUISITION				
	Farmland	AC	4.4	$ 50,000.00	$ 220,000
				Subtotal ROW Costs, Item 14	**$ 220,000**
15	CONTINGENCY	LS	10% of Items 1-14	N/A	$ 908,000
	TOTAL PROJECT COST				**$ 9,990,000**

ASSUMPTIONS

1. 4% annual inflation rate for construction costs.

I-80 / Middle Road Interchange
Bettendorf, Iowa

Ramp D Planning Level Opinion of Probable Cost
HR Green Company -- January 2014
Alternative 6-Compressed Diamond

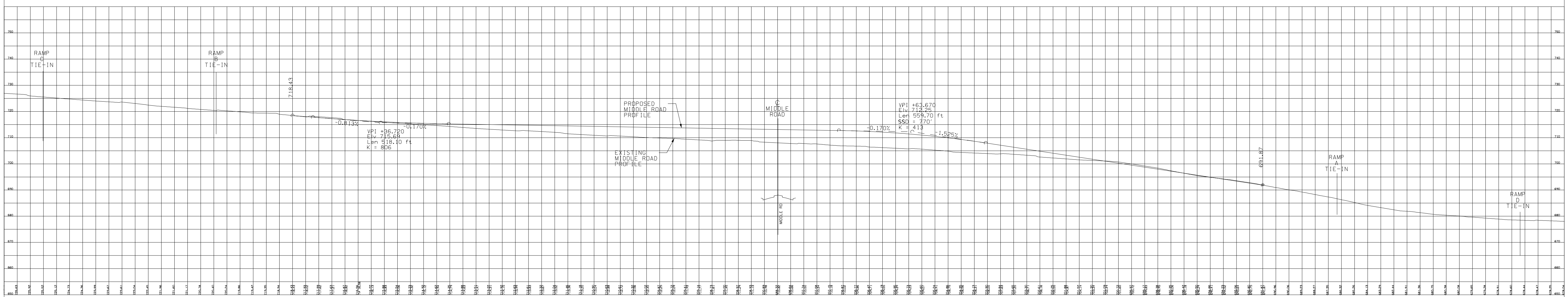
ITEM	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
1	PAVEMENT REMOVAL	SY	8,125	$ 7.00	$ 57,000
2	NEW PAVEMENT				
	Ramp D	SY	4,100	$ 50.00	$ 205,000
3	SHOULDERS				
	Ramp D	SY	2,300	$ 45.00	$ 104,000
4	TEMPORARY PAVING (For Staging)				
	I-80 Tie-In	SY	1,400	$ 45.00	$ 63,000
5	EARTHWORK	CY	294,608	$ 8.00	$ 2,357,000
	Ramp D		294,608		
6	MODIFIED BASE	CY	2,133	$ 35.00	$ 75,000
				Subtotal, Items 1-6	$ 2,861,000
	ALLOWANCES:				
7	DRAINAGE	LS	12% of items 1-6	N/A	$ 343,000
8	EROSION CONTROL	LS	2% of items 1-6	N/A	$ 57,000
9	SIGNING/MARKINGS	LS	3% of items 1-6	N/A	$ 86,000
10	TYPICAL UTILITIES	LS	5% of items 1-6	N/A	$ 143,000
11	INCIDENTAL	LS	12% of items 1-6	N/A	$ 343,000
				Subtotal Construction Costs, Items 1-11 (Current Year)	**$ 3,833,000**
			YEARS UNTIL CONSTRUCTION (4% per annum Inflation)	4	
				Subtotal Construction Costs, Items 1-11 (Construction Year)	**$4,485,000**
12	ENGINEERING	LS	25% of Items 1-11	N/A	$ 1,121,250
13	ROW ACQUISITION				
	Farmland	AC	9.7	$ 50,000.00	$ 485,000
				Subtotal ROW Costs, Item 14	**$ 485,000**
14	CONTINGENCY	LS	10% of Items 1-13	N/A	$ 561,000
	TOTAL PROJECT COST				**$ 6,170,000**

ASSUMPTIONS

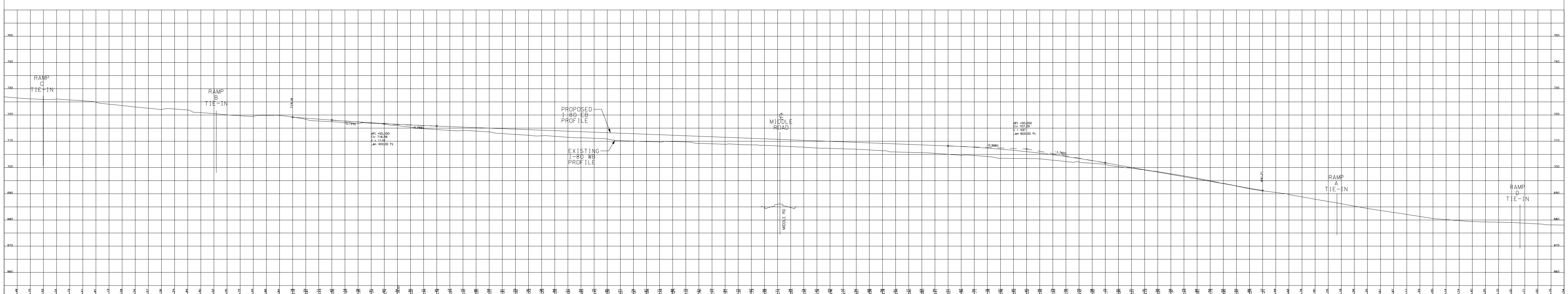
1. 4% annual inflation rate for construction costs.

Appendix F: Proposed I-80 and Ramp Profiles

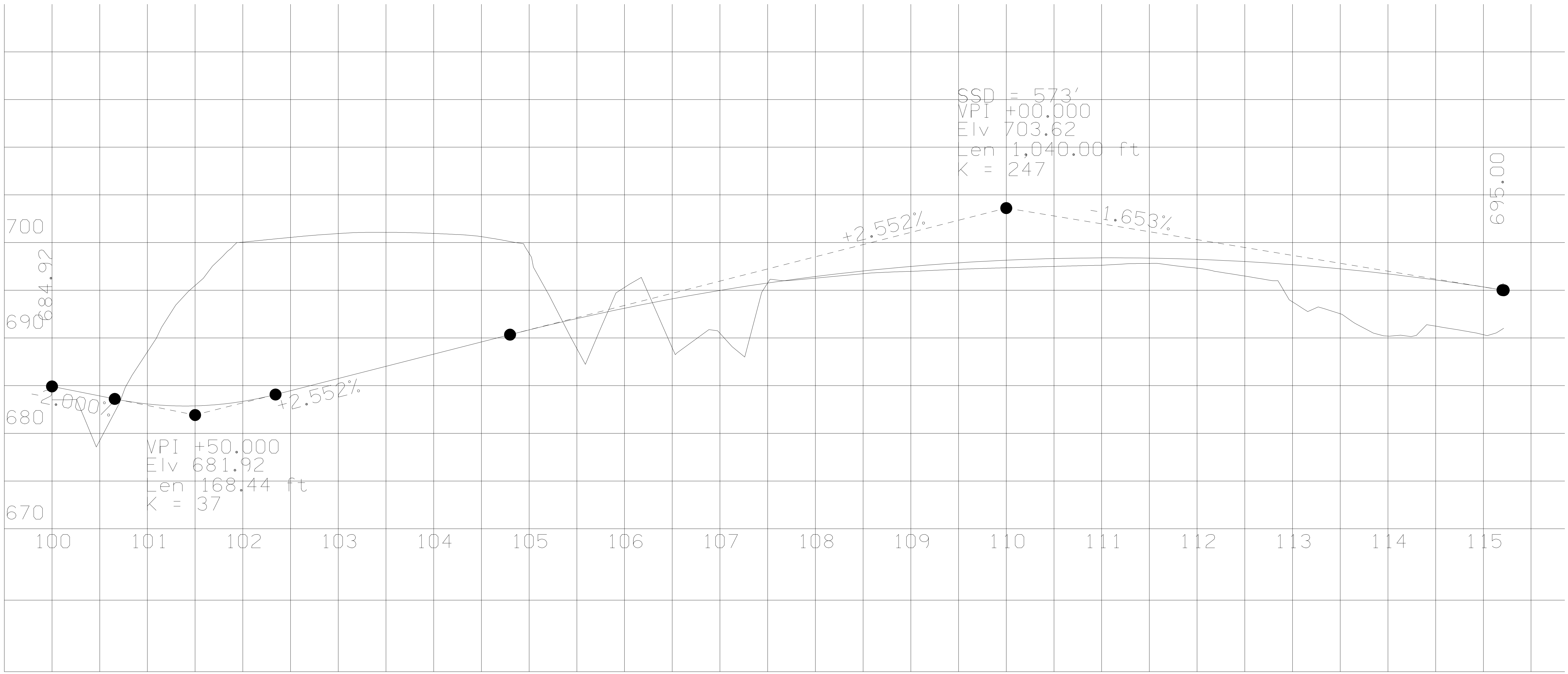
Appendix F: Proposed I-80 and Ramp Profiles



I-80 EB PROPOSED PROFILE

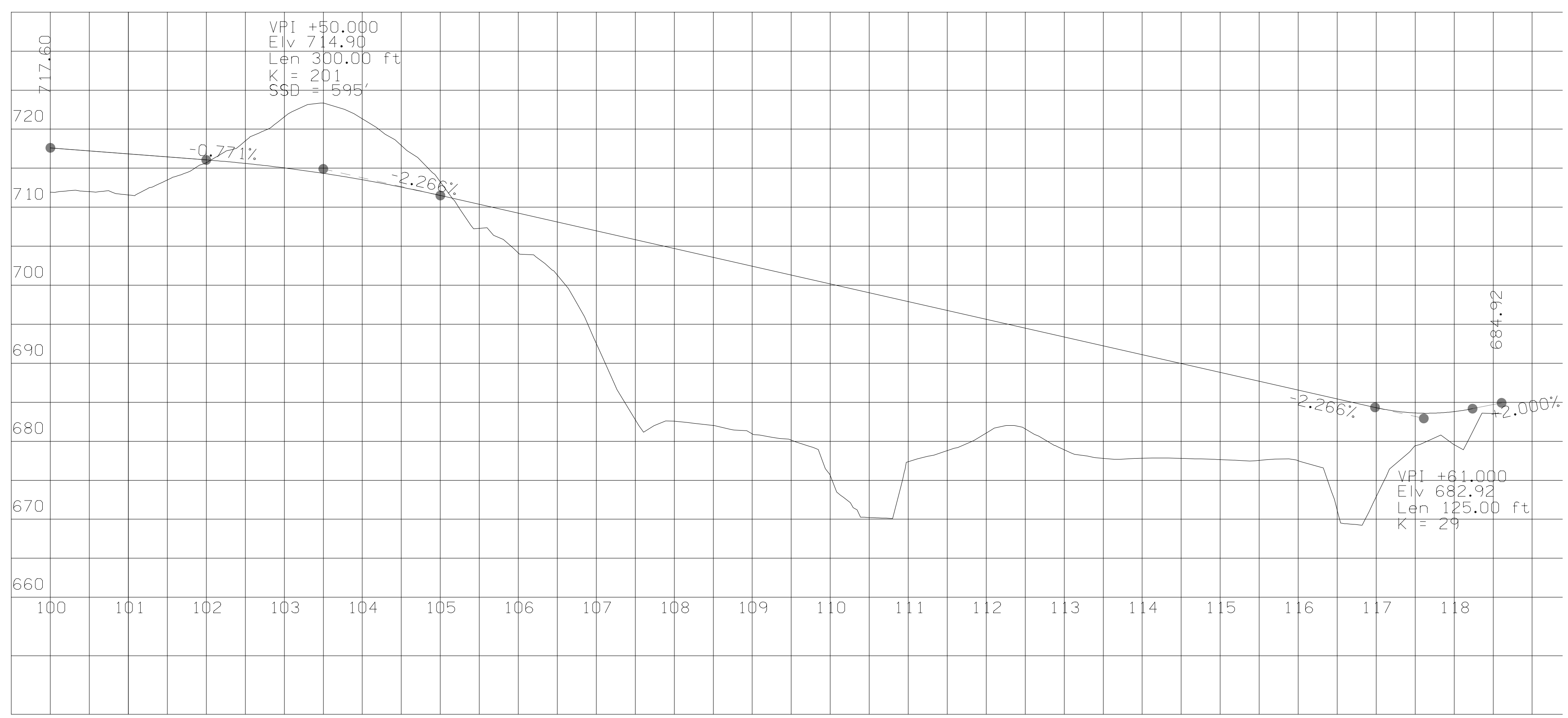


I-80 WB PROPOSED PROFILE

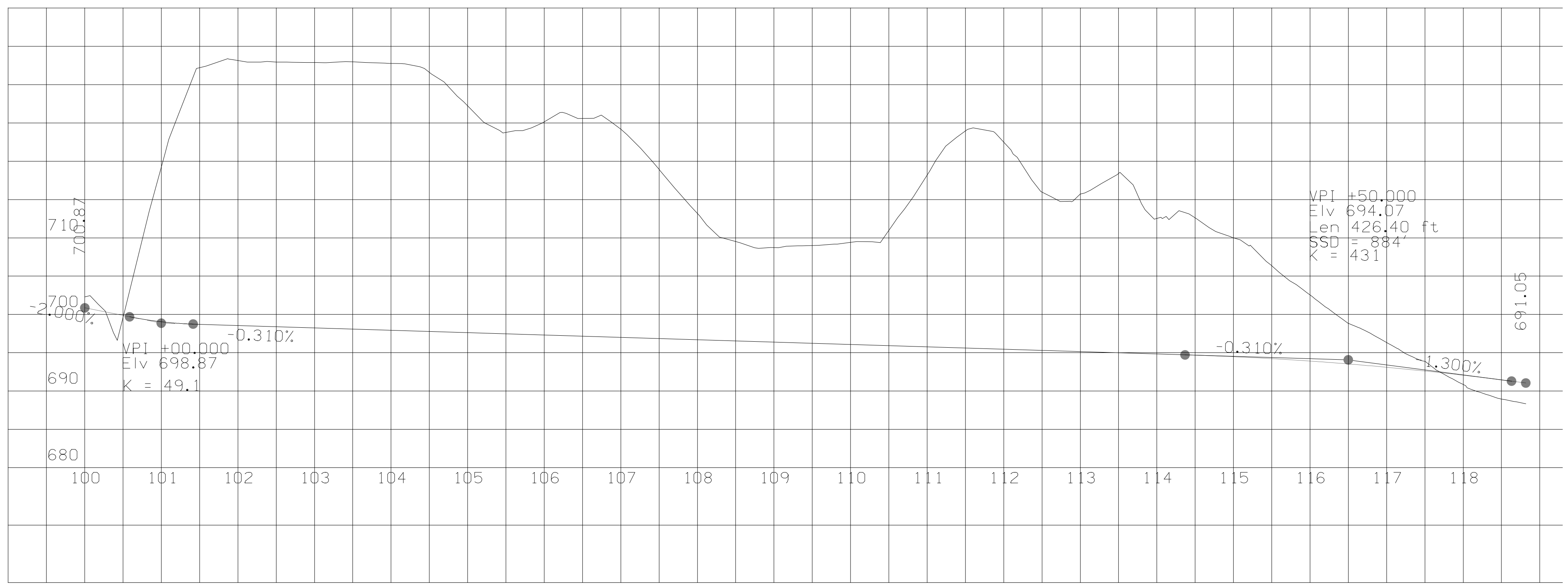


RAMP A
PROPOSED PROFILE

RAMP B
PROPOSED PROFILE



RAMP C
PROPOSED PROFILE



RAMP D
PROPOSED PROFILE

Appendix G: ISATe Calculations

Output Summary

General Information

Project description:	I-80/Middle Road Interchange Existing Conditions				
Analyst:	TCW	Date:	1/31/2014	Area type:	Urban
First year of analysis:	2040				
Last year of analysis:	2041				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility		**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:		1.0	0.0	0.0	0.1	0.2	0.6
Estimated average crash freq. during Study Period, crashes/yr:		0.5	0.0	0.0	0.1	0.1	0.3
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	3	1.0	0.0	0.0	0.1	0.2	0.6
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during	2040	0.5	0.0	0.0	0.1	0.1	0.3
the Study Period, crashes:	2041	0.5	0.0	0.0	0.1	0.1	0.3
	2042						
	2043						
	2044						
	2045						
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Sideswipe crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Other multiple-vehicle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Total multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	0.7	0.0	0.0	0.1	0.1	0.5
	Crashes with other object:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.2	0.0	0.0	0.0	0.0	0.1
	Total single-vehicle crashes:	0.9	0.0	0.0	0.1	0.2	0.6
	Total crashes:	1.0	0.0	0.0	0.1	0.2	0.6

Evaluation Site Summary

General Information

Project description:	I-80/Middle Road Interchange Existing Conditions				
Analyst:	TCW	Date:	1/31/2014	Area type:	Urban
First year of analysis:	2040	Total length of freeway segments for Study Period (mi):	0.000		
Last year of analysis:	2041				

Site Description

Freeway Segments

Number	Lanes	Study Period Length (mi)	Study Period Description
1	0	0.000	0
2	0	0.000	0
3	0	0.000	0
4	0	0.000	0
5	0	0.000	0
6	0	0.000	0
7	0	0.000	0
8	0	0.000	0
9	0	0.000	0
10	0	0.000	0
11	0	0.000	0
12	0	0.000	0
13	0	0.000	0
14	0	0.000	0
15	0	0.000	0
16	0	0.000	0
17	0	0.000	0
18	0	0.000	0
19	0	0.000	0
20	0	0.000	0

Ramp Segments

Number	Study Period Description	Number	Study Period Description
1	EB - Exising Parclo	21	0
2	EB - Exising Parclo	22	0
3	EB - Exising Parclo	23	0
4	0	24	0
5	0	25	0
6	0	26	0
7	0	27	0
8	0	28	0
9	0	29	0
10	0	30	0
11	0	31	0
12	0	32	0
13	0	33	0
14	0	34	0
15	0	35	0
16	0	36	0
17	0	37	0
18	0	38	0
19	0	39	0
20	0	40	0

Crossroad Ramp Terminals

Number	Config.	Control	Study Period Description
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0

Output Summary

General Information								
Project description:	I-80/Middle Road Interchange							
Analyst:	TCW	Date:	1/31/2014		Area type:		Urban	
First year of analysis:	2040							
Last year of analysis:	2041							
Crash Data Description								
Freeway segments	Segment crash data available?			No	First year of crash data:			
	Project-level crash data available?			No	Last year of crash data:			
Ramp segments	Segment crash data available?			No	First year of crash data:			
	Project-level crash data available?			No	Last year of crash data:			
Ramp terminals	Segment crash data available?			No	First year of crash data:			
	Project-level crash data available?			No	Last year of crash data:			
Estimated Crash Statistics								
Crashes for Entire Facility			**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:			0.5	0.0	0.0	0.1	0.1	0.3
Estimated average crash freq. during Study Period, crashes/yr:			0.2	0.0	0.0	0.0	0.0	0.1
Crashes by Facility Component		**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:		0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:		2	0.5	0.0	0.0	0.1	0.1	0.3
Crossroad ramp terminals, crashes:		0	0.0	0.0	0.0	0.0	0.0	0.0
Crashes for Entire Facility by Year		**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:		2040	0.2	0.0	0.0	0.0	0.0	0.1
		2041	0.2	0.0	0.0	0.0	0.0	0.1
		2042						
		2043						
		2044						
		2045						
		2046						
		2047						
		2048						
		2049						
		2050						
		2051						
		2052						
		2053						
		2054						
		2055						
		2056						
		2057						
		2058						
		2059						
		2060						
		2061						
		2062						
		2063						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Sideswipe crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Other multiple-vehicle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Total multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	0.3	0.0	0.0	0.0	0.1	0.2
	Crashes with other object:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.1	0.0	0.0	0.0	0.0	0.0
	Total single-vehicle crashes:	0.4	0.0	0.0	0.1	0.1	0.2
	Total crashes:	0.5	0.0	0.0	0.1	0.1	0.3

Evaluation Site Summary

General Information							
Project description:	I-80/Middle Road Interchange						
Analyst:	TCW	Date:	1/31/2014		Area type:	Urban	
First year of analysis:	2040	Total length of freeway segments for Study Period (mi):			0.000		
Last year of analysis:	2041						

Site Description

Freeway Segments

Number	Lanes	Study Period Length (mi)	Study Period Description
1	0	0.000	0
2	0	0.000	0
3	0	0.000	0
4	0	0.000	0
5	0	0.000	0
6	0	0.000	0
7	0	0.000	0
8	0	0.000	0
9	0	0.000	0
10	0	0.000	0
11	0	0.000	0
12	0	0.000	0
13	0	0.000	0
14	0	0.000	0
15	0	0.000	0
16	0	0.000	0
17	0	0.000	0
18	0	0.000	0
19	0	0.000	0
20	0	0.000	0

Ramp Segments

Number	Study Period Description	Number	Study Period Description
1	EB - Exising Parclo	21	0
2	EB - Exising Parclo	22	0
3	0	23	0
4	0	24	0
5	0	25	0
6	0	26	0
7	0	27	0
8	0	28	0
9	0	29	0
10	0	30	0
11	0	31	0
12	0	32	0
13	0	33	0
14	0	34	0
15	0	35	0
16	0	36	0
17	0	37	0
18	0	38	0
19	0	39	0
20	0	40	0

Crossroad Ramp Terminals

Number	Config.	Control	Study Period Description
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0

Appendix H: HCS and Synchro/SimTraffic Output Reports

Appendix H: HCS and Synchro/SimTraffic Output Reports

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040 SubArea

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1750
Ramp Volume, V_R	310
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1750	0.90	Rolling	25	0	0.727	1.00	2674
Ramp	310	0.90	Rolling	0	0	1.000	1.00	344
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2674 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3018	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3018	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 22.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.311 (Exhibit 13-11)

S_R= 61.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	2170
Ramp Volume, V_R	250
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2170	0.90	Rolling	21	0	0.760	1.00	3171
Ramp	250	0.90	Rolling	1	0	0.985	1.00	282
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3171 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3453	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3453	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 26.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.354 (Exhibit 13-11)

S_R= 60.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 60.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	2180
Ramp Volume, V_R	1040
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2180	0.90	Rolling	13	0	0.837	1.00	2895
Ramp	1040	0.90	Rolling	1	0	0.985	1.00	1173
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2895 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4068	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4068	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 30.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.459 (Exibit 13-11)

S_R= 57.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1700
Ramp Volume, V_R	400
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1700	0.90	Rolling	21	0	0.760	1.00	2484
Ramp	400	0.90	Rolling	0	0	1.000	1.00	444
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2484 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2928	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2928	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 21.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.304 (Exhibit 13-11)

S_R= 61.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*EB Rest Area/Middle Rd*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2250*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.727*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1719*	pc/h/ln
S	*69.3*	mph
D = v_p / S	*24.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	J. Andrew Swisher, PE, PTOE	Highway/Direction of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	From/To	I-74/EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub-Area Analysis

Project Description I-80/Middle Rd IJR

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	2250	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	25
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Rolling
DDHV = AADT x K x D		veh/h	Grade % Length	mi
			Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.727

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft			
Rt-Side Lat. Clearance	6.0	ft	f_{LW}	0.0	mph
Number of Lanes, N	2		f_{LC}	0.0	mph
Total Ramp Density, TRD	0.50	ramps/mi	TRD Adjustment	1.8	mph
FFS (measured)		mph	FFS	73.6	mph
Base free-flow Speed, BFFS	75.4	mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1719	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	69.3	mph	S	mph
D = v_p / S	24.8	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*Middle Rd/US 67*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2060*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.727*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1574*	pc/h/ln
S	*71.4*	mph
D = v_p / S	*22.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*EB Rest Area/Middle Rd*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3130*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2287*	pc/h/ln
S	*56.7*	mph
D = v_p / S	*40.4*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*I-74/EB Rest Area*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3130*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2287*	pc/h/ln
S	*56.7*	mph
D = v_p / S	*40.4*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*Middle Rd/US 67*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2420*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1768*	pc/h/ln
S	*68.5*	mph
D = v_p / S	*25.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*Middle Rd/WB Rest Area*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3220*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.847*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2111*	pc/h/ln
S	*61.3*	mph
D = v_p / S	*34.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*US 67/Middle Rd*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2540*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.837*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1686*	pc/h/ln
S	*69.8*	mph
D = v_p / S	*24.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13
f_{LC} - Exhibit 11-9
f_p - Page 11-18
TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*WB Rest Area/I-74*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3220*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.847*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2111*	pc/h/ln
S	*61.3*	mph
D = v_p / S	*34.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*Middle Rd/WB Rest Area*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2100*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1534*	pc/h/ln
S	*71.8*	mph
D = v_p / S	*21.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

- N - Number of lanes
- V - Hourly volume
- v_p - Flow rate
- LOS - Level of service
- DDHV - Directional design hour volume
- S - Speed
- D - Density
- FFS - Free-flow speed
- BFFS - Base free-flow speed

Factor Location

- E_R - Exhibits 11-10, 11-12
- E_T - Exhibits 11-10, 11-11, 11-13
- f_p - Page 11-18
- LOS, S, FFS, v_p - Exhibits 11-2, 11-3
- f_{LW} - Exhibit 11-8
- f_{LC} - Exhibit 11-9
- TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information / Site Information

Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*US 67/Middle Rd*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*PM Peak*	Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2090*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs / Calc Speed Adj and FFS

Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*2*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures / Design (N)

Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1527*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*71.9*	mph	S	mph
D = v_p / S	*21.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary / Factor Location

N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*WB Rest Area/I-74*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*PM Peak*	Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2100*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1534*	pc/h/ln
S	*71.8*	mph
D = v_p / S	*21.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	2250
Ramp Volume, V_R	110
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2250	0.90	Rolling	25	0	0.727	1.00	3437
Ramp	110	0.90	Rolling	25	0	0.727	1.00	168
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3437 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3437	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	3269	Exhibit 13-8	4800	No
V_R	168	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3437	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 29.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.313 (Exhibit 13-12)

S_R= 61.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	3130
Ramp Volume, V_R	130
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3130	0.90	Rolling	21	0	0.760	1.00	4573
Ramp	130	0.90	Rolling	10	0	0.870	1.00	166
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4573 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4573	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	4407	Exhibit 13-8	4800	No
V_R	166	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4573	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

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

D_R = 39.1 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.313 (Exhibit 13-12)

S_R= 61.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	2250
Ramp Volume, V_R	500
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2250	0.90	Rolling	25	0	0.727	1.00	3437
Ramp	500	0.90	Rolling	10	0	0.870	1.00	639
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3437 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3437	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2798	Exhibit 13-8	4800	No
V_R	639	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3437	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 29.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.356 (Exhibit 13-12)

S_R= 60.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	3130
Ramp Volume, V_R	960
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3130	0.90	Rolling	21	0	0.760	1.00	4573
Ramp	960	0.90	Rolling	4	0	0.943	1.00	1131
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4573 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4573	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	3442	Exhibit 13-8	4800	No
V_R	1131	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4573	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

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

D_R = 39.1 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.400 (Exhibit 13-12)

S_R= 58.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 58.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	2060
Ramp Volume, V_R	70
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2060	0.90	Rolling	25	0	0.727	1.00	3147
Ramp	70	0.90	Rolling	20	0	0.769	1.00	101
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 3147 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3147	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	3046	Exhibit 13-8	4800	No
V_R	101	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3147	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 26.8 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.307 (Exhibit 13-12)
S_R= 61.4 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 61.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	2420
Ramp Volume, V_R	210
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2420	0.90	Rolling	21	0	0.760	1.00	3536
Ramp	210	0.90	Rolling	6	0	0.917	1.00	254
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3536 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3536	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	3282	Exhibit 13-8	4800	No
V_R	254	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3536	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 30.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.321 (Exhibit 13-12)

S_R= 61.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	I-74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	3220
Ramp Volume, V_R	600
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3220	0.90	Rolling	12	0	0.847	1.00	4222
Ramp	600	0.90	Rolling	2	0	0.971	1.00	687
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4222 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4222	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	3535	Exhibit 13-8	4800	No
V_R	687	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4222	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 36.1 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.490 (Exhibit 13-12)

S_R= 56.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	I-74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	2100
Ramp Volume, V_R	380
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2100	0.90	Rolling	21	0	0.760	1.00	3068
Ramp	380	0.90	Rolling	3	0	0.957	1.00	441
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3068 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3068	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2627	Exhibit 13-8	4800	No
V_R	441	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3068	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 26.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.468 (Exhibit 13-12)

S_R= 56.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	2540
Ramp Volume, V_R	360
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2540	0.90	Rolling	13	0	0.837	1.00	3373
Ramp	360	0.90	Rolling	4	0	0.943	1.00	424
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3373 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3373	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2949	Exhibit 13-8	4800	No
V_R	424	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3373	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 28.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.336 (Exhibit 13-12)

S_R= 60.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	500	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	2090	V_D = veh/h
	Ramp Volume, V_R	390	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2090	0.90	Rolling	21	0	0.760	1.00	3054
Ramp	390	0.90	Rolling	4	0	0.943	1.00	459
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3054 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3054	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2595	Exhibit 13-8	4800	No
V_R	459	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3054	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 26.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.339 (Exhibit 13-12)

S_R= 60.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	3220
Ramp Volume, V_R	120
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3220	0.90	Rolling	12	0	0.847	1.00	4222
Ramp	120	0.90	Rolling	25	0	0.727	1.00	183
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4222 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4222	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	4039	Exhibit 13-8	4800	No
V_R	183	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4222	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 36.1 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.314 (Exhibit 13-12)

S_R= 61.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	500	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	2100	V_D = veh/h
	Ramp Volume, V_R	120	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2100	0.90	Rolling	21	0	0.760	1.00	3068
Ramp	120	0.90	Rolling	25	0	0.727	1.00	183
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3068 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3068	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2885	Exhibit 13-8	4800	No
V_R	183	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3068	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 26.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.314 (Exhibit 13-12)

S_R= 61.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	2140
Ramp Volume, V_R	110
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2140	0.90	Rolling	25	0	0.727	1.00	3269
Ramp	110	0.90	Rolling	25	0	0.727	1.00	168
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3269 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3437	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3437	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 29.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.397 (Exhibit 13-11)

S_R= 58.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 58.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	3000
Ramp Volume, V_R	130
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3000	0.90	Rolling	21	0	0.760	1.00	4383
Ramp	130	0.90	Rolling	10	0	0.870	1.00	166
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 4383 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4549	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4549	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 37.7 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

M_S = 0.645 (Exhibit 13-11)

S_R= 51.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	I-74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	2050
Ramp Volume, V_R	200
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2050	0.90	Rolling	25	0	0.727	1.00	3132
Ramp	200	0.90	Rolling	10	0	0.870	1.00	256
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3132 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3388	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3388	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 28.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.391 (Exhibit 13-11)

S_R= 59.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 59.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst	J. Andrew Swisher, PE, PTOE
Agency or Company	Howard R. Green Company
Date Performed	
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-80/Eastbound
Junction	I-74
Jurisdiction	Iowa DOT
Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	2420
Ramp Volume, V_R	710
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2420	0.90	Rolling	21	0	0.760	1.00	3536
Ramp	710	0.90	Rolling	2	0	0.971	1.00	813
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3536 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4349	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4349	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 35.9 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

M_S = 0.578 (Exhibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst	J. Andrew Swisher, PE, PTOE
Agency or Company	Howard R. Green Company
Date Performed	
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-80/Eastbound
Junction	Middle Rd
Jurisdiction	Iowa DOT
Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1750
Ramp Volume, V_R	310
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1750	0.90	Rolling	25	0	0.727	1.00	2674
Ramp	310	0.90	Rolling	0	0	1.000	1.00	344
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2674 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3018	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3018	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 25.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.366 (Exhibit 13-11)

S_R= 59.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 59.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 500	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2170	V_D = veh/h
	Ramp Volume, V_R: 250	
	Freeway Free-Flow Speed, S_{FF}: 70.0	
	Ramp Free-Flow Speed, S_{FR}: 35.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2170	0.90	Rolling	21	0	0.760	1.00	3171
Ramp	250	0.90	Rolling	1	0	0.985	1.00	282
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3171 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3453	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3453	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 29.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.409 (Exhibit 13-11)

S_R= 58.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 58.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	2180
Ramp Volume, V_R	1040
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2180	0.90	Rolling	13	0	0.837	1.00	2895
Ramp	1040	0.90	Rolling	1	0	0.985	1.00	1173
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2895 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4068	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4068	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 33.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.514 (Exhibit 13-11)

S_R= 55.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1700
Ramp Volume, V_R	400
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1700	0.90	Rolling	21	0	0.760	1.00	2484
Ramp	400	0.90	Rolling	0	0	1.000	1.00	444
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2484 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2928	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2928	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 25.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.359 (Exhibit 13-11)

S_R= 60.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 60.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	2270
Ramp Volume, V_R	270
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2270	0.90	Rolling	13	0	0.837	1.00	3014
Ramp	270	0.90	Rolling	7	0	0.905	1.00	332
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3014 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3346	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3346	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 28.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.387 (Exhibit 13-11)

S_R= 59.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 59.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	500	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	1920	V_D = veh/h
	Ramp Volume, V_R	170	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1920	0.90	Rolling	21	0	0.760	1.00	2805
Ramp	170	0.90	Rolling	12	0	0.847	1.00	223
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2805 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3028	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3028	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 25.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.357 (Exhibit 13-11)

S_R= 60.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 60.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	3100
Ramp Volume, V_R	120
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3100	0.90	Rolling	12	0	0.847	1.00	4064
Ramp	120	0.90	Rolling	25	0	0.727	1.00	183
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 4064 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4247	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4247	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 35.4 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

M_S = 0.549 (Exhibit 13-11)

S_R= 54.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 54.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1980
Ramp Volume, V_R	120
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1980	0.90	Rolling	21	0	0.760	1.00	2893
Ramp	120	0.90	Rolling	25	0	0.727	1.00	183
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2893 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3076	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3076	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 26.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.361 (Exhibit 13-11)

S_R= 59.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 59.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Intersection	*Middle Rd/EB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub Area*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 EB Ramp* North/South Street: *Middle Rd*

Intersection Orientation: *North-South* Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	150	850			1130	160
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	166	944	0	0	1255	177
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LT					TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	350	0	150			
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	388	0	166	0	0	0
Percent Heavy Vehicles	10	0	10	4	0	4
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	0	0
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LTR	
v (veh/h)	166						554	
C (m) (veh/h)	481						22	
v/c	0.35						25.18	
95% queue length	1.52						69.49	
Control Delay (s/veh)	16.4						11218	
LOS	C						F	
Approach Delay (s/veh)	--	--				11218		
Approach LOS	--	--				F		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	J. Andrew Swisher, PE, PTOE	Intersection	Middle Rd/EB Ramp Term.
Agency/Co.	Howard R. Green Company	Jurisdiction	Iowa DOT
Date Performed		Analysis Year	2035 Sub Area
Analysis Time Period	PM Peak		

Project Description *I-80/Middle Rd IJR*	
East/West Street: *I-80 EB Ramp*	North/South Street: *Middle Rd*
Intersection Orientation: *North-South*	Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	120	940			810	130
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	133	1044	0	0	900	144
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LT					TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	220	0	740			
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	244	0	822	0	0	0
Percent Heavy Vehicles	10	0	10	4	0	4
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	0	0
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LTR	
v (veh/h)	133						1066	
C (m) (veh/h)	674						105	
v/c	0.20						10.15	
95% queue length	0.73						123.37	
Control Delay (s/veh)	11.6						4196	
LOS	B						F	
Approach Delay (s/veh)	--	--				4196		
Approach LOS	--	--				F		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Intersection	*Middle Rd/Forest Grove Dr*
Jurisdiction	*City of Bettendorf*
Analysis Year	*2035 Sub Area*

Project Description *I-80/Middle Rd IJR*

East/West Street: *Forest Grove Dr* — North/South Street: *Middle Rd*

Intersection Orientation: *North-South* — Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	50	390	160	340	570	370
Peak-Hour Factor, PHF	0.55	0.93	0.71	0.66	0.77	0.67
Hourly Flow Rate, HFR (veh/h)	90	419	225	515	740	552
Percent Heavy Vehicles	0	--	--	9	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	370	310	190	130	210	250
Peak-Hour Factor, PHF	0.70	0.71	0.50	0.89	0.84	0.85
Hourly Flow Rate, HFR (veh/h)	528	436	380	146	250	294
Percent Heavy Vehicles	3	4	22	4	2	1
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	90	515		690			1344	
C (m) (veh/h)	543	908						
v/c	0.17	0.57						
95% queue length	0.59	3.66						
Control Delay (s/veh)	12.9	14.0						
LOS	B	B						
Approach Delay (s/veh)	--	--						
Approach LOS	--	--						

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Intersection	*Middle Rd/Forest Grove Dr*
Jurisdiction	*City of Bettendorf*
Analysis Year	*2035 Sub Area*

Project Description *I-80/Middle Rd IJR*

East/West Street: *Forest Grove Dr* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*50*	*460*	*230*	*290*	*470*	*270*
Peak-Hour Factor, PHF	*0.44*	*0.92*	*0.87*	*0.91*	*0.93*	*0.92*
Hourly Flow Rate, HFR (veh/h)	*113*	*499*	*264*	*318*	*505*	*293*
Percent Heavy Vehicles	*0*	--	--	*1*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration	*LTR*			*LTR*		
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*140*	*280*	*330*	*110*	*230*	*270*
Peak-Hour Factor, PHF	*0.81*	*0.78*	*0.67*	*0.86*	*0.79*	*0.79*
Hourly Flow Rate, HFR (veh/h)	*172*	*358*	*492*	*127*	*291*	*341*
Percent Heavy Vehicles	*0*	*0*	*13*	*1*	*1*	*5*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration		*LTR*			*LTR*	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LTR*	*LTR*		*LTR*			*LTR*	
v (veh/h)	*113*	*318*		*759*			*1022*	
C (m) (veh/h)	*833*	*854*		*0*			*0*	
v/c	*0.14*	*0.37*						
95% queue length	*0.47*	*1.73*						
Control Delay (s/veh)	*10.0*	*11.7*						
LOS	*A*	*B*		*F*			*F*	
Approach Delay (s/veh)	--	--						
Approach LOS	--	--						

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Intersection	*Middle Rd/WB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub Area*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 WB Ramp* North/South Street: *Middle Rd*

Intersection Orientation: *North-South* Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*940*	*260*	*780*	*1100*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*1044*	*288*	*866*	*1222*	*0*
Percent Heavy Vehicles	*0*	*--*	*--*	*1*	*--*	*--*
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration			*TR*	*LT*		
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*190*	*0*	*170*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*211*	*0*	*188*
Percent Heavy Vehicles	*0*	*0*	*0*	*4*	*0*	*4*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*1*	*0*
Configuration					*LTR*	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LTR*				
v (veh/h)		*866*		*399*				
C (m) (veh/h)		*521*		*0*				
v/c		*1.66*						
95% queue length		*49.66*						
Control Delay (s/veh)		*326.3*						
LOS		*F*		*F*				
Approach Delay (s/veh)	--	--						
Approach LOS	--	--						

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Intersection	*Middle Rd/WB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub Area*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 WB Ramp* North/South Street: *Middle Rd*

Intersection Orientation: *North-South* Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		1570	110	290	720	
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	0	1744	122	322	800	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				220	0	170
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	0	0	0	244	0	188
Percent Heavy Vehicles	0	0	0	4	0	4
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LTR				
v (veh/h)		322		432				
C (m) (veh/h)		328		0				
v/c		0.98						
95% queue length		10.62						
Control Delay (s/veh)		81.6						
LOS		F		F				
Approach Delay (s/veh)	--	--						
Approach LOS	--	--						

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040 SubArea

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1750
Ramp Volume, V_R	310
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1750	0.90	Rolling	25	0	0.727	1.00	2674
Ramp	310	0.90	Rolling	0	0	1.000	1.00	344
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2674 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3018	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3018	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 22.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.331 (Exhibit 13-11)

S_R= 60.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 60.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	2170	V_D = veh/h
	Ramp Volume, V_R	250	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	35.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2170	0.90	Rolling	21	0	0.760	1.00	3171
Ramp	250	0.90	Rolling	1	0	0.985	1.00	282
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3171 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3453	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3453	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 26.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.374 (Exhibit 13-11)

S_R= 59.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 59.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	2180
Ramp Volume, V_R	1040
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2180	0.90	Rolling	13	0	0.837	1.00	2895
Ramp	1040	0.90	Rolling	1	0	0.985	1.00	1173
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2895 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4068	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4068	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 30.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.479 (Exhibit 13-11)

S_R= 56.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	1700	V_D = veh/h
	Ramp Volume, V_R	400	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	35.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1700	0.90	Rolling	21	0	0.760	1.00	2484
Ramp	400	0.90	Rolling	0	0	1.000	1.00	444
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2484 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2928	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2928	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 21.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.324 (Exhibit 13-11)

S_R= 60.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 60.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Eastbound*
Agency or Company	*Howard R. Green Company*	From/To	*I-74/EB Rest Area*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*890*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	*0.727*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*2*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures			Design (N)	
			Design (N)	
Operational (LOS)			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*680*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*75.0*	mph	S	mph
D = v_p / S	*9.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*EB Rest Area/Middle Rd*
Jurisdiction	*Iowa DOT*
Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*890*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.727*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*680*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*9.1*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*MR/US67*
Jurisdiction	*Iowa DOT*
Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*860*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.727*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*657*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*8.8*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Eastbound*
Agency or Company	*Howard R. Green Company*	From/To	*EB Rest Area/Middle Rd*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*PM Peak*	Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1240*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*906*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*12.1*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13
f_{LC} - Exhibit 11-9
f_p - Page 11-18
TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*I-74/EB Rest Area*
Jurisdiction	*Iowa DOT*
Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1240*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*906*	pc/h/ln
S	*75.0*	mph
$D = v_p / S$	*12.1*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
$D = v_p / S$		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	J. Andrew Swisher, PE, PTOE	Highway/Direction of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	From/To	MR/US67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1190*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*869*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*11.6*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*MR/WB Rest Area*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1230*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.847*

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*2*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*806*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*75.0*	mph	S	mph
D = v_p / S	*10.7*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13
f_{LC} - Exhibit 11-9
f_p - Page 11-18
TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*US67/MR*
Jurisdiction	*Iowa DOT*
Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1190*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.837*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*790*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*10.5*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		**Site Information**	
Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*WB Rest Area/I74*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1230*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.847*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*806*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*10.7*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*MR/WB Rest Area*
Jurisdiction	*Iowa DOT*
Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*960*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*701*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*9.3*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*US67/MR*
Jurisdiction	*Iowa DOT*
Analysis Year	*2008*

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*990*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*723*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*9.6*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	J. Andrew Swisher, PE, PTOE	Highway/Direction of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	From/To	WB Rest Area/I74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description *I-80/Middle Road IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	960	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	21
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Rolling
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi

Calculate Flow Adjustments

f_p	1.00	E_R	2.0
E_T	2.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.760

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	12.0	ft			
Rt-Side Lat. Clearance	6.0	ft	f_{LW}	0.0	mph
Number of Lanes, N	2		f_{LC}	0.0	mph
Total Ramp Density, TRD	0.50	ramps/mi	TRD Adjustment	1.8	mph
FFS (measured)		mph	FFS	73.6	mph
Base free-flow Speed, BFFS	75.4	mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	701	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	75.0	mph	S	mph
D = v_p / S	9.3	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	A		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	890
Ramp Volume, V_R	50
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	890	0.90	Rolling	25	0	0.727	1.00	1360
Ramp	50	0.90	Rolling	25	0	0.727	1.00	76
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1360 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1360	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1284	Exhibit 13-8	4800	No
V_R	76	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1360	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 11.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.305 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1240
Ramp Volume, V_R	60
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1240	0.90	Rolling	21	0	0.760	1.00	1812
Ramp	60	0.90	Rolling	10	0	0.870	1.00	77
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1812 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1812	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1735	Exhibit 13-8	4800	No
V_R	77	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1812	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 15.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.305 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	890
Ramp Volume, V_R	100
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	890	0.90	Rolling	25	0	0.727	1.00	1360
Ramp	100	0.90	Rolling	10	0	0.870	1.00	128
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 1360 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1360	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1232	Exhibit 13-8	4800	No
V_R	128	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1360	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 11.4 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.310 (Exhibit 13-12)
S_R= 61.3 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 61.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1240
Ramp Volume, V_R	140
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1240	0.90	Rolling	21	0	0.760	1.00	1812
Ramp	140	0.90	Rolling	4	0	0.943	1.00	165
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1812 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1812	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1647	Exhibit 13-8	4800	No
V_R	165	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1812	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 15.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.313 (Exhibit 13-12)

S_R= 61.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	860
Ramp Volume, V_R	60
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	860	0.90	Rolling	25	0	0.727	1.00	1314
Ramp	60	0.90	Rolling	20	0	0.769	1.00	87
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1314 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1314	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1227	Exhibit 13-8	4800	No
V_R	87	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1314	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 11.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.306 (Exhibit 13-12)

S_R= 61.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1190
Ramp Volume, V_R	140
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1190	0.90	Rolling	21	0	0.760	1.00	1739
Ramp	140	0.90	Rolling	6	0	0.917	1.00	170
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1739 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1739	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1569	Exhibit 13-8	4800	No
V_R	170	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1739	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 14.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.313 (Exhibit 13-12)

S_R= 61.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	I74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1230
Ramp Volume, V_R	230
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1230	0.90	Rolling	12	0	0.847	1.00	1613
Ramp	230	0.90	Rolling	2	0	0.971	1.00	263
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 1613 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1613	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1350	Exhibit 13-8	4800	No
V_R	263	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1613	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 13.6 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.452 (Exhibit 13-12)
S_R= 57.4 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 57.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	I74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	960
Ramp Volume, V_R	170
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	960	0.90	Rolling	21	0	0.760	1.00	1403
Ramp	170	0.90	Rolling	3	0	0.957	1.00	197
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1403 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1403	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1206	Exhibit 13-8	4800	No
V_R	197	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1403	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 11.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.446 (Exhibit 13-12)

S_R= 57.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 57.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1190
Ramp Volume, V_R	120
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1190	0.90	Rolling	13	0	0.837	1.00	1580
Ramp	120	0.90	Rolling	4	0	0.943	1.00	141
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1580 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1580	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1439	Exhibit 13-8	4800	No
V_R	141	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1580	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 13.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.311 (Exhibit 13-12)

S_R= 61.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	990
Ramp Volume, V_R	120
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	990	0.90	Rolling	21	0	0.760	1.00	1447
Ramp	120	0.90	Rolling	4	0	0.943	1.00	141
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 1447 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1447	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1306	Exhibit 13-8	4800	No
V_R	141	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1447	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 12.2 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.311 (Exhibit 13-12)
S_R= 61.3 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 61.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1230
Ramp Volume, V_R	30
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1230	0.90	Rolling	12	0	0.847	1.00	1613
Ramp	30	0.90	Rolling	25	0	0.727	1.00	46
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1613 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1613	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1567	Exhibit 13-8	4800	No
V_R	46	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1613	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 13.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.302 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 500	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 960	V_D = veh/h
	Ramp Volume, V_R: 50	
	Freeway Free-Flow Speed, S_{FF}: 70.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	960	0.90	Rolling	21	0	0.760	1.00	1403
Ramp	50	0.90	Rolling	25	0	0.727	1.00	76
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1403 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1403	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1327	Exhibit 13-8	4800	No
V_R	76	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1403	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 11.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.305 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	840
Ramp Volume, V_R	50
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	840	0.90	Rolling	25	0	0.727	1.00	1283
Ramp	50	0.90	Rolling	25	0	0.727	1.00	76
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1283 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1359	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1359	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 12.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.291 (Exhibit 13-11)

S_R= 61.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1180
Ramp Volume, V_R	60
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1180	0.90	Rolling	21	0	0.760	1.00	1724
Ramp	60	0.90	Rolling	10	0	0.870	1.00	77
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1724 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1801	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1801	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 16.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.300 (Exhibit 13-11)

S_R= 61.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	I-74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	810
Ramp Volume, V_R	80
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	810	0.90	Rolling	25	0	0.727	1.00	1237
Ramp	80	0.90	Rolling	10	0	0.870	1.00	102
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1237 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1339	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1339	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 12.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.291 (Exhibit 13-11)

S_R= 61.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	I-74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	960
Ramp Volume, V_R	280
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	960	0.90	Rolling	21	0	0.760	1.00	1403
Ramp	280	0.90	Rolling	2	0	0.971	1.00	320
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1403 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1723	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1723	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 15.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.298 (Exhibit 13-11)

S_R= 61.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	500	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	790	V_D = veh/h
	Ramp Volume, V_R	70	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	35.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	790	0.90	Rolling	25	0	0.727	1.00	1207
Ramp	70	0.90	Rolling	0	0	1.000	1.00	78
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1207 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1285	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1285	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 12.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.300 (Exhibit 13-11)

S_R= 61.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 500	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1100	V_D = veh/h
	Ramp Volume, V_R: 90	
	Freeway Free-Flow Speed, S_{FF}: 70.0	
	Ramp Free-Flow Speed, S_{FR}: 35.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1100	0.90	Rolling	21	0	0.760	1.00	1607
Ramp	90	0.90	Rolling	1	0	0.985	1.00	102
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1607 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1709	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1709	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 15.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.308 (Exhibit 13-11)

S_R= 61.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1070
Ramp Volume, V_R	160
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1070	0.90	Rolling	13	0	0.837	1.00	1421
Ramp	160	0.90	Rolling	1	0	0.985	1.00	180
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1421 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1601	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1601	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 14.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.305 (Exhibit 13-11)

S_R= 61.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: [ ] Yes [ ] On / [x] No [ ] Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	870
Ramp Volume, V_R	90
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp: [ ] Yes [ ] On / [x] No [ ] Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	870	0.90	Rolling	21	0	0.760	1.00	1271
Ramp	90	0.90	Rolling	0	0	1.000	1.00	100
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1271 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? [ ] Yes [x] No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 [ ] Yes [x] No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1371	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1371	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 13.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.301 (Exhibit 13-11)

S_R= 61.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? [ ] Yes [ ] No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 [ ] Yes [ ] No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1000
Ramp Volume, V_R	190
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1000	0.90	Rolling	13	0	0.837	1.00	1328
Ramp	190	0.90	Rolling	7	0	0.905	1.00	233
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1328 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1561	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1561	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 14.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.295 (Exhibit 13-11)

S_R= 61.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	870
Ramp Volume, V_R	120
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	870	0.90	Rolling	21	0	0.760	1.00	1271
Ramp	120	0.90	Rolling	12	0	0.847	1.00	157
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1271 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1428	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1428	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 13.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.292 (Exhibit 13-11)

S_R= 61.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1200
Ramp Volume, V_R	30
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1200	0.90	Rolling	12	0	0.847	1.00	1573
Ramp	30	0.90	Rolling	25	0	0.727	1.00	46
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 1.000 using Equation (Exhibit 13-6)
V_{12} = 1573 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1619	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1619	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 14.9 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.296 (Exhibit 13-11)
S_R= 61.7 mph (Exhibit 13-11)
S_0= N/A mph (Exhibit 13-11)
S = 61.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2008

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	500	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	910	V_D = veh/h
	Ramp Volume, V_R	50	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	910	0.90	Rolling	21	0	0.760	1.00	1330
Ramp	50	0.90	Rolling	25	0	0.727	1.00	76
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1330 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1406	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1406	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 13.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.292 (Exhibit 13-11)

S_R= 61.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Intersection	*Middle Rd/EB Ramp Term.*
Agency/Co.	*Howard R. Green Company*	Jurisdiction	*Iowa DOT*
Date Performed		Analysis Year	*2008*
Analysis Time Period	*AM Peak*		

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 EB Ramp* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*60*	*140*			*180*	*10*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*66*	*155*	*0*	*0*	*200*	*11*
Percent Heavy Vehicles	*0*	*--*	*--*	*0*	*--*	*--*
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration	*LT*					*TR*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*20*	*0*	*80*			
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*22*	*0*	*88*	*0*	*0*	*0*
Percent Heavy Vehicles	*10*	*0*	*10*	*4*	*0*	*4*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*0*	*0*
Configuration		*LTR*				

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LT*						*LTR*	
v (veh/h)	*66*						*110*	
C (m) (veh/h)	*1372*						*722*	
v/c	*0.05*						*0.15*	
95% queue length	*0.15*						*0.54*	
Control Delay (s/veh)	*7.8*						*10.9*	
LOS	*A*						*B*	
Approach Delay (s/veh)	*--*	*--*				*10.9*		
Approach LOS	*--*	*--*				*B*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	

Site Information

Intersection	*Middle Rd/EB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2008*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 EB Ramp* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	80	130			150	10
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	88	144	0	0	166	11
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LT					TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	40	0	100			
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	44	0	111	0	0	0
Percent Heavy Vehicles	10	0	10	4	0	4
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	0	0
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LTR	
v (veh/h)	88						155	
C (m) (veh/h)	1411						703	
v/c	0.06						0.22	
95% queue length	0.20						0.84	
Control Delay (s/veh)	7.7						11.6	
LOS	A						B	
Approach Delay (s/veh)	--	--				11.6		
Approach LOS	--	--				B		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Intersection	*Middle Rd/Forest Grove Dr*
Jurisdiction	*City of Bettendorf*
Analysis Year	*2008*

Project Description *I-80/Middle Rd IJR*

East/West Street: *Forest Grove Dr* — North/South Street: *Middle Rd*

Intersection Orientation: *North-South* — Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	10	120	50	20	200	40
Peak-Hour Factor, PHF	0.55	0.93	0.71	0.66	0.77	0.67
Hourly Flow Rate, HFR (veh/h)	18	129	70	30	259	59
Percent Heavy Vehicles	0	--	--	9	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	70	70	40	20	20	10
Peak-Hour Factor, PHF	0.70	0.71	0.50	0.89	0.84	0.85
Hourly Flow Rate, HFR (veh/h)	100	98	80	22	23	11
Percent Heavy Vehicles	3	4	22	4	2	1
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	18	30		56			278	
C (m) (veh/h)	1253	1333		373			457	
v/c	0.01	0.02		0.15			0.61	
95% queue length	0.04	0.07		0.52			3.96	
Control Delay (s/veh)	7.9	7.8		16.3			24.4	
LOS	A	A		C			C	
Approach Delay (s/veh)	--	--	16.3			24.4		
Approach LOS	--	--	C			C		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	

Site Information

Intersection	*Middle Rd/Forest Grove Dr*
Jurisdiction	*City of Bettendorf*
Analysis Year	*2008*

Project Description *I-80/Middle Rd IJR*

East/West Street: *Forest Grove Dr* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	10	160	90	40	180	30
Peak-Hour Factor, PHF	0.44	0.92	0.87	0.91	0.93	0.92
Hourly Flow Rate, HFR (veh/h)	22	173	103	43	193	32
Percent Heavy Vehicles	0	--	--	1	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	40	40	20	40	50	10
Peak-Hour Factor, PHF	0.81	0.78	0.67	0.86	0.79	0.79
Hourly Flow Rate, HFR (veh/h)	49	51	29	46	63	12
Percent Heavy Vehicles	0	0	13	1	1	5
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	22	43		121			129	
C (m) (veh/h)	1356	1293		396			416	
v/c	0.02	0.03		0.31			0.31	
95% queue length	0.05	0.10		1.27			1.30	
Control Delay (s/veh)	7.7	7.9		18.0			17.5	
LOS	A	A		C			C	
Approach Delay (s/veh)	--	--	18.0			17.5		
Approach LOS	--	--	C			C		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Intersection	*Middle Rd/WB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2008*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 WB Ramp* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*50*	*110*	*50*	*80*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*55*	*122*	*55*	*88*	*0*
Percent Heavy Vehicles	*0*	*--*	*--*	*1*	*--*	*--*
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration			*TR*	*LT*		
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*110*	*0*	*10*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*122*	*0*	*11*
Percent Heavy Vehicles	*0*	*0*	*0*	*4*	*0*	*4*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*1*	*0*
Configuration					*LTR*	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LTR*				
v (veh/h)		*55*		*133*				
C (m) (veh/h)		*1405*		*666*				
v/c		*0.04*		*0.20*				
95% queue length		*0.12*		*0.74*				
Control Delay (s/veh)		*7.7*		*11.7*				
LOS		*A*		*B*				
Approach Delay (s/veh)	--	--	*11.7*					
Approach LOS	--	--	*B*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Intersection	*Middle Rd/WB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2008*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 WB Ramp* North/South Street: *Middle Rd*

Intersection Orientation: *North-South* Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*100*	*70*	*20*	*50*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*111*	*77*	*22*	*55*	*0*
Percent Heavy Vehicles	*0*	*--*	*--*	*0*	*--*	*--*
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration			*TR*	*LT*		
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*110*	*0*	*10*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*122*	*0*	*11*
Percent Heavy Vehicles	*0*	*0*	*0*	*4*	*0*	*4*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*1*	*0*
Configuration					*LTR*	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*LT*		*LTR*				
v (veh/h)		*22*		*133*				
C (m) (veh/h)		*1398*		*734*				
v/c		*0.02*		*0.18*				
95% queue length		*0.05*		*0.66*				
Control Delay (s/veh)		*7.6*		*11.0*				
LOS		*A*		*B*				
Approach Delay (s/veh)	*--*	*--*	*11.0*					
Approach LOS	*--*	*--*	*B*					

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	600	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	1450	V_D = veh/h
	Ramp Volume, V_R	250	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1450	0.90	Rolling	25	0	0.727	1.00	2215
Ramp	250	0.90	Rolling	10	0	0.870	1.00	319
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge Areas)

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge Areas)

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2215 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge Areas)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge Areas)

	Actual	Capacity		LOS F?
V_F	2215	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1896	Exhibit 13-8	4800	No
V_R	319	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2215	Exhibit 13-8	4400:All	No

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

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

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

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

D_R = 17.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination (Merge Areas)

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Speed Determination (Diverge Areas)

D_s = 0.327 (Exhibit 13-12)

S_R= 60.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	600
Freeway Volume, V_F	2030
Ramp Volume, V_R	430
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2030	0.90	Rolling	21	0	0.760	1.00	2966
Ramp	430	0.90	Rolling	4	0	0.943	1.00	506
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2966 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2966	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2460	Exhibit 13-8	4800	No
V_R	506	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2966	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 24.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.344 (Exhibit 13-12)

S_R= 60.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	600
Freeway Volume, V_F	1580
Ramp Volume, V_R	260
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1580	0.90	Rolling	13	0	0.837	1.00	2098
Ramp	260	0.90	Rolling	4	0	0.943	1.00	306
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2098 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2098	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1792	Exhibit 13-8	4800	No
V_R	306	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2098	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 16.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.326 (Exhibit 13-12)

S_R= 60.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	600	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	1320	V_D = veh/h
	Ramp Volume, V_R	270	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1320	0.90	Rolling	21	0	0.760	1.00	1929
Ramp	270	0.90	Rolling	4	0	0.943	1.00	318
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1929 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1929	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1611	Exhibit 13-8	4800	No
V_R	318	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1929	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 15.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.327 (Exhibit 13-12)

S_R= 60.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1200
Ramp Volume, V_R	230
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1200	0.90	Rolling	25	0	0.727	1.00	1833
Ramp	230	0.90	Rolling	0	0	1.000	1.00	256
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1833 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2089	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2089	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 15.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.282 (Exhibit 13-11)

S_R= 62.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 62.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1600
Ramp Volume, V_R	230
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1600	0.90	Rolling	21	0	0.760	1.00	2338
Ramp	230	0.90	Rolling	1	0	0.985	1.00	259
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2338 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2597	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2597	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 19.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.303 (Exhibit 13-11)

S_R= 61.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	1320	V_D = veh/h
	Ramp Volume, V_R	500	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	35.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1320	0.90	Rolling	13	0	0.837	1.00	1753
Ramp	500	0.90	Rolling	1	0	0.985	1.00	564
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1753 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2317	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2317	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 17.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.291 (Exhibit 13-11)

S_R= 61.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1050
Ramp Volume, V_R	250
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1050	0.90	Rolling	21	0	0.760	1.00	1534
Ramp	250	0.90	Rolling	0	0	1.000	1.00	278
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1534 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1812	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1812	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 13.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.275 (Exhibit 13-11)

S_R= 62.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 62.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*Tyler Wiles, PE*	Highway/Direction of Travel	*I-80/Eastbound*
Agency or Company	*Howard R. Green Company*	From/To	*Eastbound Rest Area/Middle Rd*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1450*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.727*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1108*	pc/h/ln
S	*74.9*	mph
D = v_p / S	*14.8*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13
f_{LC} - Exhibit 11-9
f_p - Page 11-18
TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*Tyler Wiles, PE*	Highway/Direction of Travel	*I-80/Eastbound*
Agency or Company	*Howard R. Green Company*	From/To	*I-74/Eastbound Rest Area*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1450*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.727*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*2*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1108*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*74.9*	mph	S	mph
D = v_p / S	*14.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*Tyler Wiles, PE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*Middle Rd/US67*
Jurisdiction	*Iowa DOT*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1430*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.727*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1092*	pc/h/ln
S	*74.9*	mph
D = v_p / S	*14.6*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*Tyler Wiles, PE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	
Jurisdiction	*Iowa DOT*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2030*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1483*	pc/h/ln
S	*72.4*	mph
D = v_p / S	*20.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*Tyler Wiles, PE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*I-74/Eastbound Rest Area*
Jurisdiction	*Iowa DOT*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2030*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1483*	pc/h/ln
S	*72.4*	mph
D = v_p / S	*20.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*Tyler Wiles, PE*	Highway/Direction of Travel	*I-80/Eastbound*
Agency or Company	*Howard R. Green Company*	From/To	*Middle Rd/US67*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*PM Peak*	Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1830*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1337*	pc/h/ln
S	*73.7*	mph
D = v_p / S	*18.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

- N - Number of lanes
- V - Hourly volume
- v_p - Flow rate
- LOS - Level of service
- S - Speed
- D - Density
- FFS - Free-flow speed
- BFFS - Base free-flow speed
- DDHV - Directional design hour volume

Factor Location

- E_R - Exhibits 11-10, 11-12
- E_T - Exhibits 11-10, 11-11, 11-13
- f_p - Page 11-18
- LOS, S, FFS, v_p - Exhibits 11-2, 11-3
- f_{LW} - Exhibit 11-8
- f_{LC} - Exhibit 11-9
- TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*Tyler Wiles, PE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*Middle Rd/WB Rest Area*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2040*
Project Description	*I-80/Middle Rd IJR*		

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1820*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.847*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*2*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1193*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*74.6*	mph	S		mph
D = v_p / S	*16.0*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*B*		Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*Tyler Wiles, PE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*US67/Middle Rd*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2040*
Project Description	*I-80/Middle Rd IJR*		

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1580*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.837*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*2*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1049*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*75.0*	mph	S	mph
D = v_p / S	*14.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*Tyler Wiles, PE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*WB Rest Area/I74*
Jurisdiction	*Iowa DOT*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1820*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.847*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1193*	pc/h/ln
S	*74.6*	mph
D = v_p / S	*16.0*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*Tyler Wiles, PE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*Middle Rd/WB Rest Area*
Jurisdiction	*Iowa DOT*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1300*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*950*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*12.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*Tyler Wiles, PE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*US67/Middle Rd*
Jurisdiction	*Iowa DOT*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1320*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*964*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*12.9*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13
f_{LC} - Exhibit 11-9
f_p - Page 11-18
TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		**Site Information**	
Analyst	*Tyler Wiles, PE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*WB Rest Area/I74*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*PM Peak*	Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1300*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*950*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*12.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

- N - Number of lanes
- V - Hourly volume
- v_p - Flow rate
- LOS - Level of service
- DDHV - Directional design hour volume
- S - Speed
- D - Density
- FFS - Free-flow speed
- BFFS - Base free-flow speed

Factor Location

- E_R - Exhibits 11-10, 11-12
- E_T - Exhibits 11-10, 11-11, 11-13
- f_p - Page 11-18
- LOS, S, FFS, v_p - Exhibits 11-2, 11-3
- f_{LW} - Exhibit 11-8
- f_{LC} - Exhibit 11-9
- TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1450
Ramp Volume, V_R	80
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1450	0.90	Rolling	25	0	0.727	1.00	2215
Ramp	80	0.90	Rolling	25	0	0.727	1.00	122
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2215 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2215	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2093	Exhibit 13-8	4800	No
V_R	122	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2215	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 18.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.309 (Exhibit 13-12)

S_R= 61.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	2030
Ramp Volume, V_R	100
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2030	0.90	Rolling	21	0	0.760	1.00	2966
Ramp	100	0.90	Rolling	10	0	0.870	1.00	128
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2966 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2966	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2838	Exhibit 13-8	4800	No
V_R	128	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2966	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 25.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.310 (Exhibit 13-12)

S_R= 61.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1450
Ramp Volume, V_R	250
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1450	0.90	Rolling	25	0	0.727	1.00	2215
Ramp	250	0.90	Rolling	10	0	0.870	1.00	319
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2215 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2215	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1896	Exhibit 13-8	4800	No
V_R	319	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2215	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 18.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.327 (Exhibit 13-12)

S_R= 60.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	500	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	2030	V_D = veh/h
	Ramp Volume, V_R	430	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2030	0.90	Rolling	21	0	0.760	1.00	2966
Ramp	430	0.90	Rolling	4	0	0.943	1.00	506
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12}

Merge Areas

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

L_{EQ} =	(Equation 13-6 or 13-7)
P_{FM} =	using Equation (Exhibit 13-6)
V_{12} =	pc/h
V_3 or V_{av34}	pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h?	☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2	☐ Yes ☐ No
If Yes,V_{12a} =	pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas

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

L_{EQ} =	(Equation 13-12 or 13-13)
P_{FD} =	1.000 using Equation (Exhibit 13-7)
V_{12} =	2966 pc/h
V_3 or V_{av34}	0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h?	☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2	☐ Yes ☑ No
If Yes,V_{12a} =	pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge Areas

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Diverge Areas

	Actual	Capacity		LOS F?
V_F	2966	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2460	Exhibit 13-8	4800	No
V_R	506	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2966	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge Areas

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Diverge Areas

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

D_R = 25.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

Merge Areas

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

D_s = 0.344 (Exhibit 13-12)

S_R= 60.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1430
Ramp Volume, V_R	190
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1430	0.90	Rolling	25	0	0.727	1.00	2185
Ramp	190	0.90	Rolling	20	0	0.769	1.00	274
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2185 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2185	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1911	Exhibit 13-8	4800	No
V_R	274	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2185	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 18.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.323 (Exhibit 13-12)

S_R= 61.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1830
Ramp Volume, V_R	320
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1830	0.90	Rolling	21	0	0.760	1.00	2674
Ramp	320	0.90	Rolling	6	0	0.917	1.00	388
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2674 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2674	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2286	Exhibit 13-8	4800	No
V_R	388	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2674	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 22.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.333 (Exhibit 13-12)

S_R= 60.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	I-74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	500	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	1820	V_D = veh/h
	Ramp Volume, V_R	330	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	35.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1820	0.90	Rolling	12	0	0.847	1.00	2386
Ramp	330	0.90	Rolling	2	0	0.971	1.00	378
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2386 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2386	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2008	Exhibit 13-8	4800	No
V_R	378	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2386	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 20.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.462 (Exhibit 13-12)

S_R= 57.1 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 57.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	I-74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp				Downstream Adj Ramp	
☐ Yes	☐ On	Number of Lanes, N	2	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	500	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	1300	V_D =	veh/h
		Ramp Volume, V_R	250		
		Freeway Free-Flow Speed, S_{FF}	70.0		
		Ramp Free-Flow Speed, S_{FR}	35.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1300	0.90	Rolling	21	0	0.760	1.00	1899
Ramp	250	0.90	Rolling	3	0	0.957	1.00	290
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1899 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1899	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1609	Exhibit 13-8	4800	No
V_R	290	Exhibit 13-10	2000	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1899	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 16.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.454 (Exhibit 13-12)

S_R= 57.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 57.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1580
Ramp Volume, V_R	260
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1580	0.90	Rolling	13	0	0.837	1.00	2098
Ramp	260	0.90	Rolling	4	0	0.943	1.00	306
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2098 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2098	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1792	Exhibit 13-8	4800	No
V_R	306	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2098	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 17.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.326 (Exhibit 13-12)

S_R= 60.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	500	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	1320	V_D = veh/h
	Ramp Volume, V_R	270	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1320	0.90	Rolling	21	0	0.760	1.00	1929
Ramp	270	0.90	Rolling	4	0	0.943	1.00	318
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1929 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1929	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1611	Exhibit 13-8	4800	No
V_R	318	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1929	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 16.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.327 (Exhibit 13-12)

S_R= 60.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 60.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1820
Ramp Volume, V_R	50
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1820	0.90	Rolling	12	0	0.847	1.00	2386
Ramp	50	0.90	Rolling	25	0	0.727	1.00	76
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2386 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2386	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	2310	Exhibit 13-8	4800	No
V_R	76	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2386	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 20.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.305 (Exhibit 13-12)

S_R= 61.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	1300
Ramp Volume, V_R	70
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1300	0.90	Rolling	21	0	0.760	1.00	1899
Ramp	70	0.90	Rolling	25	0	0.727	1.00	107
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1899 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1899	Exhibit 13-8	4800	No
$V_{FO} = V_F - V_R$	1792	Exhibit 13-8	4800	No
V_R	107	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1899	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 16.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.308 (Exhibit 13-12)

S_R= 61.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 61.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1370
Ramp Volume, V_R	80
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1370	0.90	Rolling	25	0	0.727	1.00	2093
Ramp	80	0.90	Rolling	25	0	0.727	1.00	122
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2093 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2215	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2215	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 19.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.312 (Exhibit 13-11)

S_R= 61.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	EB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: Yes ☐ On ☐ / No ☑ Off ☐

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1930
Ramp Volume, V_R	100
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: Yes ☐ On ☐ / No ☑ Off ☐

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1930	0.90	Rolling	21	0	0.760	1.00	2820
Ramp	100	0.90	Rolling	10	0	0.870	1.00	128
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2820 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2948	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2948	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 25.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.350 (Exhibit 13-11)

S_R= 60.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 60.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

HCS2010™ Version 6.3 Generated: 1/29/2014 11:39 AM

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	I-74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1250
Ramp Volume, V_R	200
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1250	0.90	Rolling	25	0	0.727	1.00	1910
Ramp	200	0.90	Rolling	10	0	0.870	1.00	256
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1910 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2166	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2166	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 19.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.310 (Exhibit 13-11)

S_R= 61.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	I-74
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1580
Ramp Volume, V_R	450
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1580	0.90	Rolling	21	0	0.760	1.00	2309
Ramp	450	0.90	Rolling	2	0	0.971	1.00	515
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2309 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2824	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2824	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 24.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.342 (Exhibit 13-11)

S_R= 60.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 60.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1200
Ramp Volume, V_R	230
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1200	0.90	Rolling	25	0	0.727	1.00	1833
Ramp	230	0.90	Rolling	0	0	1.000	1.00	256
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1833 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2089	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2089	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 18.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.317 (Exhibit 13-11)

S_R= 61.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1600
Ramp Volume, V_R	230
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1600	0.90	Rolling	21	0	0.760	1.00	2338
Ramp	230	0.90	Rolling	1	0	0.985	1.00	259
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2338 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2597	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2597	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 22.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.338 (Exhibit 13-11)

S_R= 60.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 60.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1320
Ramp Volume, V_R	500
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1320	0.90	Rolling	13	0	0.837	1.00	1753
Ramp	500	0.90	Rolling	1	0	0.985	1.00	564
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1753 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2317	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2317	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 20.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.326 (Exhibit 13-11)

S_R= 60.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 60.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	500	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	1050	V_D = veh/h
	Ramp Volume, V_R	250	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	35.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1050	0.90	Rolling	21	0	0.760	1.00	1534
Ramp	250	0.90	Rolling	0	0	1.000	1.00	278
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1534 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1812	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1812	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 16.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.310 (Exhibit 13-11)

S_R= 61.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1240
Ramp Volume, V_R	340
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1240	0.90	Rolling	13	0	0.837	1.00	1646
Ramp	340	0.90	Rolling	7	0	0.905	1.00	417
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1646 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2063	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2063	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 18.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.307 (Exhibit 13-11)

S_R= 61.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	US 67
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	500
Deceleration Lane Length L_D	
Freeway Volume, V_F	1070
Ramp Volume, V_R	250
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1070	0.90	Rolling	21	0	0.760	1.00	1563
Ramp	250	0.90	Rolling	12	0	0.847	1.00	328
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1563 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1891	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1891	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 16.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.302 (Exhibit 13-11)

S_R= 61.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp		
☐ Yes ☐ On	Number of Lanes, N	2
☑ No ☐ Off	Acceleration Lane Length, L_A	500
L_{up} = ft	Deceleration Lane Length L_D	
V_u = veh/h	Freeway Volume, V_F	1770
	Ramp Volume, V_R	50
	Freeway Free-Flow Speed, S_{FF}	70.0
	Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1770	0.90	Rolling	12	0	0.847	1.00	2321
Ramp	50	0.90	Rolling	25	0	0.727	1.00	76
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2321 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2397	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2397	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 21.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.319 (Exhibit 13-11)

S_R= 61.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	WB Rest Area
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	500	☑ No ☐ Off
	Deceleration Lane Length L_D		
L_{up} = ft	Freeway Volume, V_F	1230	L_{down} = ft
	Ramp Volume, V_R	70	
	Freeway Free-Flow Speed, S_{FF}	70.0	
V_u = veh/h	Ramp Free-Flow Speed, S_{FR}	45.0	V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1230	0.90	Rolling	21	0	0.760	1.00	1797
Ramp	70	0.90	Rolling	25	0	0.727	1.00	107
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1797 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1904	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1904	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 17.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.302 (Exhibit 13-11)

S_R= 61.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*Tyler Wiles, PE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Intersection	*Middle Rd/EB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 EB Ramp* North/South Street: *Middle Rd*

Intersection Orientation: *North-South* Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*180*	*510*			*720*	*50*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*200*	*566*	*0*	*0*	*800*	*55*
Percent Heavy Vehicles	*0*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*1*	*0*
Configuration	*LT*					*TR*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*70*	*0*	*180*			
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*77*	*0*	*200*	*0*	*0*	*0*
Percent Heavy Vehicles	*10*	*0*	*10*	*4*	*0*	*4*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*0*	*0*
Configuration		*LTR*				

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*LT*						*LTR*	
v (veh/h)	*200*						*277*	
C (m) (veh/h)	*793*						*156*	
v/c	*0.25*						*1.78*	
95% queue length	*1.00*						*20.25*	
Control Delay (s/veh)	*11.1*						*423.7*	
LOS	*B*						*F*	
Approach Delay (s/veh)	--	--				*423.7*		
Approach LOS	--	--				*F*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*Tyler Wiles, PE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Intersection	*Middle Rd/EB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 EB Ramp* North/South Street: *Middle Rd*

Intersection Orientation: *North-South* Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	190	530			520	40
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	211	588	0	0	577	44
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LT					TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	150	0	280			
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	166	0	311	0	0	0
Percent Heavy Vehicles	10	0	10	4	0	4
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	0	0
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LT						LTR	
v (veh/h)	211						477	
C (m) (veh/h)	969						186	
v/c	0.22						2.56	
95% queue length	0.83						40.76	
Control Delay (s/veh)	9.7						758.8	
LOS	A						F	
Approach Delay (s/veh)	--	--				758.8		
Approach LOS	--	--				F		

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*Tyler Wiles, PE*	Intersection	*Middle Rd/Forest Grove Dr*
Agency/Co.	*Howard R. Green Company*	Jurisdiction	*City of Bettendorf*
Date Performed		Analysis Year	*2040*
Analysis Time Period	*AM Peak*		
Project Description *I-80/Middle Rd IJR*			
East/West Street: *Forest Grove Dr*		North/South Street: *Middle Rd*	
Intersection Orientation: *North-South*		Study Period (hrs): *0.25*	

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	50	390	80	30	690	0
Peak-Hour Factor, PHF	0.55	0.93	0.71	0.66	0.77	0.67
Hourly Flow Rate, HFR (veh/h)	90	419	112	45	896	0
Percent Heavy Vehicles	0	--	--	9	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	280	140	170	50	60	20
Peak-Hour Factor, PHF	0.70	0.71	0.50	0.89	0.84	0.85
Hourly Flow Rate, HFR (veh/h)	400	197	340	56	71	23
Percent Heavy Vehicles	3	4	22	4	2	1
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	90	45		150			937	
C (m) (veh/h)	766	1002		0			19	
v/c	0.12	0.04					49.32	
95% queue length	0.40	0.14					117.73	
Control Delay (s/veh)	10.3	8.8					22128	
LOS	B	A		F			F	
Approach Delay (s/veh)	--	--				22128		
Approach LOS	--	--				F		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*Tyler Wiles, PE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Intersection	*Middle Rd/Forest Grove Dr*
Jurisdiction	*City of Bettendorf*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

East/West Street: *Forest Grove Dr* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	50	540	150	60	600	140
Peak-Hour Factor, PHF	0.44	0.92	0.87	0.91	0.93	0.92
Hourly Flow Rate, HFR (veh/h)	113	586	172	65	645	152
Percent Heavy Vehicles	0	--	--	1	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration	LTR			LTR		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	160	80	90	90	150	20
Peak-Hour Factor, PHF	0.81	0.78	0.67	0.86	0.79	0.79
Hourly Flow Rate, HFR (veh/h)	197	102	134	104	189	25
Percent Heavy Vehicles	0	0	13	1	1	5
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration		LTR			LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	113	65		318			433	
C (m) (veh/h)	834	858		0			0	
v/c	0.14	0.08						
95% queue length	0.47	0.25						
Control Delay (s/veh)	10.0	9.5						
LOS	A	A		F			F	
Approach Delay (s/veh)	--	--						
Approach LOS	--	--						

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TWO-WAY STOP CONTROL SUMMARY

General Information		Site Information	
Analyst	*Tyler Wiles, PE*	Intersection	*Middle Rd/WB Ramp Term.*
Agency/Co.	*Howard R. Green Company*	Jurisdiction	*Iowa DOT*
Date Performed		Analysis Year	*2040*
Analysis Time Period	*AM Peak*		

Project Description *I-80/Middle Rd IJR*	
East/West Street: *I-80 WB Ramp*	North/South Street: *Middle Rd*
Intersection Orientation: *North-South*	Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		290	290	210	540	
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	0	322	322	233	600	0
Percent Heavy Vehicles	0	--	--	1	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				230	0	30
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	0	0	0	255	0	33
Percent Heavy Vehicles	0	0	0	4	0	4
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LTR				
v (veh/h)		233		288				
C (m) (veh/h)		946		103				
v/c		0.25		2.80				
95% queue length		0.97		27.11				
Control Delay (s/veh)		10.0		899.4				
LOS		B		F				
Approach Delay (s/veh)	--	--		899.4				
Approach LOS	--	--		F				

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*Tyler Wiles, PE*
Agency/Co.	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Intersection	*Middle Rd/WB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2040*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 WB Ramp* North/South Street: *Middle Rd*

Intersection Orientation: *North-South* Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		510	170	80	320	
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	0	566	188	88	355	0
Percent Heavy Vehicles	0	--	--	0	--	--
Median Type	Undivided					
RT Channelized			0			0
Lanes	0	1	0	0	1	0
Configuration			TR	LT		
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				240	0	30
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	0	0	0	266	0	33
Percent Heavy Vehicles	0	0	0	4	0	4
Percent Grade (%)		0			0	
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	0	1	0
Configuration					LTR	

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LTR				
v (veh/h)		88		299				
C (m) (veh/h)		865		197				
v/c		0.10		1.52				
95% queue length		0.34		18.73				
Control Delay (s/veh)		9.6		301.2				
LOS		A		F				
Approach Delay (s/veh)	--	--		301.2				
Approach LOS	--	--		F				

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1200
Ramp Volume, V_R	230
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1200	0.90	Rolling	25	0	0.727	1.00	1833
Ramp	230	0.90	Rolling	0	0	1.000	1.00	256
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1833 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2089	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2089	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 15.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.282 (Exhibit 13-11)

S_R= 62.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 62.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp		
☐ Yes ☐ On	Number of Lanes, N	2
☑ No ☐ Off	Acceleration Lane Length, L_A	1000
L_{up} = ft	Deceleration Lane Length L_D	
V_u = veh/h	Freeway Volume, V_F	1600
	Ramp Volume, V_R	230
	Freeway Free-Flow Speed, S_{FF}	70.0
	Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1600	0.90	Rolling	21	0	0.760	1.00	2338
Ramp	230	0.90	Rolling	1	0	0.985	1.00	259
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2338 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2597	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2597	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 19.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.303 (Exhibit 13-11)

S_R= 61.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1320
Ramp Volume, V_R	500
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1320	0.90	Rolling	13	0	0.837	1.00	1753
Ramp	500	0.90	Rolling	1	0	0.985	1.00	564
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1753 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2317	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2317	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 17.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.291 (Exhibit 13-11)

S_R= 61.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1050	V_D = veh/h
	Ramp Volume, V_R: 250	
	Freeway Free-Flow Speed, S_{FF}: 70.0	
	Ramp Free-Flow Speed, S_{FR}: 35.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1050	0.90	Rolling	21	0	0.760	1.00	1534
Ramp	250	0.90	Rolling	0	0	1.000	1.00	278
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1534 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1812	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1812	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 13.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.275 (Exhibit 13-11)

S_R= 62.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 62.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040 - Improved PARCLO - DIA

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1250
Ramp Volume, V_R	180
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1250	0.90	Rolling	25	0	0.727	1.00	1910
Ramp	180	0.90	Rolling	0	0	1.000	1.00	200
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1910 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2110	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2110	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 15.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.283 (Exhibit 13-11)

S_R= 62.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 62.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040 - Improved PARCLO - DIA

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1640
Ramp Volume, V_R	190
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1640	0.90	Rolling	21	0	0.760	1.00	2396
Ramp	190	0.90	Rolling	1	0	0.985	1.00	214
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2396 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2610	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2610	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 19.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.304 (Exhibit 13-11)

S_R= 61.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040 - Improved PARCLO - DIA

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1610
Ramp Volume, V_R	210
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1610	0.90	Rolling	13	0	0.837	1.00	2138
Ramp	210	0.90	Rolling	1	0	0.985	1.00	237
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2138 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2375	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2375	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 17.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.293 (Exhibit 13-11)

S_R= 61.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040 - Improved PARCLO - DIA

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1000	☑ No ☐ Off
	Deceleration Lane Length L_D		
	Freeway Volume, V_F	1220	
L_{up} = ft	Ramp Volume, V_R	80	L_{down} = ft
	Freeway Free-Flow Speed, S_{FF}	70.0	
V_u = veh/h	Ramp Free-Flow Speed, S_{FR}	35.0	V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1220	0.90	Rolling	21	0	0.760	1.00	1783
Ramp	80	0.90	Rolling	0	0	1.000	1.00	89
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1783 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1872	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1872	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 13.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.276 (Exhibit 13-11)

S_R= 62.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 62.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040 - Improved PARCLO - LOOP

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1200
Ramp Volume, V_R	50
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1200	0.90	Rolling	25	0	0.727	1.00	1833
Ramp	50	0.90	Rolling	0	0	1.000	1.00	56
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 1.000 using Equation (Exhibit 13-6)
V_{12} = 1833 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1889	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1889	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 13.9 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.277 (Exibit 13-11)
S_R= 62.2 mph (Exhibit 13-11)
S_0= N/A mph (Exhibit 13-11)
S = 62.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040 - Improved PARCLO - LOOP

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1600
Ramp Volume, V_R	40
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1600	0.90	Rolling	21	0	0.760	1.00	2338
Ramp	40	0.90	Rolling	1	0	0.985	1.00	45
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2338 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2383	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2383	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 17.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.293 (Exibit 13-11)

S_R= 61.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 61.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040 - Improved PARCLO - LOOP

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1320
Ramp Volume, V_R	290
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1320	0.90	Rolling	13	0	0.837	1.00	1753
Ramp	290	0.90	Rolling	1	0	0.985	1.00	327
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1753 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2080	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2080	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 15.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.282 (Exibit 13-11)

S_R= 62.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 62.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040 - Improved PARCLO - LOOP

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1050
Ramp Volume, V_R	170
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	35.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1050	0.90	Rolling	21	0	0.760	1.00	1534
Ramp	170	0.90	Rolling	0	0	1.000	1.00	189
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1534 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1723	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1723	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 12.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.273 (Exibit 13-11)

S_R= 62.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 62.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Intersection	*Middle Road/Indiana Avenue*
Agency or Co.	*HR Green, Inc.*	E/W Street Name	
Date Performed		N/S Street Name	
Time Period	*AM Peak*	Analysis Year	*2040*
		Project ID	*I-80/Middle Road IJR*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes(N)	0	1	0		0	1	0		1	0	1		0	0	0	
Volume (V), veh/h		20	300	0	450	20		0	130		190	0				0
Heavy Veh. Adj. (f_{HV}), %	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Peak Hour Factor (PHF)	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00
No. of Pedestrians Crossing Entry	0				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929
Follow-Up Headway (sec)	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	504			146			22			672		
Exiting Flow (V_{ex}), pc/h	235			168			0			840		
Entry Flow (V_e), pc/h		358			526		146	213				
Entry Volume veh/h		348			511		142	207				

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		683			977		1105	1105			577	
Capacity (c), veh/h		663			949		1073	1073			0	
v/c Ratio (X)		0.52			0.54		0.13	0.19				

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		13.9			10.8		4.5	5.1				
Lane LOS		B			B		A	A				
Lane 95% Queue		3.1			3.3		0.5	0.7				
Approach Delay, s/veh	13.88			10.81			4.88					
Approach LOS, s/veh	B			B			A					
Intersection Delay, s/veh	9.98											
Intersection LOS	A											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	J. Andrew Swisher, PE, PTOE	Intersection	Middle Road/Indiana Avenue
Agency or Co.	HR Green, Inc.	E/W Street Name	Indiana Avenue
Date Performed		N/S Street Name	
Time Period	AM Peak	Analysis Year	2040
		Project ID	I-80/Middle Road IJR

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes(N)	0	1	0		0	1	0		1	0	1		0	0	0	
Volume (V), veh/h		20	160	0	240	20		0	220		320	0				0
Heavy Veh. Adj. (f_{HV}), %	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Peak Hour Factor (PHF)	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00
No. of Pedestrians Crossing Entry	0				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929
Follow-Up Headway (sec)	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	269			246			22			537		
Exiting Flow (V_{ex}), pc/h	380			268			0			448		
Entry Flow (V_e), pc/h		201			291		246	358				
Entry Volume veh/h		195			283		239	348				

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		863			884		1105	1105			660	
Capacity (c), veh/h		838			858		1073	1073			0	
v/c Ratio (X)		0.23			0.33		0.22	0.32				

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		6.8			7.9		5.4	6.6				
Lane LOS		A			A		A	A				
Lane 95% Queue		0.9			1.4		0.9	1.4				
Approach Delay, s/veh	6.76			7.89			6.11					
Approach LOS, s/veh	A			A			A					
Intersection Delay, s/veh	6.70											
Intersection LOS	A											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	J. Andrew Swisher, PE, PTOE	Intersection	Middle Road/Indiana Avenue
Agency or Co.	HR Green, Inc.	E/W Street Name	Indiana Avenue
Date Performed		N/S Street Name	
Time Period	AM Peak	Analysis Year	2040
		Project ID	I-80/Middle Road IJR

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes(N)	0	1	0		0	1	0		1	0	1		0	0	0	
Volume (V), veh/h		20	940	0	940	20		0	550		560	0				0
Heavy Veh. Adj. (f_{HV}), %	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Peak Hour Factor (PHF)	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00
No. of Pedestrians Crossing Entry	0				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929
Follow-Up Headway (sec)	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	1052			616			22			1690		
Exiting Flow (V_{ex}), pc/h	649			638			0			2104		
Entry Flow (V_e), pc/h		1074			1074		616	627				
Entry Volume veh/h		1043			1043		598	609				

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		395			610		1105	1105			209	
Capacity (c), veh/h		383			592		1073	1073			0	
v/c Ratio (X)		2.72			1.76		0.56	0.57				

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		804.1			367.2		10.3	10.5				
Lane LOS		F			F		B	B				
Lane 95% Queue		87.0			62.6		3.6	3.7				
Approach Delay, s/veh	804.11			367.22			10.39					
Approach LOS, s/veh	F			F			B					
Intersection Delay, s/veh	374.81											
Intersection LOS	F											

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ROUNDABOUT REPORT

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Intersection	*Middle Road/Indiana Avenue*
Agency or Co.	*HR Green, Inc.*	E/W Street Name	
Date Performed		N/S Street Name	
Time Period	*AM Peak*	Analysis Year	*2040*
		Project ID	*I-80/Middle Road IJR*

Project Description:

Volume Adjustment and Site Characteristics

	EB				WB				NB				SB			
	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R	U
Number of Lanes(N)	0	1	0		0	1	0		1	0	1		0	0	0	
Volume (V), veh/h		20	500	0	0	20		0	870		870	0				0
Heavy Veh. Adj. (f_{HV}), %	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Peak Hour Factor (PHF)	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00	0.92	0.92	0.92	1.00
No. of Pedestrians Crossing Entry	0				0				0				0			

Critical and Follow-Up Headway Adjustment

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (sec)	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929	5.1929
Follow-Up Headway (sec)	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858	3.1858

Flow Computations

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Circulating Flow (V_c), pc/h	0			974			22			996		
Exiting Flow (V_{ex}), pc/h	996			996			0			560		
Entry Flow (V_e), pc/h		582			22		916	1032				
Entry Volume veh/h		565			21		889	1002				

Capacity and v/c Ratios

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Capacity (c_{PCE}), pc/h		1130			427		1105	1105			417	
Capacity (c), veh/h		1097			415		1073	1073			0	
v/c Ratio (X)		0.52			0.05		0.83	0.93				

Delay and Level of Service

	EB			WB			NB			SB		
	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		9.3			9.4		21.3	33.5				
Lane LOS		A			A		C	D				
Lane 95% Queue		3.0			0.2		10.1	15.4				
Approach Delay, s/veh	9.29			9.40			27.76					
Approach LOS, s/veh	A			A			D					
Intersection Delay, s/veh	23.39											
Intersection LOS	C											

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040 SubArea

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	1750	V_D = veh/h
	Ramp Volume, V_R	310	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1750	0.90	Rolling	25	0	0.727	1.00	2674
Ramp	310	0.90	Rolling	0	0	1.000	1.00	344
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 1619 pc/h

V_3 or V_{av34} 1055 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3018	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1963	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 14.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.259 (Exibit 13-11)

S_R= 62.8 mph (Exhibit 13-11)

S_0= 68.0 mph (Exhibit 13-11)

S = 64.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	2170
Ramp Volume, V_R	250
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2170	0.90	Rolling	21	0	0.760	1.00	3171
Ramp	250	0.90	Rolling	1	0	0.985	1.00	282
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 1920 pc/h

V_3 or V_{av34} 1251 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3453	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2202	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 16.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.266 (Exibit 13-11)

S_R= 62.5 mph (Exhibit 13-11)

S_0= 67.3 mph (Exhibit 13-11)

S = 64.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	2180
Ramp Volume, V_R	1040
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2180	0.90	Rolling	13	0	0.837	1.00	2895
Ramp	1040	0.90	Rolling	1	0	0.985	1.00	1173
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 1753 pc/h

V_3 or V_{av34} 1142 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4068	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2926	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 21.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.304 (Exibit 13-11)

S_R= 61.5 mph (Exhibit 13-11)

S_0= 67.7 mph (Exhibit 13-11)

S = 63.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	Tyler Wiles, PE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2040

Project Description I-80/Middle Rd IJR

Inputs

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

Number of Lanes, N	3
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	1700
Ramp Volume, V_R	400
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

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

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1700	0.90	Rolling	21	0	0.760	1.00	2484
Ramp	400	0.90	Rolling	0	0	1.000	1.00	444
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 1504 pc/h

V_3 or V_{av34} 980 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2928	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1948	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

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

D_R = 14.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.258 (Exibit 13-11)

S_R= 62.8 mph (Exhibit 13-11)

S_0= 68.3 mph (Exhibit 13-11)

S = 64.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Eastbound*
Agency or Company	*Howard R. Green Company*	From/To	*EB Rest Area/Middle Rd*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2250*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.727*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*3*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1146*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*74.8*	mph	S		mph
D = v_p / S	*15.3*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*B*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Eastbound*
From/To	*Middle Rd/US 67*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2060*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*25*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.727*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1049*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*14.0*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Eastbound*
Agency or Company	*Howard R. Green Company*	From/To	*EB Rest Area/Middle Rd*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*PM Peak*	Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3130*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*3*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1524*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*72.0*	mph	S	mph
D = v_p / S	*21.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Eastbound*
Agency or Company	*Howard R. Green Company*	From/To	*Middle Rd/US 67*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*PM Peak*	Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2420*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*3*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures			Design (N)	
			Design (N)	
Operational (LOS)			Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1179*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*74.6*	mph	S	mph
D = v_p / S	*15.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*US 67/Middle Rd*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2540*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.837*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1124*	pc/h/ln
S	*74.8*	mph
D = v_p / S	*15.0*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information / Site Information

Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*WB Rest Area/I-74*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*AM Peak*	Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3220*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.847*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1407*	pc/h/ln
S	*73.2*	mph
D = v_p / S	*19.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*J. Andrew Swisher, PE, PTOE*	Highway/Direction of Travel	*I-80/Westbound*
Agency or Company	*Howard R. Green Company*	From/To	*US 67/Middle Rd*
Date Performed		Jurisdiction	*Iowa DOT*
Analysis Time Period	*PM Peak*	Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2090*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width	*12.0*	ft			
Rt-Side Lat. Clearance	*6.0*	ft	f_{LW}	*0.0*	mph
Number of Lanes, N	*3*		f_{LC}	*0.0*	mph
Total Ramp Density, TRD	*0.50*	ramps/mi	TRD Adjustment	*1.8*	mph
FFS (measured)		mph	FFS	*73.6*	mph
Base free-flow Speed, BFFS	*75.4*	mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1018*	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*75.0*	mph	S		mph
D = v_p / S	*13.6*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*B*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*J. Andrew Swisher, PE, PTOE*
Agency or Company	*Howard R. Green Company*
Date Performed	
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-80/Westbound*
From/To	*WB Rest Area/I-74*
Jurisdiction	*Iowa DOT*
Analysis Year	*2035 Sub-Area Analysis*

Project Description *I-80/Middle Rd IJR*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2100*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*21*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Rolling*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*2.0*
E_T	*2.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.760*

Speed Inputs

Lane Width	*12.0*	ft
Rt-Side Lat. Clearance	*6.0*	ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD	*0.50*	ramps/mi
FFS (measured)		mph
Base free-flow Speed, BFFS	*75.4*	mph

Calc Speed Adj and FFS

f_{LW}	*0.0*	mph
f_{LC}	*0.0*	mph
TRD Adjustment	*1.8*	mph
FFS	*73.6*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1023*	pc/h/ln
S	*75.0*	mph
D = v_p / S	*13.6*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	2250
Ramp Volume, V_R	500
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2250	0.90	Rolling	25	0	0.727	1.00	3437
Ramp	500	0.90	Rolling	10	0	0.870	1.00	639
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 0.645 using Equation (Exhibit 13-7)

V_{12} = 2443 pc/h

V_3 or V_{av34} 994 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3437	Exhibit 13-8	7200	No
$V_{FO} = V_F - V_R$	2798	Exhibit 13-8	7200	No
V_R	639	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2443	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 20.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.356 (Exhibit 13-12)

S_R= 60.0 mph (Exhibit 13-12)

S_0= 76.8 mph (Exhibit 13-12)

S = 64.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Eastbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N	3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	500	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F	3130	V_D = veh/h
	Ramp Volume, V_R	960	
	Freeway Free-Flow Speed, S_{FF}	70.0	
	Ramp Free-Flow Speed, S_{FR}	45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3130	0.90	Rolling	21	0	0.760	1.00	4573
Ramp	960	0.90	Rolling	4	0	0.943	1.00	1131
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.594 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3174 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 1399 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

	Actual	Capacity		LOS F?
V_F	4573	Exhibit 13-8	7200	No
$V_{FO} = V_F - V_R$	3442	Exhibit 13-8	7200	No
V_R	1131	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3174	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734\ v_R + 0.0078\ V_{12} - 0.00627\ L_A$	$D_R = 4.252 + 0.0086\ V_{12} - 0.009\ L_D$
D_R = (pc/mi/ln)	D_R = 27.0 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = C (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exhibit 13-11)	D_s = 0.400 (Exhibit 13-12)
S_R= mph (Exhibit 13-11)	S_R= 58.8 mph (Exhibit 13-12)
S_0= mph (Exhibit 13-11)	S_0= 75.2 mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 63.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	AM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 500	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2540	V_D = veh/h
	Ramp Volume, V_R: 360	
	Freeway Free-Flow Speed, S_{FF}: 70.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2540	0.90	Rolling	13	0	0.837	1.00	3373
Ramp	360	0.90	Rolling	4	0	0.943	1.00	424
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exhibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 0.656 using Equation (Exhibit 13-7)

V_{12} = 2359 pc/h

V_3 or V_{av34} 1014 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3373	Exhibit 13-8	7200	No
$V_{FO} = V_F - V_R$	2949	Exhibit 13-8	7200	No
V_R	424	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2359	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 20.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.336 (Exhibit 13-12)

S_R= 60.6 mph (Exhibit 13-12)

S_0= 76.7 mph (Exhibit 13-12)

S = 64.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	J. Andrew Swisher, PE, PTOE	Freeway/Dir of Travel	I-80/Westbound
Agency or Company	Howard R. Green Company	Junction	Middle Rd
Date Performed		Jurisdiction	Iowa DOT
Analysis Time Period	PM Peak	Analysis Year	2035 Sub Area

Project Description I-80/Middle Rd IJR

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Number of Lanes, N	3
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	500
Freeway Volume, V_F	2090
Ramp Volume, V_R	390
Freeway Free-Flow Speed, S_{FF}	70.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2090	0.90	Rolling	21	0	0.760	1.00	3054
Ramp	390	0.90	Rolling	4	0	0.943	1.00	459
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

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

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

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

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

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

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

P_{FD} = 0.663 using Equation (Exhibit 13-7)

V_{12} = 2178 pc/h

V_3 or V_{av34} 876 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3054	Exhibit 13-8	7200	No
$V_{FO} = V_F - V_R$	2595	Exhibit 13-8	7200	No
V_R	459	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2178	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

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

D_R = 18.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.339 (Exhibit 13-12)

S_R= 60.5 mph (Exhibit 13-12)

S_0= 76.8 mph (Exhibit 13-12)

S = 64.4 mph (Exhibit 13-13)

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*JDW*
Agency/Co.	*HRG*
Date Performed	*3/3/14*
Analysis Time Period	*AM Peak*

Site Information

Intersection	*Middle Rd/EB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2020-Opening Year*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 EB Ramp* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*279*	*105*	*25*	*383*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*310*	*116*	*27*	*425*	*0*
Percent Heavy Vehicles	*0*	--	--	*2*	--	--
Median Type	*Raised curb*					
RT Channelized			*0*			*0*
Lanes	*0*	*2*	*0*	*1*	*2*	*0*
Configuration		*T*	*TR*	*L*	*T*	
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*39*		*118*			
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*43*	*0*	*131*	*0*	*0*	*0*
Percent Heavy Vehicles	*10*	*0*	*10*	*4*	*0*	*4*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*1*	*0*	*0*	*0*
Configuration	*L*		*R*			

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*L*				*L*		*R*
v (veh/h)		*27*				*43*		*131*
C (m) (veh/h)		*1130*				*385*		*801*
v/c		*0.02*				*0.11*		*0.16*
95% queue length		*0.07*				*0.37*		*0.58*
Control Delay (s/veh)		*8.3*				*15.5*		*10.4*
LOS		*A*				*C*		*B*
Approach Delay (s/veh)	--	--				*11.6*		
Approach LOS	--	--				*B*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*JDW*
Agency/Co.	*HRG*
Date Performed	*3/3/14*
Analysis Time Period	*PM Peak*

Site Information

Intersection	*Middle Rd/EB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2020-Opening Year*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 EB Ramp* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		280	121	21	289	
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	0	311	134	23	321	0
Percent Heavy Vehicles	0	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	0	2	0	1	2	0
Configuration		T	TR	L	T	
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	81		168			
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	90	0	186	0	0	0
Percent Heavy Vehicles	10	0	10	4	0	4
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	1	0	1	0	0	0
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		L				L		R
v (veh/h)		23				90		186
C (m) (veh/h)		1112				455		858
v/c		0.02				0.20		0.22
95% queue length		0.06				0.73		0.82
Control Delay (s/veh)		8.3				14.9		10.4
LOS		A				B		B
Approach Delay (s/veh)	--	--				11.8		
Approach LOS	--	--				B		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*JDW*
Agency/Co.	*HRG*
Date Performed	*3/3/14*
Analysis Time Period	*AM Peak*

Site Information

Intersection	*Middle Rd/EB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2020-Opening Year*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 WB Ramp* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	178	140			253	110
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	197	155	0	0	281	122
Percent Heavy Vehicles	0	--	--	2	--	--
Median Type	Raised curb					
RT Channelized			0			0
Lanes	1	2	0	0	2	0
Configuration	L	T			T	TR
Upstream Signal		0			0	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				155		18
Peak-Hour Factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Hourly Flow Rate, HFR (veh/h)	0	0	0	172	0	20
Percent Heavy Vehicles	10	0	10	4	0	4
Percent Grade (%)	0			0		
Flared Approach		N			N	
Storage		0			0	
RT Channelized			0			0
Lanes	0	0	0	1	0	1
Configuration				L		R

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	L		L		R			
v (veh/h)	197		172		20			
C (m) (veh/h)	1167		312		975			
v/c	0.17		0.55		0.02			
95% queue length	0.61		3.13		0.06			
Control Delay (s/veh)	8.7		29.8		8.8			
LOS	A		D		A			
Approach Delay (s/veh)	--	--	27.6					
Approach LOS	--	--	D					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*JDW*
Agency/Co.	*HRG*
Date Performed	*3/3/14*
Analysis Time Period	*PM Peak*

Site Information

Intersection	*Middle Rd/EB Ramp Term.*
Jurisdiction	*Iowa DOT*
Analysis Year	*2020-Opening Year*

Project Description *I-80/Middle Rd IJR*

East/West Street: *I-80 WB Ramp* | North/South Street: *Middle Rd*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*108*	*254*			*151*	*43*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*120*	*282*	*0*	*0*	*167*	*47*
Percent Heavy Vehicles	*0*	--	--	*2*	--	--
Median Type	*Raised curb*					
RT Channelized			*0*			*0*
Lanes	*1*	*2*	*0*	*0*	*2*	*0*
Configuration	*L*	*T*			*T*	*TR*
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*159*		*18*
Peak-Hour Factor, PHF	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*176*	*0*	*20*
Percent Heavy Vehicles	*10*	*0*	*10*	*4*	*0*	*4*
Percent Grade (%)	*0*			*0*		
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*		*L*		*R*			
v (veh/h)	*120*		*176*		*20*			
C (m) (veh/h)	*1368*		*388*		*899*			
v/c	*0.09*		*0.45*		*0.02*			
95% queue length	*0.29*		*2.29*		*0.07*			
Control Delay (s/veh)	*7.9*		*21.8*		*9.1*			
LOS	*A*		*C*		*A*			
Approach Delay (s/veh)	--	--	*20.5*					
Approach LOS	--	--	*C*					

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2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	62.8	17.6	50.7	33.1	57.8	11.8	37.8

3: I-80 Westbound & Performance by movement

Movement	EBR	WBT	All
Delay / Veh (s)	6.8	1.1	5.2

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	48.7	19.6	31.0	8.5	16.1	6.9	18.5

5: I-80 Eastbound & Performance by movement

Movement	EBT	WBR	All
Delay / Veh (s)	1.1	1.6	1.3

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	43.8	42.9	14.1	40.8	50.9	11.7	23.0	22.8	8.3	21.9	14.6	8.0

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	24.2

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	95.0	48.6	341.3	290.4	23.0	6.7	11.2	114.7

Total Network Performance

Delay / Veh (s)	121.1

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	22.8	46.2	0.3	23
I-80 Eastbound	4	10.3	31.0	0.3	39
I-80 Westbound	2	53.2	74.2	0.3	13
Indiana Ave	10	20.1	56.9	0.4	26
Total		106.4	208.4	1.3	22

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
I-80 Westbound	2	6.9	44.7	0.4	33
I-80 Eastbound	4	17.7	38.5	0.3	24
Forest Grove Dr	6	14.8	37.2	0.3	32
Total		39.5	120.4	1.0	30

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	165	201	106	543	580	250	250	1344	714
Average Queue (ft)	87	97	39	316	325	169	247	579	280
95th Queue (ft)	146	160	82	482	519	288	267	1097	665
Link Distance (ft)		440		1277	1277			2064	2064
Upstream Blk Time (%)								0	
Queuing Penalty (veh)								0	
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)	1	2			36	4	45	0	
Queuing Penalty (veh)	3	4			94	17	246	0	

Intersection: 3: I-80 Westbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	238	289	232	180	191	223	364	383	170
Average Queue (ft)	129	143	51	78	70	90	153	165	33
95th Queue (ft)	204	231	129	149	148	174	279	295	97
Link Distance (ft)		595			1661	1661	1277	1277	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	6	9	0	3	0			9	
Queuing Penalty (veh)	20	22	0	12	1			15	

Intersection: 5: I-80 Eastbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	238	205	193	97	172	138	149	74	51	118	127	61
Average Queue (ft)	145	88	106	46	82	64	83	37	13	46	49	7
95th Queue (ft)	223	155	161	78	143	114	131	64	38	98	104	31
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	9	1	2		0	0	0				0	
Queuing Penalty (veh)	13	2	3		1	0	1				0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	201	200	225	161
Average Queue (ft)	79	67	80	24
95th Queue (ft)	152	157	178	81
Link Distance (ft)		1661	1661	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	2	1	2	
Queuing Penalty (veh)	5	3	6	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	977	250	250	1858	354	66
Average Queue (ft)	439	237	249	1474	91	9
95th Queue (ft)	873	296	253	2336	252	34
Link Distance (ft)	4645			1834	2064	2064
Upstream Blk Time (%)				25		
Queuing Penalty (veh)				0		
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		34	58			
Queuing Penalty (veh)		7	12			

Network Summary

Network wide Queuing Penalty: 484

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	39.8	1.2	20.7	27.7	15.4	46.0	6.6	24.4

3: I-80 Westbound & Performance by movement

Movement	EBR	WBT	All
Delay / Veh (s)	2.4	1.1	1.7

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	30.8	15.3	27.3	16.4	25.9	7.7	22.7

5: I-80 Eastbound & Performance by movement

Movement	EBT	WBR	All
Delay / Veh (s)	3.7	1.3	3.2

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	31.2	29.7	11.3	29.6	34.7	11.6	21.0	22.3	8.8	19.8	10.6	7.3

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	18.9

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	48.9	10.3	35.9	22.4	38.5	8.3	14.7	23.7

Total Network Performance

Delay / Veh (s)	61.6

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	22.3	45.4	0.3	23
I-80 Eastbound	4	15.3	36.9	0.3	33
I-80 Westbound	2	26.5	47.3	0.3	20
Indiana Ave	10	38.9	75.9	0.4	19
Total		103.0	205.5	1.3	23

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
I-80 Westbound	2	5.6	43.3	0.4	34
I-80 Eastbound	4	27.1	47.9	0.3	19
Forest Grove Dr	6	10.4	32.1	0.3	37
Total		43.2	123.3	1.0	29

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	138	150	116	536	562	250	240	336	242
Average Queue (ft)	68	84	46	308	300	67	152	79	74
95th Queue (ft)	114	131	87	483	502	210	242	238	178
Link Distance (ft)		440		1277	1277			2064	2064
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)	0	0	0		19		15	0	
Queuing Penalty (veh)	0	1	0		21		53	0	

Intersection: 3: I-80 Westbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	250	538	250	123	254	273	289	304	179
Average Queue (ft)	178	220	80	57	125	145	162	173	46
95th Queue (ft)	259	403	210	105	216	241	263	273	139
Link Distance (ft)		595			1661	1661	1277	1277	
Upstream Blk Time (%)		0							
Queuing Penalty (veh)		2							
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	13	17	0	0	3			11	
Queuing Penalty (veh)	77	79	0	0	4			14	

Intersection: 5: I-80 Eastbound &

Movement	EB
Directions Served	T
Maximum Queue (ft)	82
Average Queue (ft)	3
95th Queue (ft)	40
Link Distance (ft)	1482
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	202	126	159	86	121	102	131	84	49	123	150	49
Average Queue (ft)	99	53	74	36	52	52	73	38	16	51	56	11
95th Queue (ft)	172	98	124	65	103	91	116	64	38	101	110	35
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	2	0	0		0		0			0	0	
Queuing Penalty (veh)	3	0	1		0		0			0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	156	150	447	43
Average Queue (ft)	67	38	64	12
95th Queue (ft)	130	99	295	33
Link Distance (ft)		1661	1661	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	1	0	0	
Queuing Penalty (veh)	1	0	0	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	60	178	250	364	738	328
Average Queue (ft)	20	74	177	59	331	42
95th Queue (ft)	53	136	271	239	608	219
Link Distance (ft)	4645			1834	2064	2064
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		1	18			
Queuing Penalty (veh)		0	4			

Network Summary

Network wide Queuing Penalty: 263

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	32.2	1.2	6.4	10.1	5.9	11.0	5.2	10.9

3: I-80 Westbound & Performance by movement

Movement	EBR	WBT	All
Delay / Veh (s)	2.1	0.6	1.6

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	35.4	7.8	12.4	4.4	7.6	4.2	8.2

5: I-80 Eastbound & Performance by movement

Movement	EBT	WBR	All
Delay / Veh (s)	0.5	1.4	0.9

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	31.4	25.9	14.5	28.9	36.6	10.2	20.7	10.1	6.4	9.8	12.5	5.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	16.1

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBR	All
Delay / Veh (s)	38.7	10.7	21.1	14.7	12.3	3.6	14.2

Total Network Performance

Delay / Veh (s)	34.6

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	10.1	33.2	0.3	32
I-80 Eastbound	4	4.5	31.5	0.3	38
I-80 Westbound	2	9.5	30.3	0.3	31
Indiana Ave	10	12.9	49.8	0.4	29
Total		37.1	144.8	1.3	32

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
I-80 Westbound	2	3.9	41.4	0.4	35
I-80 Eastbound	4	9.5	30.2	0.3	31
Forest Grove Dr	6	11.8	38.6	0.3	31
Total		25.2	110.1	1.0	33

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	114	130	37	109	103	159	134	100	120
Average Queue (ft)	56	68	11	43	43	53	67	32	46
95th Queue (ft)	96	105	31	89	88	111	119	72	94
Link Distance (ft)		440		1277	1277			2064	2064
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)		0				0	0	0	
Queuing Penalty (veh)		0				0	0	0	

Intersection: 3: I-80 Westbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	54	89	62	147	65	95	157	164	44
Average Queue (ft)	18	45	28	59	14	31	50	70	11
95th Queue (ft)	47	79	47	109	46	76	118	137	35
Link Distance (ft)		595			1661	1661	1277	1277	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)				0				0	
Queuing Penalty (veh)				0				0	

Intersection: 5: I-80 Eastbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	219	63	95	98	76	63	71	35	51	100	103	23
Average Queue (ft)	119	21	40	45	26	13	30	13	16	30	30	2
95th Queue (ft)	193	49	75	80	61	39	61	36	39	74	74	13
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	3										0	
Queuing Penalty (veh)	2										0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	44	181	188	88
Average Queue (ft)	10	65	80	14
95th Queue (ft)	32	140	162	50
Link Distance (ft)		1661	1661	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		0	1	
Queuing Penalty (veh)		0	2	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	53	161	250	362	122	40
Average Queue (ft)	15	75	156	41	36	6
95th Queue (ft)	42	133	256	204	90	23
Link Distance (ft)	4645			1834	2064	2064
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	9			
Queuing Penalty (veh)		0	2			

Network Summary

Network wide Queuing Penalty: 7

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	27.6	0.6	7.8	6.8	3.5	10.4	4.9	10.0

3: I-80 Westbound & Performance by movement

Movement	EBR	WBT	All
Delay / Veh (s)	1.1	0.7	0.9

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	29.4	8.4	13.3	5.6	7.7	3.6	9.5

5: I-80 Eastbound & Performance by movement

Movement	EBT	WBR	All
Delay / Veh (s)	0.9	1.4	1.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	27.3	28.6	11.0	27.1	29.0	9.8	17.8	12.0	6.3	12.1	10.6	4.2

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	14.4

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	30.7	5.7	17.3	15.3	10.0	5.7	4.3	9.7

Total Network Performance

Delay / Veh (s)			30.7

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	12.0	34.9	0.3	31
I-80 Eastbound	4	5.1	32.0	0.3	38
I-80 Westbound	2	5.3	26.3	0.3	35
Indiana Ave	10	10.2	46.8	0.4	31
Total		32.5	140.0	1.3	33

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
I-80 Westbound	2	3.6	41.7	0.4	35
I-80 Eastbound	4	10.4	30.9	0.3	30
Forest Grove Dr	6	9.0	35.8	0.3	34
Total		23.0	108.4	1.0	33

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	107	128	35	137	109	58	95	69	78
Average Queue (ft)	54	66	11	41	45	23	37	23	32
95th Queue (ft)	93	106	31	94	90	48	73	59	69
Link Distance (ft)		440		1277	1277			2064	2064
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)		0			0				
Queuing Penalty (veh)		0			0				

Intersection: 3: I-80 Westbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	88	108	96	121	85	96	103	104	59
Average Queue (ft)	38	62	40	60	21	35	38	51	13
95th Queue (ft)	70	97	71	102	59	79	85	96	41
Link Distance (ft)		595			1661	1661	1277	1277	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)				0				0	
Queuing Penalty (veh)				0				0	

Intersection: 5: I-80 Eastbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	143	60	62	67	101	69	97	38	42	140	116	17
Average Queue (ft)	63	15	29	28	48	29	52	12	15	50	45	1
95th Queue (ft)	114	40	57	56	90	58	85	35	35	103	94	8
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	0									0	0	
Queuing Penalty (veh)	0									0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	55	112	137	47
Average Queue (ft)	22	42	61	10
95th Queue (ft)	46	92	116	31
Link Distance (ft)		1661	1661	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		0	0	
Queuing Penalty (veh)		0	0	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	53	84	194	45	143	52
Average Queue (ft)	17	42	88	14	44	12
95th Queue (ft)	47	70	150	41	109	33
Link Distance (ft)	4645			1834	2064	2064
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)			1			
Queuing Penalty (veh)			0			

Network Summary

Network wide Queuing Penalty: 0

2: Middle Rd & Performance by movement

Movement	SBT	NWR	All
Delay / Veh (s)	4.9	3.6	4.4

3: Middle Rd & MR NB to EB Performance by movement

Movement	NBT	NBR	All
Delay / Veh (s)	2.6	1.0	2.4

4: Middle Rd & Performance by movement

Movement	NBR	SBT	All
Delay / Veh (s)	2.6	1.1	1.7

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	34.4	33.0	13.9	33.3	41.7	10.7	27.2	24.9	8.9	23.8	12.7	4.9

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	21.1

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	66.8	33.3	279.9	243.0	25.1	1.4	3.9	93.1

13: Middle Rd & I-80 EB to SB Performance by movement

Movement	SBT	SER	All
Delay / Veh (s)	4.7	12.2	5.6

14: Middle Rd & Performance by movement

Movement	NBT	SWT	All
Delay / Veh (s)	22.2	6.7	13.6

16: Middle Rd & MR SB to EB Performance by movement

Movement	SBL	SBT	All
Delay / Veh (s)	3.1	3.0	3.0

21: Middle Rd & I-80 EB to NB Performance by movement

Movement	NBT	NEL	All
Delay / Veh (s)	5.8	9.7	6.9

22: Middle Rd & I-80 WB to SB Performance by movement

Movement	SBT	SWL	All
Delay / Veh (s)	4.7	11.8	5.9

23: Middle Rd & MR NB to WB Performance by movement

Movement	NBL	NBT	All
Delay / Veh (s)	4.0	4.1	4.1

24: Middle Rd & Performance by movement

Movement	SBT	NET	All
Delay / Veh (s)	15.5	23.7	19.4

25: I-80 WB to NB & Middle Rd Performance by movement

Movement	NBT	NEL	All
Delay / Veh (s)	13.1	4.3	5.6

26: Middle Rd & MR SB to WB Performance by movement

Movement	SBT	SBR	All
Delay / Veh (s)	6.2	6.2	6.2

27: I-80 WB Exit & I-80 WB to SB Performance by movement

Movement	WBL	WBR	All
Delay / Veh (s)	1.8	1.2	1.5

29: I-80 EB Entrance & MR NB to EB Performance by movement

Movement	NBR	SBL	All
Delay / Veh (s)	1.4	0.4	0.9

31: I-80 WB Entrance & MR SB to WB Performance by movement

Movement	NBL	SWR	All
Delay / Veh (s)	1.2	7.0	5.5

33: I-80 EB Exit & I-80 EB to NB Performance by movement

Movement	EBL	EBR	All
Delay / Veh (s)	2.6	1.8	2.3

Total Network Performance

Delay / Veh (s)	97.7

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	24.9	48.1	0.3	22
Middle Rd	4	3.2	23.2	0.3	50
MR NB to EB	3	2.6	7.8	0.1	26
Middle Rd	14	22.2	25.9	0.0	6
Indiana Ave	10	0.0	0.0	0.3	
Total		52.9	105.0	1.0	36

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Middle Rd	2	4.7	36.6	0.3	33
MR SB to WB	26	6.2	11.6	0.1	20
Middle Rd	24	15.5	18.7	0.0	7
I-80 WB to SB	22	4.7	8.5	0.0	20
MR SB to EB	16	3.2	9.4	0.1	29
Middle Rd	14	6.7	9.0	0.0	15
Forest Grove Dr	6	0.0	0.0	0.3	
Total		41.1	93.8	0.9	35

Intersection: 2: Middle Rd &

Movement	SB	SB	NW	NW
Directions Served	T	T	R	R
Maximum Queue (ft)	38	85	61	77
Average Queue (ft)	2	6	7	19
95th Queue (ft)	28	49	36	55
Link Distance (ft)	1698	1698	305	305
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 3: Middle Rd & MR NB to EB

Movement	NB	NB
Directions Served	T	TR
Maximum Queue (ft)	67	78
Average Queue (ft)	6	4
95th Queue (ft)	36	35
Link Distance (ft)	266	266
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 4: Middle Rd &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	230	195	167	107	163	123	146	72	62	130	133	53
Average Queue (ft)	113	68	84	44	67	59	79	36	20	50	53	9
95th Queue (ft)	198	139	142	82	128	106	127	59	47	102	108	34
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	4	0	1	0	0	0	0			0	0	
Queuing Penalty (veh)	7	1	2	0	0	0	0			0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	168	132	151	72
Average Queue (ft)	80	60	73	17
95th Queue (ft)	142	116	132	47
Link Distance (ft)		1572	1572	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	1	0	0	
Queuing Penalty (veh)	3	0	1	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	631	250	250	1867	358	46
Average Queue (ft)	262	228	249	1497	147	7
95th Queue (ft)	600	294	251	2289	269	26
Link Distance (ft)	4651			1840	1698	1698
Upstream Blk Time (%)				22		
Queuing Penalty (veh)				0		
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		26	57			
Queuing Penalty (veh)		5	11			

Intersection: 13: Middle Rd & I-80 EB to SB

Movement	SB	SB	SE
Directions Served	T	T	R
Maximum Queue (ft)	81	77	134
Average Queue (ft)	30	32	59
95th Queue (ft)	63	65	112
Link Distance (ft)	178	178	158
Upstream Blk Time (%)			0
Queuing Penalty (veh)			0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 14: Middle Rd &

Movement	NB	NB	SW	SW
Directions Served	T	T	T	T
Maximum Queue (ft)	259	271	127	134
Average Queue (ft)	179	171	58	71
95th Queue (ft)	254	252	106	120
Link Distance (ft)	185	185	105	105
Upstream Blk Time (%)	7	6	2	3
Queuing Penalty (veh)	31	25	11	16
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 16: Middle Rd & MR SB to EB

Movement	SB	SB
Directions Served	LT	T
Maximum Queue (ft)	5	4
Average Queue (ft)	0	0
95th Queue (ft)	3	3
Link Distance (ft)	360	360
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 21: Middle Rd & I-80 EB to NB

Movement	NB	NB	NE
Directions Served	T	T	L
Maximum Queue (ft)	65	60	236
Average Queue (ft)	26	20	102
95th Queue (ft)	60	49	193
Link Distance (ft)	115	115	207
Upstream Blk Time (%)			1
Queuing Penalty (veh)			3
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 22: Middle Rd & I-80 WB to SB

Movement	SB	SB	SW
Directions Served	T	T	L
Maximum Queue (ft)	56	59	152
Average Queue (ft)	24	20	70
95th Queue (ft)	52	49	127
Link Distance (ft)	145	145	210
Upstream Blk Time (%)			0
Queuing Penalty (veh)			0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 23: Middle Rd & MR NB to WB

Movement	NB	NB
Directions Served	LT	T
Maximum Queue (ft)	88	62
Average Queue (ft)	7	9
95th Queue (ft)	44	39
Link Distance (ft)	362	362
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 24: Middle Rd &

Movement	SB	SB	NE	NE
Directions Served	T	T	T	T
Maximum Queue (ft)	228	228	221	223
Average Queue (ft)	174	160	146	158
95th Queue (ft)	254	226	220	229
Link Distance (ft)	160	160	158	158
Upstream Blk Time (%)	8	7	10	16
Queuing Penalty (veh)	44	37	48	74
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 25: I-80 WB to NB & Middle Rd

Movement	NB	NE	NE
Directions Served	T	L	L
Maximum Queue (ft)	138	90	87
Average Queue (ft)	64	33	42
95th Queue (ft)	116	69	77
Link Distance (ft)	155	174	174
Upstream Blk Time (%)	0		
Queuing Penalty (veh)	0		
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 26: Middle Rd & MR SB to WB

Movement	SB	SB
Directions Served	T	TR
Maximum Queue (ft)	246	294
Average Queue (ft)	40	53
95th Queue (ft)	167	207
Link Distance (ft)	313	313
Upstream Blk Time (%)	0	1
Queuing Penalty (veh)	2	7
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 27: I-80 WB Exit & I-80 WB to SB

Movement	WB
Directions Served	LR
Maximum Queue (ft)	5
Average Queue (ft)	0
95th Queue (ft)	4
Link Distance (ft)	1188
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 29: I-80 EB Entrance & MR NB to EB

Movement	NB
Directions Served	R
Maximum Queue (ft)	61
Average Queue (ft)	17
95th Queue (ft)	45
Link Distance (ft)	152
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 31: I-80 WB Entrance & MR SB to WB

Movement	NB	SW
Directions Served	L	R
Maximum Queue (ft)	27	277
Average Queue (ft)	2	135
95th Queue (ft)	14	264
Link Distance (ft)	229	210
Upstream Blk Time (%)		4
Queuing Penalty (veh)		30
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 33: I-80 EB Exit & I-80 EB to NB

Movement	EB
Directions Served	LR
Maximum Queue (ft)	14
Average Queue (ft)	1
95th Queue (ft)	8
Link Distance (ft)	1249
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 360

2: Middle Rd & Performance by movement

Movement	SBT	NWT	NWR	All
Delay / Veh (s)	1.9	2.4	4.9	3.8

3: Middle Rd & MR NB to EB Performance by movement

Movement	NBT	NBR	All
Delay / Veh (s)	3.0	1.0	2.7

4: Middle Rd & Performance by movement

Movement	NBR	SBT	All
Delay / Veh (s)	2.8	1.0	1.9

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	28.2	26.4	11.6	25.2	28.5	11.2	21.5	21.5	9.0	16.0	6.3	3.4

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	16.1

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	46.7	10.0	35.9	19.4	23.5	1.9	6.9	16.1

13: Middle Rd & I-80 EB to SB Performance by movement

Movement	SBT	SER	All
Delay / Veh (s)	5.2	6.4	5.5

14: Middle Rd & Performance by movement

Movement	NBT	SWT	All
Delay / Veh (s)	20.9	6.6	14.3

16: Middle Rd & MR SB to EB Performance by movement

Movement	SBL	SBT	All
Delay / Veh (s)	2.9	2.7	2.8

21: Middle Rd & I-80 EB to NB Performance by movement

Movement	NBT	NEL	All
Delay / Veh (s)	8.6	12.6	10.3

22: Middle Rd & I-80 WB to SB Performance by movement

Movement	SBT	SWL	All
Delay / Veh (s)	11.0	4.7	9.5

23: Middle Rd & MR NB to WB Performance by movement

Movement	NBL	NBT	All
Delay / Veh (s)	3.3	4.0	4.0

24: Middle Rd & Performance by movement

Movement	SBT	NET	All
Delay / Veh (s)	20.9	12.1	14.8

25: I-80 WB to NB & Middle Rd Performance by movement

Movement	NBT	NEL	All
Delay / Veh (s)	20.5	5.2	6.7

26: Middle Rd & MR SB to WB Performance by movement

Movement	SBT	SBR	All
Delay / Veh (s)	3.6	1.6	3.1

27: I-80 WB Exit & I-80 WB to SB Performance by movement

Movement	WBL	WBR	All
Delay / Veh (s)	1.9	1.5	1.7

29: I-80 EB Entrance & MR NB to EB Performance by movement

Movement	NBR	SBL	All
Delay / Veh (s)	1.2	0.3	0.7

31: I-80 WB Entrance & MR SB to WB Performance by movement

Movement	NBL	SWR	All
Delay / Veh (s)	0.6	1.7	1.4

33: I-80 EB Exit & I-80 EB to NB Performance by movement

Movement	EBL	EBR	All
Delay / Veh (s)	9.4	8.4	9.2

Total Network Performance

Delay / Veh (s)	54.6

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	21.5	44.6	0.3	24
Middle Rd	4	3.4	24.0	0.3	48
MR NB to EB	3	3.0	8.1	0.1	25
Middle Rd	14	20.9	24.6	0.0	7
Indiana Ave	10	0.0	0.0	0.3	
Total		48.8	101.3	1.0	38

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Middle Rd	2	2.0	33.8	0.3	36
MR SB to WB	26	3.6	9.1	0.1	26
Middle Rd	24	20.9	24.1	0.0	6
I-80 WB to SB	22	0.0	0.0	0.0	
MR SB to EB	16	3.0	9.3	0.1	30
Middle Rd	14	6.6	8.9	0.0	15
Forest Grove Dr	6	0.0	0.0	0.3	
Total		36.1	85.2	0.9	39

Intersection: 2: Middle Rd &

Movement	NW	NW
Directions Served	R	R
Maximum Queue (ft)	67	91
Average Queue (ft)	11	33
95th Queue (ft)	41	76
Link Distance (ft)	305	305
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 3: Middle Rd & MR NB to EB

Movement	NB	NB
Directions Served	T	TR
Maximum Queue (ft)	87	75
Average Queue (ft)	6	6
95th Queue (ft)	40	45
Link Distance (ft)	266	266
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 4: Middle Rd &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	206	146	127	79	87	110	129	81	49	109	126	51
Average Queue (ft)	91	47	69	36	43	45	65	39	16	50	55	12
95th Queue (ft)	167	101	114	67	78	87	106	68	40	95	107	37
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	2		0			0	0			0	0	
Queuing Penalty (veh)	2		0			0	0			0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	179	87	114	49
Average Queue (ft)	64	26	41	13
95th Queue (ft)	124	65	86	33
Link Distance (ft)		1572	1572	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	1			
Queuing Penalty (veh)	1			

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	101	169	250	454	526	213
Average Queue (ft)	18	68	178	84	278	37
95th Queue (ft)	65	127	281	320	447	131
Link Distance (ft)	4651			1840	1698	1698
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	17			
Queuing Penalty (veh)		0	3			

Intersection: 13: Middle Rd & I-80 EB to SB

Movement	SB	SB	SE
Directions Served	T	T	R
Maximum Queue (ft)	70	75	158
Average Queue (ft)	34	34	63
95th Queue (ft)	62	64	117
Link Distance (ft)	178	178	158
Upstream Blk Time (%)			0
Queuing Penalty (veh)			0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 14: Middle Rd &

Movement	NB	NB	SW	SW
Directions Served	T	T	T	T
Maximum Queue (ft)	253	260	122	123
Average Queue (ft)	179	184	53	61
95th Queue (ft)	254	258	100	106
Link Distance (ft)	185	185	105	105
Upstream Blk Time (%)	6	7	1	1
Queuing Penalty (veh)	27	31	5	4
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 16: Middle Rd & MR SB to EB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 21: Middle Rd & I-80 EB to NB

Movement	NB	NB	NE
Directions Served	T	T	L
Maximum Queue (ft)	98	91	282
Average Queue (ft)	42	41	229
95th Queue (ft)	84	80	321
Link Distance (ft)	115	115	207
Upstream Blk Time (%)	0	0	10
Queuing Penalty (veh)	1	0	77
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 22: Middle Rd & I-80 WB to SB

Movement	SB	SB	SW
Directions Served	T	T	L
Maximum Queue (ft)	102	100	119
Average Queue (ft)	43	44	51
95th Queue (ft)	85	89	93
Link Distance (ft)	145	145	210
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 23: Middle Rd & MR NB to WB

Movement	NB	NB
Directions Served	LT	T
Maximum Queue (ft)	86	75
Average Queue (ft)	13	14
95th Queue (ft)	53	50
Link Distance (ft)	362	362
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 24: Middle Rd &

Movement	SB	SB	NE	NE
Directions Served	T	T	T	T
Maximum Queue (ft)	223	224	216	214
Average Queue (ft)	137	134	174	181
95th Queue (ft)	213	206	237	234
Link Distance (ft)	160	160	158	158
Upstream Blk Time (%)	4	4	9	12
Queuing Penalty (veh)	14	13	74	91
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 25: I-80 WB to NB & Middle Rd

Movement	NB	NE	NE
Directions Served	T	L	L
Maximum Queue (ft)	158	105	107
Average Queue (ft)	80	59	63
95th Queue (ft)	140	98	97
Link Distance (ft)	155	174	174
Upstream Blk Time (%)	1		
Queuing Penalty (veh)	1		
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 26: Middle Rd & MR SB to WB

Movement	SB	SB
Directions Served	T	TR
Maximum Queue (ft)	105	73
Average Queue (ft)	5	3
95th Queue (ft)	39	36
Link Distance (ft)	313	313
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 27: I-80 WB Exit & I-80 WB to SB

Movement	WB
Directions Served	LR
Maximum Queue (ft)	53
Average Queue (ft)	2
95th Queue (ft)	21
Link Distance (ft)	1188
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 29: I-80 EB Entrance & MR NB to EB

Movement	NB
Directions Served	R
Maximum Queue (ft)	48
Average Queue (ft)	14
95th Queue (ft)	41
Link Distance (ft)	152
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 31: I-80 WB Entrance & MR SB to WB

Movement	SW
Directions Served	R
Maximum Queue (ft)	82
Average Queue (ft)	29
95th Queue (ft)	67
Link Distance (ft)	210
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 33: I-80 EB Exit & I-80 EB to NB

Movement	EB
Directions Served	LR
Maximum Queue (ft)	382
Average Queue (ft)	70
95th Queue (ft)	253
Link Distance (ft)	1249
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 348

2: Middle Rd & Performance by movement

Movement	SBT	NWT	NWR	All
Delay / Veh (s)	1.6	1.9	0.8	1.4

3: Middle Rd & MR NB to EB Performance by movement

Movement	NBT	NBR	All
Delay / Veh (s)	1.6	0.7	1.4

4: Middle Rd & Performance by movement

Movement	NBR	SBT	All
Delay / Veh (s)	2.5	1.0	1.6

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	34.7	23.4	13.5	25.7	33.2	9.1	18.1	9.8	6.7	11.4	11.8	3.5

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	15.6

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	34.7	10.3	16.6	8.9	12.7	0.2	1.2	12.0

13: Middle Rd & I-80 EB to SB Performance by movement

Movement	SBT	SER	All
Delay / Veh (s)	4.5	5.0	4.6

14: Middle Rd & Performance by movement

Movement	NBT	SWT	All
Delay / Veh (s)	13.7	6.4	9.4

16: Middle Rd & MR SB to EB Performance by movement

Movement	SBL	SBT	All
Delay / Veh (s)	1.8	1.6	1.6

21: Middle Rd & I-80 EB to NB Performance by movement

Movement	NBT	NEL	All
Delay / Veh (s)	4.9	4.3	4.8

22: Middle Rd & I-80 WB to SB Performance by movement

Movement	SBT	SWL	All
Delay / Veh (s)	4.4	3.7	4.2

23: Middle Rd & MR NB to WB Performance by movement

Movement	NBL	NBT	All
Delay / Veh (s)	3.6	2.0	2.8

24: Middle Rd & Performance by movement

Movement	SBT	NET	All
Delay / Veh (s)	10.0	8.5	9.5

25: I-80 WB to NB & Middle Rd Performance by movement

Movement	NBT	NEL	All
Delay / Veh (s)	9.3	2.2	2.9

26: Middle Rd & MR SB to WB Performance by movement

Movement	SBT	SBR	All
Delay / Veh (s)	2.5	0.9	2.0

27: I-80 WB Exit & I-80 WB to SB Performance by movement

Movement	WBL	WBR	All
Delay / Veh (s)	0.8	0.5	0.7

29: I-80 EB Entrance & MR NB to EB Performance by movement

Movement	NBR	SBL	All
Delay / Veh (s)	0.8	0.3	0.7

31: I-80 WB Entrance & MR SB to WB Performance by movement

Movement	NBL	SWR	All
Delay / Veh (s)	0.8	2.9	1.7

33: I-80 EB Exit & I-80 EB to NB Performance by movement

Movement	EBL	EBR	All
Delay / Veh (s)	1.2	0.8	0.9

Total Network Performance

Delay / Veh (s)	36.4

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	9.8	32.6	0.3	32
Middle Rd	4	3.5	29.5	0.3	39
MR NB to EB	3	1.6	6.8	0.1	30
Middle Rd	14	13.7	17.3	0.0	9
Indiana Ave	10	5.9	12.0	0.3	101
Total		34.5	98.2	1.0	38

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Middle Rd	2	1.7	33.6	0.3	36
MR SB to WB	26	2.5	7.9	0.1	30
Middle Rd	24	10.0	13.2	0.0	11
I-80 WB to SB	22	4.4	8.1	0.0	21
MR SB to EB	16	1.6	7.8	0.1	35
Middle Rd	14	6.4	8.7	0.0	15
Forest Grove Dr	6	0.0	0.0	0.3	
Total		26.4	79.3	0.9	42

Intersection: 2: Middle Rd &

Movement	NW
Directions Served	R
Maximum Queue (ft)	18
Average Queue (ft)	1
95th Queue (ft)	7
Link Distance (ft)	305
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 3: Middle Rd & MR NB to EB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: Middle Rd &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	237	65	89	106	72	48	66	30	55	83	90	25
Average Queue (ft)	123	22	38	46	26	16	30	12	16	26	27	2
95th Queue (ft)	208	52	71	85	58	41	59	34	38	63	68	12
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	6											
Queuing Penalty (veh)	5											

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	45	123	137	52
Average Queue (ft)	10	57	69	11
95th Queue (ft)	32	106	121	31
Link Distance (ft)		1572	1572	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)			0	
Queuing Penalty (veh)			0	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	69	153	249	317	118	33
Average Queue (ft)	18	73	130	23	46	7
95th Queue (ft)	52	127	219	140	95	21
Link Distance (ft)	4651			1840	1698	1698
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	4			
Queuing Penalty (veh)		0	1			

Intersection: 13: Middle Rd & I-80 EB to SB

Movement	SB	SB	SE
Directions Served	T	T	R
Maximum Queue (ft)	73	64	110
Average Queue (ft)	23	29	48
95th Queue (ft)	56	57	81
Link Distance (ft)	178	178	158
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 14: Middle Rd &

Movement	NB	NB	SW	SW
Directions Served	T	T	T	T
Maximum Queue (ft)	185	152	107	127
Average Queue (ft)	98	65	47	64
95th Queue (ft)	157	121	86	104
Link Distance (ft)	185	185	105	105
Upstream Blk Time (%)	0	0	0	1
Queuing Penalty (veh)	1	0	1	3
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 16: Middle Rd & MR SB to EB

Movement	SB
Directions Served	T
Maximum Queue (ft)	4
Average Queue (ft)	0
95th Queue (ft)	3
Link Distance (ft)	360
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 21: Middle Rd & I-80 EB to NB

Movement	NB	NB	NE
Directions Served	T	T	L
Maximum Queue (ft)	62	38	67
Average Queue (ft)	20	11	24
95th Queue (ft)	52	34	54
Link Distance (ft)	115	115	207
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 22: Middle Rd & I-80 WB to SB

Movement	SB	SB	SW
Directions Served	T	T	L
Maximum Queue (ft)	44	56	90
Average Queue (ft)	10	19	43
95th Queue (ft)	33	48	74
Link Distance (ft)	145	145	210
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 23: Middle Rd & MR NB to WB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 24: Middle Rd &

Movement	SB	SB	NE	NE
Directions Served	T	T	T	T
Maximum Queue (ft)	133	150	72	76
Average Queue (ft)	63	78	20	30
95th Queue (ft)	110	129	52	61
Link Distance (ft)	160	160	158	158
Upstream Blk Time (%)	0	0		
Queuing Penalty (veh)	0	1		
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 25: I-80 WB to NB & Middle Rd

Movement	NB	NE	NE
Directions Served	T	L	L
Maximum Queue (ft)	65	27	30
Average Queue (ft)	17	8	13
95th Queue (ft)	47	25	34
Link Distance (ft)	155	174	174
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 26: Middle Rd & MR SB to WB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 27: I-80 WB Exit & I-80 WB to SB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 29: I-80 EB Entrance & MR NB to EB

Movement	NB
Directions Served	R
Maximum Queue (ft)	39
Average Queue (ft)	6
95th Queue (ft)	26
Link Distance (ft)	152
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 31: I-80 WB Entrance & MR SB to WB

Movement	NB	SW
Directions Served	L	R
Maximum Queue (ft)	18	100
Average Queue (ft)	1	37
95th Queue (ft)	9	77
Link Distance (ft)	229	210
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 33: I-80 EB Exit & I-80 EB to NB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Network Summary

Network wide Queuing Penalty: 11

2: Middle Rd & Performance by movement

Movement	SBT	NWR	All
Delay / Veh (s)	1.0	1.4	1.2

3: Middle Rd & MR NB to EB Performance by movement

Movement	NBT	NBR	All
Delay / Veh (s)	2.0	0.9	1.7

4: Middle Rd & Performance by movement

Movement	NBR	SBT	All
Delay / Veh (s)	3.1	1.1	2.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	26.0	22.6	10.8	22.4	24.5	10.2	18.2	10.6	7.1	11.5	8.4	2.9

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	12.5

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	23.4	5.5	14.7	9.9	9.0	0.5	2.5	7.9

13: Middle Rd & I-80 EB to SB Performance by movement

Movement	SBT	SER	All
Delay / Veh (s)	7.0	4.0	6.0

14: Middle Rd & Performance by movement

Movement	NBT	SWT	All
Delay / Veh (s)	10.4	9.0	9.7

16: Middle Rd & MR SB to EB Performance by movement

Movement	SBL	SBT	All
Delay / Veh (s)	1.7	1.5	1.5

21: Middle Rd & I-80 EB to NB Performance by movement

Movement	NBT	NEL	All
Delay / Veh (s)	3.8	4.1	3.8

22: Middle Rd & I-80 WB to SB Performance by movement

Movement	SBT	SWL	All
Delay / Veh (s)	4.3	2.9	3.7

23: Middle Rd & MR NB to WB Performance by movement

Movement	NBL	NBT	All
Delay / Veh (s)	2.6	2.0	2.2

24: Middle Rd & Performance by movement

Movement	SBT	NET	All
Delay / Veh (s)	9.1	6.9	7.7

25: I-80 WB to NB & Middle Rd Performance by movement

Movement	NBT	NEL	All
Delay / Veh (s)	10.0	2.4	2.9

26: Middle Rd & MR SB to WB Performance by movement

Movement	SBT	SBR	All
Delay / Veh (s)	1.5	0.2	1.2

27: I-80 WB Exit & I-80 WB to SB Performance by movement

Movement	WBL	WBR	All
Delay / Veh (s)	0.9	0.6	0.9

29: I-80 EB Entrance & MR NB to EB Performance by movement

Movement	NBR	SBL	All
Delay / Veh (s)	0.9	0.3	0.8

31: I-80 WB Entrance & MR SB to WB Performance by movement

Movement	NBL	SWR	All
Delay / Veh (s)	0.4	1.5	0.7

33: I-80 EB Exit & I-80 EB to NB Performance by movement

Movement	EBL	EBR	All
Delay / Veh (s)	2.6	1.8	2.0

Total Network Performance

Delay / Veh (s)	31.1

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	10.6	33.6	0.3	32
Middle Rd	4	3.8	29.9	0.3	38
MR NB to EB	3	0.0	0.0	0.1	
Middle Rd	14	10.4	14.1	0.0	11
Indiana Ave	10	8.1	18.9	0.3	74
Total		33.0	96.5	1.0	40

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Middle Rd	2	1.0	33.2	0.3	36
MR SB to WB	26	1.5	6.9	0.1	34
Middle Rd	24	9.1	12.4	0.0	11
I-80 WB to SB	22	4.3	8.1	0.0	21
MR SB to EB	16	1.4	7.7	0.1	36
Middle Rd	14	9.0	11.3	0.0	12
Forest Grove Dr	6	8.4	33.4	0.3	34
Total		34.7	112.9	0.9	29

Intersection: 2: Middle Rd &

Movement	NW	NW
Directions Served	R	R
Maximum Queue (ft)	10	36
Average Queue (ft)	0	4
95th Queue (ft)	4	19
Link Distance (ft)	305	305
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 3: Middle Rd & MR NB to EB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: Middle Rd &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	129	39	71	76	90	70	88	39	59	94	110	24
Average Queue (ft)	62	11	27	29	40	27	48	11	17	38	45	2
95th Queue (ft)	110	33	55	56	75	55	79	34	42	81	95	11
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	0										0	
Queuing Penalty (veh)	0										0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	53	106	117	41
Average Queue (ft)	21	32	47	10
95th Queue (ft)	46	74	94	29
Link Distance (ft)		1572	1572	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		0		
Queuing Penalty (veh)		0		

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	48	84	175	40	152	61
Average Queue (ft)	18	38	80	9	58	17
95th Queue (ft)	45	69	135	32	123	43
Link Distance (ft)	4651			1840	1698	1698
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)			0			
Queuing Penalty (veh)			0			

Intersection: 13: Middle Rd & I-80 EB to SB

Movement	SB	SB	SE
Directions Served	T	T	R
Maximum Queue (ft)	57	61	134
Average Queue (ft)	22	30	54
95th Queue (ft)	47	59	97
Link Distance (ft)	178	178	158
Upstream Blk Time (%)			0
Queuing Penalty (veh)			0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 14: Middle Rd &

Movement	NB	NB	SW	SW
Directions Served	T	T	T	T
Maximum Queue (ft)	149	176	112	114
Average Queue (ft)	81	74	48	66
95th Queue (ft)	132	134	93	107
Link Distance (ft)	185	185	105	105
Upstream Blk Time (%)		0	1	1
Queuing Penalty (veh)		0	2	2
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 16: Middle Rd & MR SB to EB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 21: Middle Rd & I-80 EB to NB

Movement	NB	NB	NE
Directions Served	T	T	L
Maximum Queue (ft)	54	40	89
Average Queue (ft)	10	8	35
95th Queue (ft)	36	30	65
Link Distance (ft)	115	115	207
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 22: Middle Rd & I-80 WB to SB

Movement	SB	SB	SW
Directions Served	T	T	L
Maximum Queue (ft)	45	44	83
Average Queue (ft)	8	14	40
95th Queue (ft)	30	37	69
Link Distance (ft)	145	145	210
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 23: Middle Rd & MR NB to WB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 24: Middle Rd &

Movement	SB	SB	NE	NE
Directions Served	T	T	T	T
Maximum Queue (ft)	104	103	94	97
Average Queue (ft)	44	54	31	42
95th Queue (ft)	81	91	72	82
Link Distance (ft)	160	160	158	158
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 25: I-80 WB to NB & Middle Rd

Movement	NB	NE	NE
Directions Served	T	L	L
Maximum Queue (ft)	67	50	53
Average Queue (ft)	23	17	21
95th Queue (ft)	57	38	43
Link Distance (ft)	155	174	174
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 26: Middle Rd & MR SB to WB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 27: I-80 WB Exit & I-80 WB to SB

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 29: I-80 EB Entrance & MR NB to EB

Movement	NB
Directions Served	R
Maximum Queue (ft)	50
Average Queue (ft)	9
95th Queue (ft)	36
Link Distance (ft)	152
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 31: I-80 WB Entrance & MR SB to WB

Movement	SW
Directions Served	R
Maximum Queue (ft)	55
Average Queue (ft)	13
95th Queue (ft)	41
Link Distance (ft)	210
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 33: I-80 EB Exit & I-80 EB to NB

Movement	EB
Directions Served	LR
Maximum Queue (ft)	38
Average Queue (ft)	1
95th Queue (ft)	18
Link Distance (ft)	1249
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 5

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	57.6	16.2	52.2	7.2	16.4	15.4	18.5

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	44.5	16.9	12.0	6.0	15.5	8.7	15.2

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	43.4	43.1	14.2	39.7	51.4	12.1	23.7	22.4	8.1	19.7	11.0	5.3

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	22.9

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	91.7	56.5	318.9	266.6	23.5	1.8	4.2	108.5

Total Network Performance

Delay / Veh (s)	100.8

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	22.4	45.6	0.3	23
	4	14.1	35.1	0.3	35
I-80 Westbound	2	8.5	32.6	0.3	33
Indiana Ave	10	23.6	56.6	0.4	23
Total		68.5	169.9	1.3	28

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	18.4	52.9	0.4	25
I-80 Eastbound	4	8.3	32.8	0.3	33
Forest Grove Dr	6	10.6	32.6	0.3	37
Total		37.3	118.3	1.0	30

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	170	169	92	250	372	272	276	313	249
Average Queue (ft)	88	98	38	160	67	54	130	130	115
95th Queue (ft)	149	155	72	253	216	165	238	246	237
Link Distance (ft)		448			1541	1541	1826	1826	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	1	1		15	0			3	3
Queuing Penalty (veh)	2	3		72	0			27	16

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	227	262	152	226	212	85	111	183	211
Average Queue (ft)	136	137	44	88	82	12	48	67	81
95th Queue (ft)	204	208	109	185	183	62	89	137	156
Link Distance (ft)		598		1654	1654			1541	1541
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)	6	5	0		1		0	0	
Queuing Penalty (veh)	19	13	0		2		0	1	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	243	180	208	128	155	146	160	93	63	143	138	44
Average Queue (ft)	142	83	99	48	74	68	86	40	16	47	46	7
95th Queue (ft)	227	145	156	90	129	120	135	71	41	108	108	29
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	9	1	2		1	0	1			0	0	
Queuing Penalty (veh)	13	2	3		1	0	1			0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	181	140	172	65
Average Queue (ft)	67	51	64	14
95th Queue (ft)	134	110	132	42
Link Distance (ft)		1654	1654	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	1	0	1	
Queuing Penalty (veh)	3	0	2	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	1064	250	250	1860	340	54
Average Queue (ft)	504	242	249	1459	153	9
95th Queue (ft)	1017	283	251	2251	282	33
Link Distance (ft)	4651			1840	1826	1826
Upstream Blk Time (%)				21		
Queuing Penalty (veh)				0		
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		40	58			
Queuing Penalty (veh)		8	12			

Network Summary

Network wide Queuing Penalty: 201

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	34.3	20.7	14.7	11.5	7.6	5.2	12.3

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	30.6	14.7	18.9	7.3	22.1	14.7	20.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	26.9	26.1	10.9	28.9	29.6	11.7	22.6	20.7	9.3	18.1	8.9	6.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	17.0

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	48.0	10.5	42.3	21.2	26.7	4.5	9.8	19.3

Total Network Performance

Delay / Veh (s)	47.9

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	20.7	44.0	0.3	24
	4	18.4	40.1	0.3	30
I-80 Westbound	2	11.5	36.0	0.3	31
Indiana Ave	10	27.2	59.9	0.4	22
Total		77.9	180.0	1.3	26

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	7.0	41.1	0.4	31
I-80 Eastbound	4	14.5	39.3	0.3	28
Forest Grove Dr	6	8.3	29.6	0.3	41
Total		29.8	110.0	1.0	33

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	157	158	121	90	300	300	139	138	64
Average Queue (ft)	75	86	45	36	101	106	51	49	17
95th Queue (ft)	129	137	92	68	222	221	116	112	45
Link Distance (ft)		465			1560	1560	1806	1806	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	0	0	0	0	2			0	
Queuing Penalty (veh)	1	1	0	0	2			0	

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	B5	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	T	R	L	T	T
Maximum Queue (ft)	250	670	249	258	238	243	80	147	224	231
Average Queue (ft)	166	219	67	15	125	128	10	56	101	119
95th Queue (ft)	247	453	183	134	206	211	46	107	178	200
Link Distance (ft)		598		1470	1654	1654			1560	1560
Upstream Blk Time (%)		1								
Queuing Penalty (veh)		0								
Storage Bay Dist (ft)	150		150				150	150		
Storage Blk Time (%)	10	14	0			3		0	2	
Queuing Penalty (veh)	60	65	0			3		0	2	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	192	108	127	72	115	99	131	92	46	109	114	68
Average Queue (ft)	86	47	72	33	53	43	65	41	16	44	53	16
95th Queue (ft)	150	88	114	58	98	79	107	71	37	90	99	49
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	1		0		0		0					
Queuing Penalty (veh)	2		0		0		0					

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	169	88	107	49
Average Queue (ft)	59	28	44	10
95th Queue (ft)	120	69	90	31
Link Distance (ft)		1654	1654	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	1			
Queuing Penalty (veh)	1			

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	60	192	249	445	672	268
Average Queue (ft)	17	77	185	71	278	35
95th Queue (ft)	46	144	280	294	552	197
Link Distance (ft)	4650			1840	1806	1806
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		1	24			
Queuing Penalty (veh)		0	5			

Network Summary

Network wide Queuing Penalty: 142

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	28.9	6.4	12.8	3.8	10.0	4.3	11.1

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	27.9	5.8	4.1	3.1	7.0	5.4	5.8

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	31.2	26.3	14.0	29.6	35.5	9.5	19.4	10.0	6.3	11.3	15.5	4.8

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	16.9

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBR	All
Delay / Veh (s)	39.0	9.8	18.4	14.6	11.1	1.9	12.5

Total Network Performance

Delay / Veh (s)	33.1

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	10.0	33.0	0.3	32
	4	5.1	32.2	0.3	37
I-80 Westbound	2	4.1	28.5	0.3	39
Indiana Ave	10	11.5	43.9	0.4	29
Total		30.6	137.6	1.3	34

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	10.7	44.9	0.4	29
I-80 Eastbound	4	6.3	31.1	0.3	35
Forest Grove Dr	6	15.8	42.5	0.3	28
Total		32.8	118.5	1.0	30

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	121	126	55	144	63	61	130	130	73
Average Queue (ft)	57	65	12	79	16	20	47	52	17
95th Queue (ft)	99	107	37	131	48	54	103	108	47
Link Distance (ft)		498			1560	1560	1807	1807	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	0	0		0				0	
Queuing Penalty (veh)	0	0		0				0	

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	73	76	56	72	43	37	54	103	121
Average Queue (ft)	29	34	26	14	9	5	19	23	46
95th Queue (ft)	61	60	43	46	30	19	44	66	98
Link Distance (ft)		598		1654	1654			1560	1560
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)									
Queuing Penalty (veh)									

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	225	88	103	123	77	47	66	34	46	108	99	16
Average Queue (ft)	117	24	46	45	27	16	30	13	15	32	25	1
95th Queue (ft)	195	60	86	86	59	40	57	35	38	75	70	9
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	4			0						0	0	
Queuing Penalty (veh)	2			0						0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	37	181	202	49
Average Queue (ft)	11	81	97	13
95th Queue (ft)	33	153	172	34
Link Distance (ft)		1654	1654	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		1	2	
Queuing Penalty (veh)		0	3	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	53	139	250	344	108	44
Average Queue (ft)	18	72	144	29	34	9
95th Queue (ft)	47	117	237	157	76	29
Link Distance (ft)	4650			1840	1807	1807
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	5			
Queuing Penalty (veh)		0	1			

Network Summary

Network wide Queuing Penalty: 7

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	27.4	4.3	7.6	4.3	5.0	4.4	8.9

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	27.5	6.9	6.9	4.6	6.6	4.8	7.8

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	28.0	28.4	10.4	25.7	29.8	11.6	19.2	12.7	6.6	14.9	14.8	4.4

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	15.9

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	22.7	3.1	16.1	15.5	4.3	1.2	1.8	4.3

Total Network Performance

Delay / Veh (s)	27.2

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	12.7	35.7	0.3	30
	4	7.7	34.8	0.3	35
I-80 Westbound	2	5.1	29.2	0.3	37
Indiana Ave	10	4.3	36.7	0.4	36
Total		29.8	136.4	1.3	34

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	6.1	39.8	0.4	33
I-80 Eastbound	4	5.1	29.3	0.3	37
Forest Grove Dr	6	16.7	43.5	0.3	28
Total		28.0	112.6	1.0	32

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	113	118	44	103	94	95	64	73	26
Average Queue (ft)	55	65	13	43	21	30	15	16	4
95th Queue (ft)	97	101	37	81	62	71	42	47	14
Link Distance (ft)		460			1542	1542	1827	1827	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)		0			0				
Queuing Penalty (veh)		0			0				

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	97	113	82	112	88	39	54	95	108
Average Queue (ft)	46	61	36	27	26	7	14	22	37
95th Queue (ft)	85	98	65	77	69	24	39	69	86
Link Distance (ft)		598		1654	1654			1542	1542
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)									
Queuing Penalty (veh)									

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	148	46	68	60	103	77	98	46	55	127	126	34
Average Queue (ft)	68	14	27	30	40	32	48	11	15	48	56	3
95th Queue (ft)	123	39	58	52	81	64	83	36	38	101	108	17
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	1									0	0	
Queuing Penalty (veh)	0									0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	67	154	170	56
Average Queue (ft)	25	68	89	13
95th Queue (ft)	55	129	147	35
Link Distance (ft)		1654	1654	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		0	1	
Queuing Penalty (veh)		0	1	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	53	63	80	48	61	34
Average Queue (ft)	15	24	35	16	17	7
95th Queue (ft)	42	54	67	43	44	22
Link Distance (ft)	4651			1840	1827	1827
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)						
Queuing Penalty (veh)						

Network Summary

Network wide Queuing Penalty: 2

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBT	NBR	SBT	SBR	All
Delay / Veh (s)	47.8	14.4	6.9	4.8	8.3	10.3	10.6

3: I-80 Westbound & Performance by movement

Movement	EBR	WBT	All
Delay / Veh (s)	0.8	1.0	0.9

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBT	SBR	All
Delay / Veh (s)	32.5	15.3	8.6	5.8	8.4	4.4	11.7

5: I-80 Eastbound & Performance by movement

Movement	EBT	WBR	All
Delay / Veh (s)	1.1	0.5	1.0

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	42.1	43.6	14.4	40.0	51.3	12.2	23.3	22.5	8.3	18.2	11.8	6.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	22.9

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	101.7	64.5	383.5	378.9	24.7	2.1	4.7	128.2

Total Network Performance

Delay / Veh (s)	104.0

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	22.5	45.7	0.3	23
	4	9.8	30.6	0.3	40
I-80 Westbound	2	7.1	31.2	0.3	35
Indiana Ave	10	25.5	58.6	0.4	22
Total		64.8	166.1	1.3	28

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	6.4	40.6	0.4	32
I-80 Eastbound	4	8.5	32.8	0.3	33
Forest Grove Dr	6	11.5	33.9	0.3	36
Total		26.3	107.3	1.0	34

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	T	T	R
Maximum Queue (ft)	164	180	80	191	160	57	127	145	68
Average Queue (ft)	76	87	33	52	50	21	42	53	31
95th Queue (ft)	132	146	60	123	118	48	95	113	58
Link Distance (ft)		452		1514	1514		1825	1825	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150			150
Storage Blk Time (%)	1	1			0			0	
Queuing Penalty (veh)	2	2			1			1	

Intersection: 3: I-80 Westbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	T	T	R
Maximum Queue (ft)	186	217	120	152	171	37	204	231	86
Average Queue (ft)	98	113	36	55	62	6	69	84	23
95th Queue (ft)	160	181	83	118	129	20	153	171	61
Link Distance (ft)		596		1654	1654		1514	1514	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150			150
Storage Blk Time (%)	1	3	0		0			1	
Queuing Penalty (veh)	4	7	1		0			2	

Intersection: 5: I-80 Eastbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	241	220	205	102	145	155	164	80	55	151	138	63
Average Queue (ft)	142	89	104	48	78	66	87	42	16	43	49	9
95th Queue (ft)	216	160	166	83	130	119	138	67	43	101	106	36
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	7	1	1	0	0	0	1			0	0	
Queuing Penalty (veh)	11	3	3	0	0	0	1			0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	193	161	196	149
Average Queue (ft)	68	58	68	19
95th Queue (ft)	139	130	148	74
Link Distance (ft)		1654	1654	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	1	1	1	0
Queuing Penalty (veh)	2	2	3	0

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	1150	250	250	1866	342	58
Average Queue (ft)	595	247	249	1576	157	10
95th Queue (ft)	1115	268	253	2353	282	35
Link Distance (ft)	4651			1840	1825	1825
Upstream Blk Time (%)				28		
Queuing Penalty (veh)				0		
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		43	58			
Queuing Penalty (veh)		9	12			

Network Summary

Network wide Queuing Penalty: 66

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBT	SBR	All
Delay / Veh (s)	31.2	0.5	20.5	11.3	7.3	4.8	4.6	11.0

3: I-80 Westbound & Performance by movement

Movement	EBR	WBT	All
Delay / Veh (s)	0.4	1.0	0.9

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBT	SBR	All
Delay / Veh (s)	22.1	11.5	16.8	7.6	15.7	5.1	16.6

5: I-80 Eastbound & Performance by movement

Movement	EBT	WBR	All
Delay / Veh (s)	3.1	0.5	2.8

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	26.9	24.8	10.4	27.5	30.3	11.5	21.1	22.7	9.1	21.4	10.3	6.3

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	17.8

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	48.7	9.8	33.1	18.1	26.4	4.7	10.4	17.7

Total Network Performance

Delay / Veh (s)	43.9

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	22.7	46.0	0.3	23
	4	17.9	39.7	0.3	31
I-80 Westbound	2	13.2	37.8	0.3	29
Indiana Ave	10	26.9	59.9	0.4	22
Total		80.7	183.4	1.3	26

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	4.9	38.8	0.4	33
I-80 Eastbound	4	16.6	41.1	0.3	27
Forest Grove Dr	6	10.4	31.6	0.3	38
Total		32.0	111.6	1.0	32

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	T	T	R
Maximum Queue (ft)	121	143	93	229	224	49	82	96	37
Average Queue (ft)	63	79	43	106	100	16	30	31	13
95th Queue (ft)	109	128	78	199	186	42	70	71	29
Link Distance (ft)		469		1533	1533		1806	1806	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150			150
Storage Blk Time (%)	0	0			1			0	
Queuing Penalty (veh)	0	1			1			0	

Intersection: 3: I-80 Westbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	T	T	R
Maximum Queue (ft)	249	281	188	238	263	73	238	236	169
Average Queue (ft)	144	158	47	114	124	9	109	116	31
95th Queue (ft)	219	236	118	210	223	44	201	207	87
Link Distance (ft)		595		1654	1654		1533	1533	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150			150
Storage Blk Time (%)	5	7			3			3	
Queuing Penalty (veh)	28	32			4			4	

Intersection: 5: I-80 Eastbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	181	113	138	60	115	110	125	86	50	120	142	60
Average Queue (ft)	85	47	69	32	48	46	68	40	16	52	63	14
95th Queue (ft)	145	88	112	51	94	85	106	69	37	100	120	45
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	1		0		0	0	0			0	0	
Queuing Penalty (veh)	1		0		0	0	0			0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	163	126	124	63
Average Queue (ft)	67	39	50	14
95th Queue (ft)	127	94	101	39
Link Distance (ft)		1654	1654	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	1	0	0	
Queuing Penalty (veh)	1	0	0	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	62	147	249	312	715	387
Average Queue (ft)	17	66	160	32	274	35
95th Queue (ft)	49	123	255	165	536	190
Link Distance (ft)	4651			1840	1806	1806
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	14			
Queuing Penalty (veh)		0	3			

Network Summary

Network wide Queuing Penalty: 76

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBT	SBR	All
Delay / Veh (s)	24.3	0.7	5.4	4.2	3.3	4.1	2.7	6.6

3: I-80 Westbound & Performance by movement

Movement	EBR	WBT	All
Delay / Veh (s)	0.9	0.6	0.8

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBT	SBR	All
Delay / Veh (s)	23.7	7.0	4.1	3.5	4.3	2.9	5.2

5: I-80 Eastbound & Performance by movement

Movement	EBT	WBR	All
Delay / Veh (s)	0.5	0.3	0.5

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	30.2	25.1	13.0	27.0	37.7	10.0	19.2	10.9	6.3	12.9	16.2	5.4

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	16.9

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBR	All
Delay / Veh (s)	39.3	10.9	18.1	11.3	10.9	2.0	12.7

Total Network Performance

Delay / Veh (s)	29.7

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	10.9	34.0	0.3	31
	4	5.1	32.2	0.3	37
I-80 Westbound	2	4.5	28.9	0.3	38
Indiana Ave	10	11.3	43.9	0.4	29
Total		31.8	139.0	1.3	34

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	4.8	38.8	0.4	33
I-80 Eastbound	4	4.4	28.9	0.3	38
Forest Grove Dr	6	17.0	43.8	0.3	27
Total		26.3	111.5	1.0	32

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	T	T	R
Maximum Queue (ft)	101	107	46	57	59	58	68	75	35
Average Queue (ft)	47	61	9	19	19	30	18	22	10
95th Queue (ft)	85	93	32	48	48	50	50	57	27
Link Distance (ft)		502		1533	1533		1806	1806	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150			150
Storage Blk Time (%)									
Queuing Penalty (veh)									

Intersection: 3: I-80 Westbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	T	T	R
Maximum Queue (ft)	68	101	74	42	55	31	75	114	32
Average Queue (ft)	18	39	27	8	12	5	20	32	6
95th Queue (ft)	48	75	51	27	38	16	59	79	25
Link Distance (ft)		595		1654	1654		1533	1533	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150			150
Storage Blk Time (%)								0	
Queuing Penalty (veh)								0	

Intersection: 5: I-80 Eastbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	193	54	91	99	90	53	76	34	68	92	113	18
Average Queue (ft)	108	21	39	45	30	13	30	13	18	26	37	1
95th Queue (ft)	174	49	73	85	66	39	61	35	45	63	86	7
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	2			0							0	
Queuing Penalty (veh)	2			0							0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	41	182	205	118
Average Queue (ft)	13	83	102	18
95th Queue (ft)	34	152	170	64
Link Distance (ft)		1654	1654	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		1	2	
Queuing Penalty (veh)		0	3	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	53	160	248	277	112	30
Average Queue (ft)	17	75	142	19	35	6
95th Queue (ft)	48	127	231	120	77	20
Link Distance (ft)	4651			1840	1806	1806
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	6			
Queuing Penalty (veh)		0	1			

Network Summary

Network wide Queuing Penalty: 6

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBT	SBR	All
Delay / Veh (s)	23.0	1.7	5.4	4.5	3.0	3.3	1.7	7.1

3: I-80 Westbound & Performance by movement

Movement	EBR	WBT	All
Delay / Veh (s)	0.5	0.6	0.6

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBT	SBR	All
Delay / Veh (s)	24.1	6.9	6.5	4.9	5.3	2.5	7.5

5: I-80 Eastbound & Performance by movement

Movement	EBT	WBR	All
Delay / Veh (s)	0.9	0.2	0.8

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	28.5	29.9	10.7	26.7	30.9	11.0	18.7	12.5	6.7	14.7	14.0	4.5

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	15.7

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	28.8	6.1	14.5	9.8	10.5	4.1	3.1	8.8

Total Network Performance

Delay / Veh (s)			28.6

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	12.5	35.5	0.3	30
	4	7.3	34.5	0.3	35
I-80 Westbound	2	5.1	29.1	0.3	37
Indiana Ave	10	10.7	43.5	0.4	30
Total		35.6	142.6	1.3	33

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	3.5	37.4	0.4	35
I-80 Eastbound	4	5.4	29.6	0.3	37
Forest Grove Dr	6	16.0	42.6	0.3	28
Total		24.9	109.6	1.0	33

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	T	T	R
Maximum Queue (ft)	97	94	24	74	77	38	50	49	25
Average Queue (ft)	47	53	6	21	22	18	11	11	4
95th Queue (ft)	84	89	19	54	55	40	37	32	16
Link Distance (ft)		464		1515	1515		1826	1826	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150			150
Storage Blk Time (%)									
Queuing Penalty (veh)									

Intersection: 3: I-80 Westbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	T	T	R
Maximum Queue (ft)	106	128	73	78	86	43	96	118	30
Average Queue (ft)	37	56	33	19	22	9	24	38	6
95th Queue (ft)	76	94	58	52	60	28	63	86	24
Link Distance (ft)		596		1654	1654		1515	1515	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150			150
Storage Blk Time (%)		0						0	
Queuing Penalty (veh)		0						0	

Intersection: 5: I-80 Eastbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	160	54	72	78	116	71	93	34	46	130	142	24
Average Queue (ft)	63	16	29	31	41	30	50	10	14	41	59	2
95th Queue (ft)	120	42	57	60	84	60	88	32	36	90	114	12
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	0				0					0	0	
Queuing Penalty (veh)	0				0					0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	79	137	147	53
Average Queue (ft)	25	64	78	14
95th Queue (ft)	57	117	131	36
Link Distance (ft)		1654	1654	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		0	0	
Queuing Penalty (veh)		0	0	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	57	76	185	40	139	54
Average Queue (ft)	20	42	81	10	58	14
95th Queue (ft)	52	75	142	34	118	38
Link Distance (ft)	4651			1840	1826	1826
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)			1			
Queuing Penalty (veh)			0			

Network Summary

Network wide Queuing Penalty: 1

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	62.8	17.6	50.7	33.1	57.8	11.8	37.8

3: I-80 Westbound & Performance by movement

Movement	EBR	WBT	All
Delay / Veh (s)	6.8	1.1	5.2

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	48.7	19.6	31.0	8.5	16.1	6.9	18.5

5: I-80 Eastbound & Performance by movement

Movement	EBT	WBR	All
Delay / Veh (s)	1.1	1.6	1.3

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	43.8	42.9	14.1	40.8	50.9	11.7	23.0	22.8	8.3	21.9	14.6	8.0

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	24.2

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	95.0	48.6	341.3	290.4	23.0	6.7	11.2	114.7

Total Network Performance

Delay / Veh (s)	121.1

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	22.8	46.2	0.3	23
I-80 Eastbound	4	10.3	31.0	0.3	39
I-80 Westbound	2	53.2	74.2	0.3	13
Indiana Ave	10	20.1	56.9	0.4	26
Total		106.4	208.4	1.3	22

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
I-80 Westbound	2	6.9	44.7	0.4	33
I-80 Eastbound	4	17.7	38.5	0.3	24
Forest Grove Dr	6	14.8	37.2	0.3	32
Total		39.5	120.4	1.0	30

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	165	201	106	543	580	250	250	1344	714
Average Queue (ft)	87	97	39	316	325	169	247	579	280
95th Queue (ft)	146	160	82	482	519	288	267	1097	665
Link Distance (ft)		440		1277	1277			2064	2064
Upstream Blk Time (%)								0	
Queuing Penalty (veh)								0	
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)	1	2			36	4	45	0	
Queuing Penalty (veh)	3	4			94	17	246	0	

Intersection: 3: I-80 Westbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	238	289	232	180	191	223	364	383	170
Average Queue (ft)	129	143	51	78	70	90	153	165	33
95th Queue (ft)	204	231	129	149	148	174	279	295	97
Link Distance (ft)		595			1661	1661	1277	1277	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	6	9	0	3	0			9	
Queuing Penalty (veh)	20	22	0	12	1			15	

Intersection: 5: I-80 Eastbound &

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	238	205	193	97	172	138	149	74	51	118	127	61
Average Queue (ft)	145	88	106	46	82	64	83	37	13	46	49	7
95th Queue (ft)	223	155	161	78	143	114	131	64	38	98	104	31
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	9	1	2		0	0	0				0	
Queuing Penalty (veh)	13	2	3		1	0	1				0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	201	200	225	161
Average Queue (ft)	79	67	80	24
95th Queue (ft)	152	157	178	81
Link Distance (ft)		1661	1661	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	2	1	2	
Queuing Penalty (veh)	5	3	6	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	977	250	250	1858	354	66
Average Queue (ft)	439	237	249	1474	91	9
95th Queue (ft)	873	296	253	2336	252	34
Link Distance (ft)	4645			1834	2064	2064
Upstream Blk Time (%)				25		
Queuing Penalty (veh)				0		
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		34	58			
Queuing Penalty (veh)		7	12			

Network Summary

Network wide Queuing Penalty: 484

5: I-80 Westbound & I-80 Eastbound Performance by movement

Movement	NBL	NBT	NBR2	SBL	SBT	SBR2	NEL	NER2	SWL	SWR2	All
Delay / Veh (s)	33.2	11.0	7.5	15.3	16.1	12.8	61.6	4.8	36.9	8.6	20.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	36.1	37.2	13.5	34.6	42.2	11.5	25.6	23.1	8.4	23.9	17.7	12.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	23.3

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	67.3	43.9	419.2	372.6	29.0	8.5	11.5	135.0

Total Network Performance

Delay / Veh (s)	109.8

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	23.1	46.4	0.3	23
I-80 Eastbound	5	13.6	44.0	0.5	41
Indiana Ave	10	35.7	81.7	0.5	23
Total		72.4	172.1	1.3	27

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
I-80 Westbound	5	20.9	67.2	0.5	27
Forest Grove Dr	6	18.2	51.3	0.5	34
Total		39.1	118.6	1.0	30

Intersection: 5: I-80 Westbound & I-80 Eastbound

Movement	NB	NB	NB	SB	SB	SB	SB	NE	NE	NE	SW	SW
Directions Served	L	T	T	L	T	T	>	L	L	>	L	L
Maximum Queue (ft)	231	212	199	146	222	218	289	242	260	200	115	119
Average Queue (ft)	113	72	59	48	114	117	99	137	138	30	61	62
95th Queue (ft)	199	160	130	96	188	194	253	252	261	157	105	107
Link Distance (ft)		2478	2478		2602	2602			540			456
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150			400	250		250	250	
Storage Blk Time (%)	5	0	0	0	2			4	5			
Queuing Penalty (veh)	15	1	0	0	3			12	17			

Intersection: 5: I-80 Westbound & I-80 Eastbound

Movement	SW
Directions Served	>
Maximum Queue (ft)	243
Average Queue (ft)	44
95th Queue (ft)	173
Link Distance (ft)	
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	250
Storage Blk Time (%)	0
Queuing Penalty (veh)	1

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	220	166	165	94	151	141	154	83	70	121	114	56
Average Queue (ft)	115	71	94	43	74	60	81	39	19	47	44	7
95th Queue (ft)	196	131	146	75	130	110	129	67	50	100	98	30
Link Distance (ft)		1104	1104			1022	1022			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	4	0	1		0	0	1			0	0	
Queuing Penalty (veh)	7	0	1		0	0	1			0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	138	162	202	82
Average Queue (ft)	70	64	76	23
95th Queue (ft)	122	131	146	57
Link Distance (ft)		2478	2478	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	0	1	1	
Queuing Penalty (veh)	1	2	2	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	780	250	250	1857	310	42
Average Queue (ft)	379	236	249	1680	139	9
95th Queue (ft)	792	294	251	2268	253	27
Link Distance (ft)	4644			1834	2602	2602
Upstream Blk Time (%)				31		
Queuing Penalty (veh)				0		
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		34	59			
Queuing Penalty (veh)		7	12			

Network Summary

Network wide Queuing Penalty: 82

5: I-80 Westbound & I-80 Eastbound Performance by movement

Movement	NBL	NBT	NBR2	SBL	SBT	SBR2	NEL	NER2	SWL	SWR2	All
Delay / Veh (s)	25.7	20.4	8.6	38.6	20.6	7.8	23.8	4.7	17.9	4.0	18.5

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	29.4	26.5	11.5	28.5	30.7	11.0	20.8	23.1	9.1	26.1	15.2	10.4

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	19.9

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	50.7	10.0	35.2	17.8	28.8	7.1	12.9	20.0

Total Network Performance

Delay / Veh (s)	42.6

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	23.1	46.2	0.3	23
I-80 Eastbound	5	21.0	52.1	0.5	34
Indiana Ave	10	28.3	74.3	0.5	25
Total		72.4	172.6	1.3	27

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
I-80 Westbound	5	22.5	68.7	0.5	27
Forest Grove Dr	6	16.8	49.1	0.5	36
Total		39.3	117.8	1.0	31

Intersection: 5: I-80 Westbound & I-80 Eastbound

Movement	NB	NB	NB	NB	SB	SB	SB	SB	NE	NE	NE	SW
Directions Served	L	T	T	>	L	T	T	>	L	L	>	L
Maximum Queue (ft)	141	238	230	99	159	220	231	151	268	272	178	99
Average Queue (ft)	55	125	124	3	74	101	105	8	155	159	26	50
95th Queue (ft)	108	200	203	50	134	175	184	66	234	237	121	87
Link Distance (ft)		2478	2478			2602	2602			540		
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			400	250		250	250
Storage Blk Time (%)	0	3	3		1	2			1	1		
Queuing Penalty (veh)	0	4	4		3	2			4	5		

Intersection: 5: I-80 Westbound & I-80 Eastbound

Movement	SW	SW
Directions Served	L	>
Maximum Queue (ft)	112	177
Average Queue (ft)	47	14
95th Queue (ft)	86	90
Link Distance (ft)	456	
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		250
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	203	174	152	72	142	102	121	75	58	111	134	51
Average Queue (ft)	97	52	69	35	53	52	71	38	18	56	58	12
95th Queue (ft)	164	111	117	62	102	91	111	62	43	102	108	38
Link Distance (ft)		1104	1104			1022	1022			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	2	0	0		0		0			0	0	
Queuing Penalty (veh)	3	0	0		0		0			0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	176	127	626	58
Average Queue (ft)	73	46	74	16
95th Queue (ft)	140	103	415	40
Link Distance (ft)		2478	2478	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	1	0	0	
Queuing Penalty (veh)	2	0	0	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	60	145	250	404	606	316
Average Queue (ft)	18	69	175	60	264	36
95th Queue (ft)	48	127	278	260	477	162
Link Distance (ft)	4644			1834	2602	2602
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	16			
Queuing Penalty (veh)		0	3			

Network Summary

Network wide Queuing Penalty: 30

5: I-80 Westbound & I-80 Eastbound Performance by movement

Movement	NBL	NBT	NBR2	SBL	SBT	SBR2	NEL	NER2	SWL	SWR2	All
Delay / Veh (s)	14.5	7.4	5.5	9.2	16.8	8.0	27.7	3.7	30.3	2.0	13.7

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	29.5	24.1	14.2	27.6	36.0	9.3	18.9	9.6	6.1	17.0	19.1	10.6

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	18.0

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	37.0	9.9	17.8	11.3	16.4	6.0	6.2	13.7

Total Network Performance

Delay / Veh (s)	35.9

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	9.6	32.6	0.3	33
I-80 Eastbound	5	8.2	48.4	0.5	36
Indiana Ave	10	17.4	62.7	0.5	29
Total		35.2	143.7	1.3	32

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
I-80 Westbound	5	17.5	63.8	0.5	29
Forest Grove Dr	6	18.5	58.5	0.5	30
Total		36.0	122.3	1.0	29

Intersection: 5: I-80 Westbound & I-80 Eastbound

Movement	NB	NB	NB	NB	SB	SB	SB	SB	NE	NE	SW
Directions Served	L	T	T	>	L	T	T	>	L	>	L
Maximum Queue (ft)	171	69	61	85	57	145	146	174	115	173	214
Average Queue (ft)	85	22	20	5	21	82	79	24	45	15	115
95th Queue (ft)	149	55	54	47	50	130	136	114	90	89	185
Link Distance (ft)		2485	2485			2608	2608		535		449
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)	150			150	150			150		250	
Storage Blk Time (%)	1			0		0	0	1			0
Queuing Penalty (veh)	1			0		0	0	3			0

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	214	57	73	93	83	44	71	31	42	106	90	30
Average Queue (ft)	111	21	37	45	31	15	32	12	16	34	20	1
95th Queue (ft)	181	48	65	79	67	38	61	35	37	80	56	12
Link Distance (ft)		1104	1104			1022	1022			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	2											
Queuing Penalty (veh)	2											

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	33	153	166	43
Average Queue (ft)	10	64	78	12
95th Queue (ft)	29	118	137	32
Link Distance (ft)		2485	2485	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		0	0	
Queuing Penalty (veh)		0	1	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	57	162	249	283	116	50
Average Queue (ft)	18	69	140	23	41	8
95th Queue (ft)	47	116	236	140	91	27
Link Distance (ft)	4644			1834	2608	2608
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	6			
Queuing Penalty (veh)		0	1			

Network Summary

Network wide Queuing Penalty: 8

5: I-80 Westbound & I-80 Eastbound Performance by movement

Movement	NBL	NBT	NBR2	SBL	SBT	SBR2	NEL	NER2	SWL	SWR2	All
Delay / Veh (s)	9.2	10.1	7.4	10.4	17.6	4.6	24.6	6.8	27.3	2.0	13.4

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	28.5	29.2	11.1	26.0	30.8	10.6	18.3	12.3	6.9	20.9	20.8	14.0

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	18.4

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	22.3	5.6	13.5	7.5	11.2	4.9	6.1	9.2

Total Network Performance

Delay / Veh (s)	33.0

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	12.3	35.4	0.3	30
I-80 Eastbound	5	11.1	51.0	0.5	35
Indiana Ave	10	11.6	56.8	0.5	32
Total		35.0	143.2	1.3	33

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
I-80 Westbound	5	18.2	63.8	0.5	29
Forest Grove Dr	6	27.0	67.8	0.5	26
Total		45.3	131.6	1.0	27

Intersection: 5: I-80 Westbound & I-80 Eastbound

Movement	NB	NB	NB	NB	SB	SB	SB	NE	NE	SW
Directions Served	L	T	T	>	L	T	T	L	>	L
Maximum Queue (ft)	99	113	118	78	62	119	108	158	254	219
Average Queue (ft)	42	38	42	3	19	59	50	76	68	120
95th Queue (ft)	81	81	89	37	49	100	94	134	211	189
Link Distance (ft)		2485	2485			2608	2608	535		449
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	150			150	150				250	
Storage Blk Time (%)	0	0	0	0		0	0		0	0
Queuing Penalty (veh)	0	0	0	0		0	0		1	0

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	144	41	82	65	107	72	102	49	58	136	122	23
Average Queue (ft)	67	15	30	31	48	31	56	14	15	49	48	2
95th Queue (ft)	120	39	60	55	89	63	91	39	38	104	104	13
Link Distance (ft)		1104	1104			1022	1022			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	0									0	0	
Queuing Penalty (veh)	0									0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	62	127	148	48
Average Queue (ft)	22	55	74	12
95th Queue (ft)	47	106	130	33
Link Distance (ft)		2485	2485	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		0	0	
Queuing Penalty (veh)		0	0	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	49	75	149	44	126	46
Average Queue (ft)	16	42	74	7	48	14
95th Queue (ft)	44	71	124	28	99	35
Link Distance (ft)	4644			1834	2608	2608
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)			0			
Queuing Penalty (veh)			0			

Network Summary

Network wide Queuing Penalty: 1

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	45.6	14.2	49.0	6.8	14.7	14.4	16.9

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	38.6	15.7	11.5	6.3	16.6	8.5	14.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	35.3	35.5	14.6	32.0	39.1	11.3	23.8	22.7	8.5	18.0	11.4	6.9

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	20.4

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	76.3	49.7	387.0	300.5	21.3	2.1	4.6	124.5

Total Network Performance

Delay / Veh (s)	105.1

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	22.7	46.0	0.3	23
	4	12.4	37.4	0.4	39
I-80 Westbound	2	6.2	18.2	0.1	30
Indiana Ave	10	22.1	61.5	0.4	26
Total		63.4	163.2	1.3	29

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	18.9	59.6	0.4	27
I-80 Eastbound	4	8.4	20.6	0.1	26
Forest Grove Dr	6	10.9	37.4	0.4	39
Total		38.2	117.6	1.0	31

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	132	153	77	248	407	279	223	263	249
Average Queue (ft)	70	81	35	146	82	70	120	118	117
95th Queue (ft)	117	130	58	248	291	205	196	209	217
Link Distance (ft)		1834			737	737	2257	2257	
Upstream Blk Time (%)					0				
Queuing Penalty (veh)					1				
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	0	0		18	0			2	3
Queuing Penalty (veh)	0	0		84	0			15	17

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	184	192	122	186	191	88	156	219	217
Average Queue (ft)	105	108	39	83	78	14	56	76	85
95th Queue (ft)	164	168	82	164	161	52	110	162	174
Link Distance (ft)		1988		2025	2025			737	737
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)	2	2			1		0	1	
Queuing Penalty (veh)	6	5			2		2	2	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	218	157	164	103	138	121	155	82	58	110	110	60
Average Queue (ft)	114	71	90	47	65	56	78	39	17	45	42	8
95th Queue (ft)	195	131	146	86	116	105	127	67	43	93	90	34
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	4	0	1	0	0	0	0	0				
Queuing Penalty (veh)	6	1	1	0	0	0	1	0				

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	163	127	160	109
Average Queue (ft)	69	53	68	22
95th Queue (ft)	133	108	129	62
Link Distance (ft)		2025	2025	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	1	0	0	0
Queuing Penalty (veh)	2	0	1	0

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	997	250	250	1861	292	63
Average Queue (ft)	442	241	249	1525	141	13
95th Queue (ft)	888	287	251	2385	255	38
Link Distance (ft)	4650			1840	2257	2257
Upstream Blk Time (%)				28		
Queuing Penalty (veh)				0		
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		38	59			
Queuing Penalty (veh)		8	12			

Network Summary

Network wide Queuing Penalty: 164

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	34.7	18.3	13.8	9.1	8.0	5.9	11.0

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	32.5	17.4	19.8	8.2	24.6	12.8	20.6

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	28.3	26.1	11.3	25.5	30.9	11.4	22.5	21.8	9.2	20.2	10.0	6.3

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	17.7

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	53.1	10.2	37.6	17.3	26.8	4.7	10.5	18.8

Total Network Performance

Delay / Veh (s)	46.6

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	21.8	45.1	0.3	24
	4	19.0	45.6	0.4	33
I-80 Westbound	2	8.1	19.5	0.1	26
Indiana Ave	10	27.5	67.1	0.4	24
Total		76.4	177.4	1.3	26

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	8.2	48.6	0.4	33
I-80 Eastbound	4	14.7	26.3	0.1	20
Forest Grove Dr	6	9.8	35.6	0.4	42
Total		32.6	110.6	1.0	33

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	143	127	87	127	246	244	138	152	92
Average Queue (ft)	66	77	40	41	98	100	54	54	24
95th Queue (ft)	113	120	74	85	195	198	112	115	58
Link Distance (ft)		1938			702	702	2247	2247	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	0	0			1			0	
Queuing Penalty (veh)	0	0			2			1	

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	248	478	225	274	261	170	168	235	224
Average Queue (ft)	164	186	54	137	142	19	61	97	106
95th Queue (ft)	240	335	133	229	237	85	128	179	185
Link Distance (ft)		1978		2067	2067			702	702
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)	10	11	0		5		1	1	
Queuing Penalty (veh)	60	54	0		6		2	2	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	200	120	131	72	106	106	130	79	65	112	119	59
Average Queue (ft)	91	48	70	35	45	48	68	40	19	49	57	14
95th Queue (ft)	163	91	118	58	87	87	113	66	47	93	102	43
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	2	0	0			0	0					
Queuing Penalty (veh)	3	0	0			0	0					

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	143	96	110	64
Average Queue (ft)	62	34	46	14
95th Queue (ft)	115	73	88	42
Link Distance (ft)		2067	2067	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)	0			
Queuing Penalty (veh)	0			

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	70	171	250	361	592	385
Average Queue (ft)	19	71	188	47	270	40
95th Queue (ft)	52	133	279	220	491	194
Link Distance (ft)	4650			1840	2247	2247
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	20			
Queuing Penalty (veh)		0	4			

Network Summary

Network wide Queuing Penalty: 135

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	31.6	7.1	12.7	3.7	9.8	4.9	11.6

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	33.4	7.2	4.8	3.3	6.6	4.2	5.9

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	31.4	26.0	13.6	31.1	39.7	9.2	19.1	10.3	6.3	13.7	15.7	5.4

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	17.0

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBR	All
Delay / Veh (s)	35.5	10.5	18.7	12.2	11.8	2.2	13.1

Total Network Performance

Delay / Veh (s)	33.8

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	10.3	33.3	0.3	32
	4	6.9	41.1	0.4	37
I-80 Westbound	2	4.1	14.2	0.1	32
Indiana Ave	10	12.1	51.9	0.4	31
Total		33.3	140.5	1.3	33

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	10.4	51.7	0.4	31
I-80 Eastbound	4	3.7	14.2	0.1	32
Forest Grove Dr	6	16.4	49.9	0.4	31
Total		30.5	115.7	1.0	31

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	122	134	32	212	155	69	132	151	71
Average Queue (ft)	57	68	10	81	18	20	48	56	23
95th Queue (ft)	101	110	31	155	78	53	104	118	55
Link Distance (ft)		1792			623	623	2278	2278	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	0	0		1				0	
Queuing Penalty (veh)	0	0		2				0	

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	82	84	57	102	66	31	52	89	104
Average Queue (ft)	32	41	31	24	10	9	17	22	36
95th Queue (ft)	71	69	50	74	36	27	43	64	80
Link Distance (ft)		1909		2119	2119			623	623
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)								0	
Queuing Penalty (veh)								0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	222	122	103	108	90	52	72	30	67	96	86	16
Average Queue (ft)	118	25	41	42	27	14	31	10	18	34	25	1
95th Queue (ft)	198	77	82	83	64	38	60	32	47	79	63	9
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	4		0	0								
Queuing Penalty (veh)	3		0	0								

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	50	183	242	53
Average Queue (ft)	15	85	100	14
95th Queue (ft)	40	155	177	36
Link Distance (ft)		2119	2119	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		1	2	
Queuing Penalty (veh)		0	3	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	62	163	249	318	116	49
Average Queue (ft)	17	73	143	24	36	8
95th Queue (ft)	49	125	238	138	81	29
Link Distance (ft)	4650			1840	2278	2278
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)		0	6			
Queuing Penalty (veh)		0	1			

Network Summary

Network wide Queuing Penalty: 10

2: I-80 Westbound & Middle Rd Performance by movement

Movement	WBL	WBR	NBL	NBT	SBT	SBR	All
Delay / Veh (s)	28.7	7.0	7.9	4.6	7.8	3.0	10.0

4: I-80 Eastbound & Middle Rd Performance by movement

Movement	EBL	EBR	NBT	NBR	SBL	SBT	All
Delay / Veh (s)	30.6	8.9	8.3	5.0	9.0	6.8	9.6

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Delay / Veh (s)	30.1	28.6	10.4	26.5	30.2	9.6	18.9	11.8	6.6	14.8	14.2	5.1

6: Forest Grove Dr & Middle Rd Performance by movement

Movement	All
Delay / Veh (s)	15.8

10: Indiana Ave & Middle Rd Performance by movement

Movement	EBT	EBR	WBL	WBT	NBL	NBT	NBR	All
Delay / Veh (s)	28.8	5.7	14.8	12.1	10.0	0.6	3.5	8.7

Total Network Performance

Delay / Veh (s)	31.5

Arterial Level of Service: NB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Forest Grove Dr	6	11.8	34.8	0.3	31
	4	9.7	43.4	0.4	34
I-80 Westbound	2	5.5	16.8	0.1	30
Indiana Ave	10	10.0	49.0	0.4	33
Total		37.1	144.1	1.3	32

Arterial Level of Service: SB Middle Rd

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	2	7.3	48.0	0.4	33
I-80 Eastbound	4	5.5	17.0	0.1	30
Forest Grove Dr	6	15.5	48.5	0.4	31
Total		28.3	113.5	1.0	32

Intersection: 2: I-80 Westbound & Middle Rd

Movement	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	L	T	T	T	T	R
Maximum Queue (ft)	122	125	38	101	88	111	76	100	49
Average Queue (ft)	59	72	11	41	24	31	25	30	11
95th Queue (ft)	99	114	33	80	67	80	62	69	31
Link Distance (ft)		1772			697	697	2247	2247	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150	150					150
Storage Blk Time (%)	0	0							
Queuing Penalty (veh)	0	0							

Intersection: 4: I-80 Eastbound & Middle Rd

Movement	EB	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	R	T	T	R	L	T	T
Maximum Queue (ft)	107	107	72	134	131	43	55	122	137
Average Queue (ft)	49	62	37	38	32	10	18	37	54
95th Queue (ft)	92	98	59	95	89	28	46	85	104
Link Distance (ft)		2013		2075	2075			697	697
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	150		150			150	150		
Storage Blk Time (%)	0				0			0	
Queuing Penalty (veh)	0				0			0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB	NB
Directions Served	L	T	T	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	170	50	69	59	109	83	107	39	42	122	130	38
Average Queue (ft)	67	16	30	28	40	32	52	11	16	45	47	3
95th Queue (ft)	134	40	56	51	83	66	90	35	36	93	97	18
Link Distance (ft)		1103	1103			1013	1013			1443	1443	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			150	150			150
Storage Blk Time (%)	1				0		0			0	0	
Queuing Penalty (veh)	1				0		0			0	0	

Intersection: 6: Forest Grove Dr & Middle Rd

Movement	SB	SB	SB	SB
Directions Served	L	T	T	R
Maximum Queue (ft)	70	161	194	92
Average Queue (ft)	24	63	83	15
95th Queue (ft)	56	128	152	54
Link Distance (ft)		2075	2075	
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)	150			150
Storage Blk Time (%)		0	1	
Queuing Penalty (veh)		0	1	

Intersection: 10: Indiana Ave & Middle Rd

Movement	EB	EB	WB	WB	NB	NB
Directions Served	T	R	L	T	L	R
Maximum Queue (ft)	53	85	182	40	140	38
Average Queue (ft)	14	44	78	9	50	11
95th Queue (ft)	41	74	136	33	103	29
Link Distance (ft)	4650			1840	2247	2247
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		150	150			
Storage Blk Time (%)			1			
Queuing Penalty (veh)			0			

Network Summary

Network wide Queuing Penalty: 3

Appendix I: Letters of Support

Appendix I: Letters of Support

Bi-State Regional Commission
Serving local governments in Muscatine and Scott Counties, Iowa, Henry, Mercer and Rock Island Counties, Illinois.

MEMORANDUM

TO: Andy Swisher, HR Green

FROM: Gena McCullough, Planning Director

DATE: April 29, 2014

RE: Concurrence with Traffic Forecast Technical Memorandum for I-80/Middle Road Interchange Justification Report

HR Green provided a January 28, 2014 memorandum summarizing the traffic forecast procedures used to determine traffic projections for the I-80/Middle Road Interchange Justification Report (IJR). As part of the IJR development process, the City of Bettendorf and their consultant, HR Green, have worked with the Quad Cities MPO staff of Bi-State Regional Commission to develop traffic forecasts for the interchange.

The metro area's travel demand model was used as the basis for the I-80/Middle Road interchange analysis, and lead to additional sensitivity analysis to explore a high growth scenario and peak hour scenarios. Having reviewed the technical memo provided by HR Green, it summarizes the results that are consistent with the Quad Cities MPO travel demand model as discussed for 2035 and 2040-horizon years. This memo will be incorporated into the IJR documentation per the requirements of the process.

cc: Brian Schmidt, City of Bettendorf

GM\sg
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Appendix J: Quad Cities Metropolitan Planning Area Transportation Policy Committee Minutes, February 25, 2014

Appendix J: Quad Cities Metropolitan Planning Area Transportation Policy Committee Minutes, February 25, 2014

Minutes of the
QUAD CITIES METROPOLITAN PLANNING AREA
TRANSPORTATION POLICY COMMITTEE

Tuesday, February 25, 2014, 12:00 p.m.
Bi-State Regional Commission, Conference Room 320
1504 Third Avenue
Rock Island, Illinois

	Policy Members Present
Ray Ambrose	Alderman, City of Davenport
Phil Banaszek	Chairman, Rock Island County
Bob Gallagher	Mayor of Bettendorf
Bill Gluba	Mayor of Davenport
John Knaack	Mayor Pro-Tem of Moline
Marty O'Boyle	Mayor of Eldridge
Sam Shea	Iowa Department of Transportation
John Thodos	Mayor of East Moline
Kris Tobin	Illinois Department of Transportation

	Others Present
Mike Clarke	City of Davenport
Doug DeLille	Illinois Department of Transportation
Gena McCullough	Bi-State Regional Commission
Brandon Melton	Bi-State Regional Commission
Geoff Olson	Bi-State Regional Commission
Becky Passman	Bi-State Regional Commission
Bryan Schmid	Bi-State Regional Commission
Lindsay Whitson	Bi-State Regional Commission
Steve Wilkins	Illinois Department of Transportation

1. Approval of the Minutes of the January 28, 2014 Transportation Policy Committee Meetings. Mayor Gallagher welcomed those present and asked for introductions. He called for approval of the minutes for the January 28, 2014 Transportation Policy Committee meeting. Mayor Gluba motioned to approve the meeting minutes as written. Mr. Ambrose seconded the motion, and it carried.

2. Consideration of the Surface Transportation Program (STP) Evaluation Process Candidate Projects for Project Selection. Ms. McCullough directed the Committee to their agenda packet items on the STP process. Candidate projects were received from Bettendorf (1), Davenport (8), East Moline (2), Eldridge (2), Moline (3), Rock Island (9), and Rock Island County (1) and reviewed by the Technical Committee members. The estimated amounts of STP funds to be programmed through FFY2019 are $4.15 million in the Illinois Quad Cities and $5.40 million balance in the Iowa Quad Cities. Previously approved in November, the Policy Committee programmed $1.9 million STP funds of the $7.24 million available in this round to an existing project, Davenport's Forest Grove Road project DA-12-02. The total candidate

projects' costs amounted to $26.98 million in the Illinois Quad Cities and $47.97 million in the Iowa Quad Cities. The evaluation scoring and summary recommendations were enclosed in Committee members' packets. A summary is provided to the Regional Transportation Advisory Group for public notification and comment.

Mr. Patel reviewed the ranking process, project locations, scores, and grouping by priorities. Ms. McCullough directed the Policy Committee to the summary on the back of their agenda and reviewed the recommendation as follows:

Transportation Policy Committee Meeting Summary 2-15-14
Quad Cities Surface Transportation Program (STP) Project Selection
Technical Committee Recommendation

ID No.	Jurisdiction	Project Location	Score	Total Cost	Federal Share	Federal Fiscal Year
		IOWA QUADCITIES				
IA - 16	Bettendorf	Interstate 80 (Middle Road EB Entrance Ramp)	**204.0**	$6,730,000	**$3,000,000**	**2019**
IA - 26	Eldridge	West LeClaire Road (Buttermilk Road to North Ninth Street)	**175.1**	$1,174,890	**$939,912**	**2016**
Prior Project	Davenport	76th Street Project (East of Hancock Street to Division Street)	**N/A**	$4,000,000	**$1,464,218**	**2018**
		Total		**$11,904,890**	**$5,404,130**	
		ILLINOIS QUADCITIES				
IL - 15	East Moline	7th Street (26th Avenue to Avenue of the Cities)	**249.4**	$800,846	**$640,677**	**2018**
IL - 7	Rock Island	38th Street (18th Avenue to 31st Avenue)	**221.3**	$1,602,163	**$1,281,730**	**~~2019~~ 2020**
IL - 11	Moline	12th Avenue (41st Street to 53rd Street)	**215.2**	$1,059,563	**$847,650**	**2017**
IL - 14	East Moline	13th Street (IL 84 to Archer Drive)	**213.2**	$853,186	**$682,549**	**2015**
IL - 12	Moline	12th Avenue (34th Street to 41st Street)	**212.2**	$879,053	**$703,242**	**2016**
		Total		**$5,194,810**	**$4,155,848**	

For the Iowa Quad Cities, the projects submitted for ranking by the City of Davenport were essentially withdrawn after the technical scoring process and a prior underfunded project already identified in the Transportation Improvement Program (TIP) DA-17-01 was requested to receive additional funds in order to complete the project. DA-17-01 has been programmed $2,132,949 to date. In Eldridge, West LeClaire Road was a higher community priority than the technical ranking identified. New targets were provided by the Illinois Department of Transportation with less funding than was anticipated. By extending programming to FFY2020, the Technical Committee recommendation would be revised to shift the 2019 project to 2020 in order to maintain reasonable fiscal constraint.

Ms. McCullough requested the projects be approved as presented and placed in the Transportation Improvement Program based on the recommended year of programming. Mayor Thodos made this motion as recommended by the Technical Committee and Mr. Banaszek seconded. The motion carried. Mayor O'Boyle expressed appreciation on behalf of Eldridge for receiving a portion of the STP funds.

3. Funding Sources Primer and Consideration of Revisions to the FFY2014-2017 Transportation Improvement Program Mr. Melton referenced a Funding Sources Primer, developed to explain the types of federal and state funding that is often discussed with revisions to the TIP. The primer describes the federal source in the respective transportation act, acronym, and the general type of projects funded under these sources. The Policy Committee had expressed interest in knowing more about these sources when considering TIP revisions. The primer was added to the TIP page of the website for future reference: http://bistateonline.org/index.php/transportation/quad-cities-metro-planning/2012-11-13-20-10-34/quad-cities-metro-tip-transportation-improvement-program. These sources are typically outlined annually in the TIP document and often referenced during the revisions process.

   Following the overview, Mr. Melton directed the Policy Committee to the list of amendments and modifications and reviewed what changes were requested. Because project IL-13-13 was received after the agenda packet was sent, approval was suggested to be conditioned on receiving no substantial public comments by 2/27/14. Mr. Ambrose motioned to approve the TIP amendments as presented. Mayor O'Boyle seconded the motion, and it carried. The approved TIP amendments and administrative modifications are attached to the minutes for reference.

4. Public Comments. There were no public comments given at the meeting.

5. Other Business. Mayor Gluba asked about the status of commercial air service to Washington, DC. Ms. McCullough indicated that the Quad Cities Chamber of Commerce was working with local Illinois legislators to introduce bills that would allow funding for a revenue guarantee to supplement service. HB3751 seeks a $1.5 appropriation annually for a 3-year period with an 80/20 matching formula. The Quad Cities Chamber is working to get a local commitment from the business community to support the service of $400,000 annually. This service would provide a stronger connection to DC that would help support efforts to maintain a strong workforce and presence at the Rock Island Arsenal. Each year, there are approximately 10,000 passengers that travel between the Quad Cities and the DC area. In a business survey by the Chamber, commercial air service to Dulles was an acceptable alternative to Reagan and would also provide international connections that could enhance its appeal.

Mr. Ambrose inquired about the recent articles on bridge restrictions. Policy Committee members expressed concerns about traffic congestion due to potential overlap of the three inner-city cross-river routes. Ms. McCullough, Mr. Shea, and Ms. Tobin indicated that the Departments of Transportation and the Rock Island Arsenal were working to schedule the bridge restrictions in consecutive order and to minimize overlap.

6. Adjournment. Mayor Gluba motioned to adjourn the meeting. Mayor Thodos seconded the motion, and the meeting was adjourned at 12:40 p.m.

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February 25, 2014 Transportation Policy Committee Meeting - Revisions to FFY 2014-2017 TIP

AMENDMENTS - COMMITTEE ACTION REQUIRED

ROADWAY/TRAIL/OTHER

PROJECT NUMBER	Year Programmed (FFY)	PROJECT ROUTE	PROJECT LOCATION	PROJECT DESCRIPTION	PLAN JUST.	TOTAL ESTIMATED COST	FEDERAL SHARE*	FEDERAL SOURCE	FEDERAL NOTES	STATE SHARE	STATE SOURCE	LOCAL SHARE	LOCAL SOURCE	NOTES
ILLINOIS DEPARTMENT OF TRANSPORTATION - IL														
IL-14-19	2014	I-74/US 6	Mississippi River Corridor	Misc	LRP40	$1,400,000	$0			$1,400,000	STA RE	$0		New Project
IL-14-20	2014	I-80	Miss. Rvr., IL 84 & BNRR W. of Rapids City	Bridge Cleaning	MAINT	$150,000	$0			$75,000	STA	$0		New Project, cost split with IA DOT
IL-14-21	2014	I-74/I-280	Over US 6, BNRR & TR 38, 1 Mi SW of Green Rock	Bridge Rehab	MAINT	$750,000	$0			$750,000	STA	$0		New Project
IL-14-22	2014	IL 92	Turkey Hollow Creek 3 Mi E of Andalusia	Bridge Deck Repair	MAINT	$350,000	$0			$350,000	STA	$0		New Project
IL-14-23	2014	US 6	0.4 Mi E of I-80	Culvert Replacement	MAINT	$150,000	$0			$150,000	STA RE	$0		New Project
IL-15-11	2015	(GRR) 3rd Ave	19th Ave to 23rd Ave (Moline)	Reconstruction	MAINT	$7,297,000	$4,638,000	Nat'l Cooridor		$1,159,000	STA	$1,500,000	CTY	Change in Fed. Source from STP, Increase Fed Funding from $3.271 M, $1.5 M Local Share added, TIP Number revised from IL-15-05 per duplicate entry
IL-13-13	2014	IL 5/John Deere Rd	Under 41st Drive Connector Flyover 0.1mi W of 38th St in Moline	Reconstruction, Bridge, and Retaining Wall	MAINT	$18,683,079	$14,859,384	NHPP		$3,648,695	STA	$175,000	LOC	Federal Funding increased from $11,060,000 (>30%); Requires public input opportunity through February 27th before approval
ROCK ISLAND COUNTY - RC														
RC-14-01	2014	Rock Island County	Various County Highways	Curve Sign Upgrade	CMP	$120,000	$101,909	HSIP				$18,091	County	New Project, Anticipated April 2014 Letting Date, Design 90% complete
CITY OF EAST MOLINE - EM														
EM-15-01	2015	13th St	IL 84 to Archer Dr			$798,783	$682,549	STP				$116,234	CTY	New Project
CITY OF MOLINE - MO														
MO-16-01	2016	12th Ave	34th St to 41st St			$823,000	$703,242	STP				$119,758	CTY	New Project
MO-17-01	2017	12th Ave	41st St to 53rd St			$992,000	$847,650	STP				$144,350	CTY	New Project
CITY OF ELDRIDGE - EL														
EL-16-01	2016	West LeClaire Rd	Buttermilk Road to N 9th St			$1,174,890	$939,912	STP				$234,978	CTY	New Project

ADMINISTRATIVE MODIFICATIONS - NO COMMITTEE ACTION REQUIRED

ROADWAY/TRAIL/OTHER

PROJECT NUMBER	Year Programmed (FFY)	PROJECT ROUTE	PROJECT LOCATION	PROJECT DESCRIPTION	PLAN JUST.	TOTAL ESTIMATED COST	FEDERAL SHARE*	FEDERAL SOURCE	FEDERAL NOTES	STATE SHARE	STATE SOURCE	LOCAL SHARE	LOCAL SOURCE	NOTES
ILLINOIS DEPARTMENT OF TRANSPORTATION - IL														
IL-14-14	2015	I-74/ US 6	Mississippi River Corridor	Land Acquisition	LRP40	$2,166,000	$1,732,000	Nat'l Cooridor		$434,000	STA	$0		Move from FFY 2014 to FFY2015, Fed. Funding increased from $1.52 M (<30%)
IL-14-13	2014	I-74/ US 6	Mississippi River Corridor	Demolition	LRP40	$1,800,000	$1,470,000	IM		$330,000	STA	$0		Fed. source changed from IM, Fed. funding increased from $1.2 M (<30%)
IL-14-18	2014	I-74/US 6	Mississippi River Corridor	Land Acquisition	LRP40	$3,600,000	$0			$3,600,000	STA	$0		Total cost reduced from $5 M
IL-13-12	2014	US 67	IL 92, RR & Mississippi River in Rock Island	Bridge Rehabilitation	MAINT	$6,232,000	$0			$3,115,000	STA	$0		Project Scope and Total Cost Increase from $2.5 M (>30%), no Fed Funds, cost split with IA DOT

February 25, 2014 Transportation Policy Committee Meeting - Revisions to FFY 2014-2017 TIP

PROJECT NUMBER	Year Programmed (FFY)	PROJECT ROUTE	PROJECT LOCATION	PROJECT DESCRIPTION	PLAN JUST.	TOTAL ESTIMATED COST	FEDERAL SHARE*	FEDERAL SOURCE	FEDERAL NOTES	STATE SHARE	STATE SOURCE	LOCAL SHARE	LOCAL SOURCE	NOTES
IL-12-28	2014	IL 92	.4 mi. N of Brights Ct to 115th St (W) in Andalusia	Pavement Widening Shoulder Reconstruction	MAINT	$5,000,000	$4,387,000/ $1,087,000	HSIP/STP		$758,000	STA	$0		Fed Funds Increased from $3.277 M (HSIP) (<30%)
IL-13-16	2014	US 6	Green River Road to SE of Edwards Road	Tree Removal	MAINT	$29,000	$26,000	HSIP		$3,000	STA	$0		Moved from FFY2013 to FFY2014
IL-12-24	2014	US 6	0.1, 0.2, & 0.5 mi. E of Green River Rd & E/W of 720 E of Colona	Culvert Replacement	MAINT	$600,000	$480,000	STP		$120,000	STA	$0		Moved from FFY2013 to FFY2014
IL-12-25	2014	US 6	Mineral Creek 1.2 mi E of Osco Rd	Bridge Replacement	MAINT	$700,000	$560,000	STP		$140,000	STA	$0		Moved from FFY2013 to FFY2014
IL-15-05	2014	US 6	0.1 mi and 0.2 mi N W, , NW and SE of Potters Bridge Rd and SE of Edwards Road	Culvert replacement	MAINT	$1,600,000	$1,280,000	STP		$320,000	STA	$0.		Moved from FFY2013 to FFY2014
CITY OF DAVENPORT - DA														
DA-15-03	2016	US 6	Kimberly Rd. Bridge over Duck Dreek	Bridge Rehabilitation	MAINT	$990,000	$6,636,000	STP-HBP				$206,000	CTY	TIP Number revised from DA-15-01 per duplication

A listing of acronyms used on this document can be found in Section III, Page 12 of the Quad Cities: Davenport-Moline-Rock Island Urbanized Area FFY 2014-17 Transportation Improvement Program

A complete copy of the document can be found at http://www.bistateonline.org

Direct Page Link: http://tinyurl.com/lpf6jsq