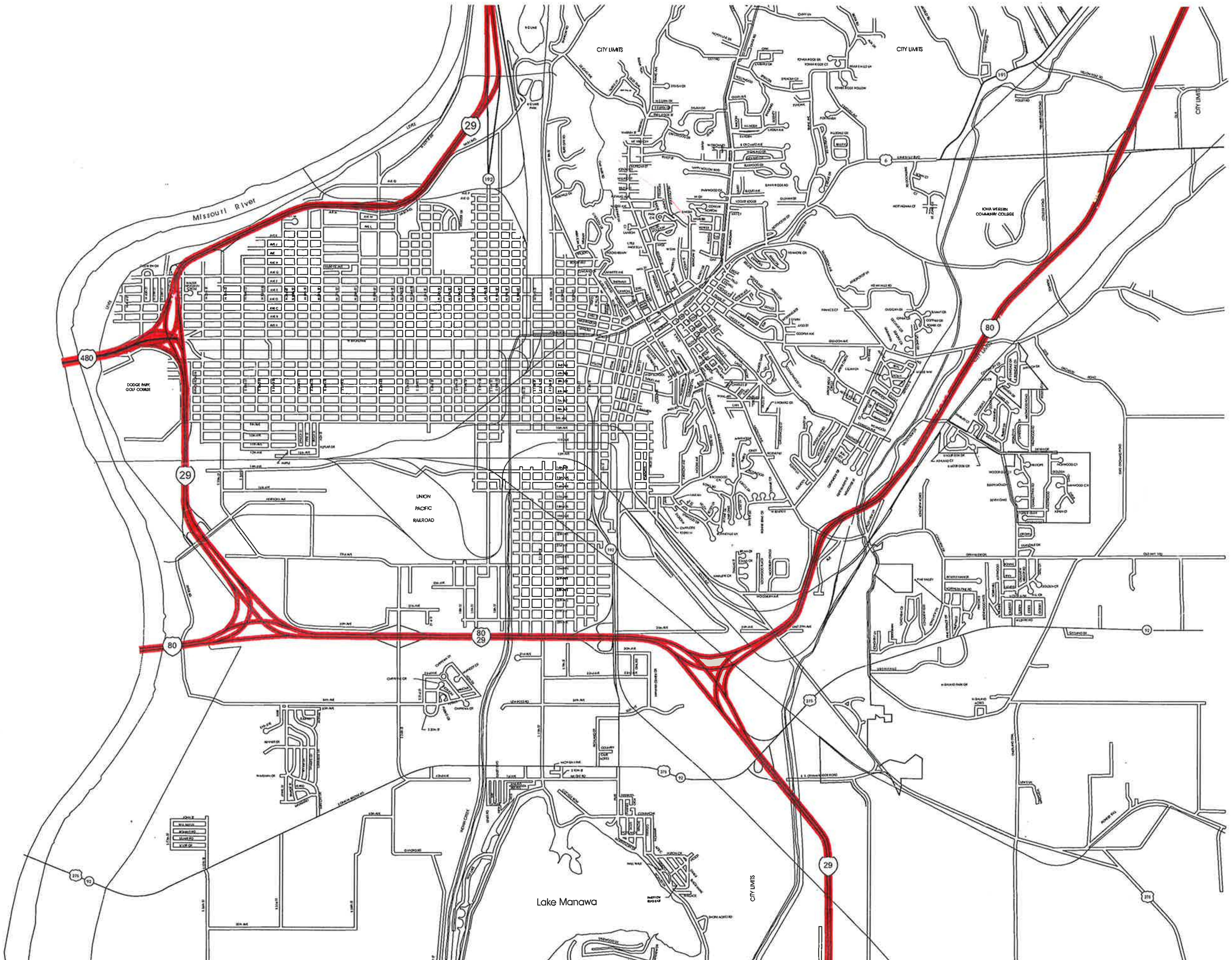



# Council Bluffs Interstate System Needs Study

## Council Bluffs, Iowa

MAPA
Metropolitan Area Planning Agency

## Phase I Report

## Analysis of Existing Conditions

September 1997

HDR

HDR Engineering, Inc.

In Association with:

hgm
ASSOCIATES INC.

# COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY

## Phase I Report
## Analysis of Existing Conditions

Prepared For

**Metropolitan Area Planning Agency**

By

**HDR Engineering, Inc**

in association with

**HGM Associates, Inc.**

**September 1997**

# TABLE OF CONTENTS



# TABLE OF CONTENTS (CONT.)



# LIST OF TABLES



# LIST OF EXHIBITS

# CHAPTER 1: INTRODUCTION

## 1.1 STUDY BACKGROUND

The Council Bluffs interstate system is comprised of portions of Interstate Highways I-80, I-29 and I-480. Together, these interstates serve as the backbone of the Council Bluffs transportation system, providing residents of the area with a level of urban mobility that has become an important measure of the "quality of life" in contemporary society.

However, the Council Bluffs area has undergone substantial changes in recent years. New development has been constructed along the interstate system and has created additional demand that is above and beyond normal traffic growth. These developments include two river boat casinos, expansion of Bluffs Run, and major retail developments along the South Expressway.

With this growth, concerns have arisen regarding the ability of the Council Bluffs interstate system to meet the needs of its users today and into the future. These concerns are based on the following characteristics of the interstate system:

- ***Physical Condition:*** The I-80/I-29 facilities that are the subject of this study are over 25 years old and have overall pavement and bridge sufficiency ratings of "Poor". This area has the third lowest interstate rating in Iowa.

- ***Traffic Operations / Safety:*** Traffic volumes in the freeway corridors are approaching capacity levels. In addition, Council Bluffs has become a major crossroads for interstate truck movements. As the operational efficiency of the system declines, the potential for accidents increases.

- ***Geometrics:*** Many of the facilities in the study area were designed to design standards which are now outdated and below current design criteria. Left hand ramps, basic lane discontinuity, lane balance, ramp spacing and other geometric features that have been found to compromise both safety and operations of a freeway system exist to varying degrees in the system.

- ***Intechange Configuration:*** There are four partial interchanges on the Council Bluffs Interstate System. Partial interchanges generally violate driver expectancy, can limit access to the surrounding areas and can result in driver confusion.

- ***Surface Streets:*** In some areas of the system, inadequate capacity on surface streets and at the intersections of the surface streets with ramp facilities is limiting the efficiency of the freeway system as a whole.

- ***Future Travel Demand***: Additional growth along the interstate system and throughout the Omaha-Council Bluffs metropolitan area will result in higher traffic volumes on the system. Without additional capacity some portions of the system will operate at unacceptable levels of service in the future. In addition, it is also logical to expect that peak periods will be spread out over longer periods of time during the day.

## 1.2 STUDY AREA

The study area is shown in Exhibit 1. The general boundaries of the study include:

| | |
|---|---|
| To the north: | I-29, north of Iowa Highway 192 (N. 16th Street) |
| To the south: | I-29, south of US Highway 275/Iowa Highway 92 |
| To the east: | I-80, east of US Highway 6 (Kanesville Boulevard) |
| To the west: | Missouri River crossings of I-80 and I-480 |

The study area includes 17 miles of mainline freeway and 14 interchanges. These interchanges are comprised of three system interchanges, seven full interchanges, and four partial interchanges.

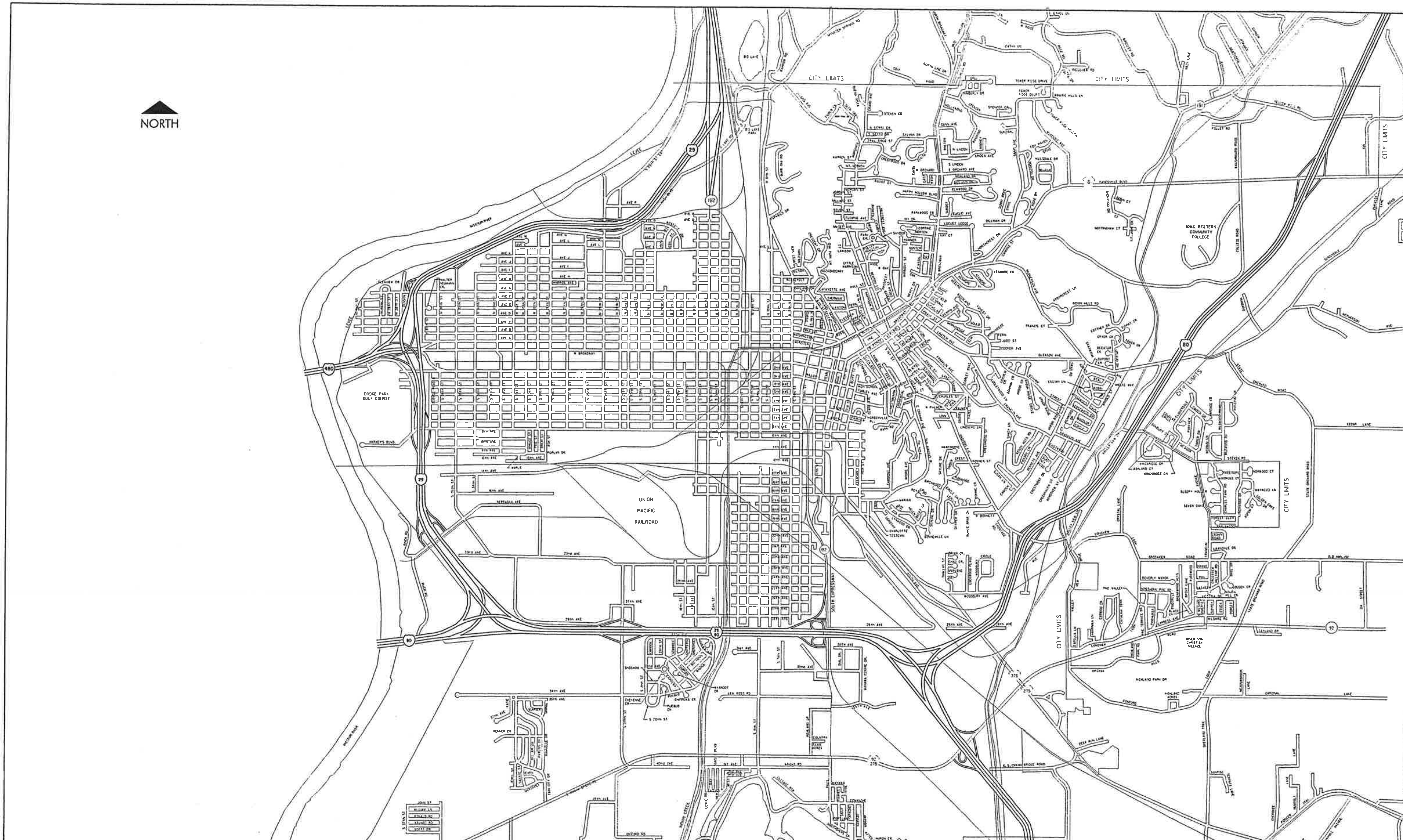
## 1.3 STUDY OBJECTIVES

The purpose of the study is to identify the needs of the system and recommend improvements to the structural condition, capacity and functionality of the system through a cost effective combination of rehabilitation and reconstruction. Three complimentary study objectives were developed for the study:

1. Identify improvements to address immediate interstate system needs;
2. Develop a program of improvements to address anticipated future needs; and
3. Implicitly take into consideration those improvements that support and enhance the economic viability and development potential within the metropolitan area.

Successful attainment of these objectives will result in the preparation of a prioritized plan that the Metropolitan Area Planning Agency (MAPA), the Iowa Department of Transportation (IaDOT) and the City of Council Bluffs can use as a guide in the development of short term and long term improvements for the interstate system. This plan will focus on:

- Maximizing the use of IaDOT's rehabilitation funds to improve short-term performance of the system.
- Planning and programming projects for the systematic upgrade and reconstruction of the system to service anticipated increases in travel demand.
- Providing opportunities for public and private sector input to generate an understanding of the appropriate system improvements.

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COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY

PHASE 1 REPORT SEPTEMBER 1997

**STUDY AREA**

EXHIBIT 1

## 1.4 STUDY APPROACH

The project approach being utilized on the Council Bluffs Interstate System Needs Study provides a process to answer the following key questions:

1. What are the current operational and safety problems on the freeway system?
2. What are the long term system needs? How can the freeway system be rehabilitated or reconstructed to address both current problems and long term needs?
3. What are the costs (construction, right of way, environmental, socioeconomic) of a program to rehabilitate/reconstruct the Council Bluffs Interstate System?
4. How can a long range program be implemented in stages to assure overall plan compatibility and reasonable operation during each stage?
5. Will individual improvements fit with each other or the system as a whole?

The study approach includes the following three phases.

- Phase I - Analysis and Evaluation of the Existing System (The focus of this report)
- Phase II - Development of Improvement Alternatives
- Phase III - Development of a Recommended Plan

The outputs of each phase are intended to provide an incremental approach to decision-making and problem-solving throughout the entire project. In addition, each phase is designed to be a logical break-point prior to the beginning of the next phase. In this way, decision makers will have an understanding of the background data and analyses necessary to provide informed direction on the work to be completed in the subsequent phase of the project.

This report presents the findings of Phase I. The purpose of this phase of the project was to assemble the required background information and to complete a comprehensive evaluation of the existing interstate system. Data collected in this phase will also provide the basis for development of alternatives in later phases.

The major tasks that were completed in this phase were:

- Detailed inventory of the geometric and operational features of the system;
- Determination of existing levels of service for the basic freeway segments, weaving areas, ramps, and the ramp-terminal intersections;
- Overall evaluation of the existing geometric and operational features of the entire system.

## 1.5 REMAINDER OF THE REPORT

The remainder of this report has been divided into the following chapters:

- Chapter 2: Overview of the Interstate System
- Chapter 3: Inventory of Existing Conditions
- Chapter 4: Evaluation of Existing Conditions
- Chapter 5: Summary and Conclusions

# CHAPTER 2: OVERVIEW OF THE INTERSTATE SYSTEM

## 2.1 SYSTEM DESCRIPTION

The Council Bluffs interstate system is comprised of portions of Interstate Highways I-80, I-29 and I-480. Although most of the study area is within the urban or suburban area of Council Bluffs, nearly all 17 miles of mainline freeway within the study area are generally classified as rural based on design elements such as the median (greater than 40 feet), design speed (70 mph), and available right-of-way (250 feet or greater). Typical cross sections of interstate system are included in Appendix B of this report.

Approximately ten miles of the Council Bluffs interstate system are designated as I-29. I-29 is a four-lane freeway which enters the study area from the north and exits the study area to the south on an alignment that parallels the Missouri River in the urban area. From the Omaha-Council Bluffs metropolitan area, I-29 provides a route to Sioux City, Iowa and Sioux Falls, South Dakota to the north, and to Kansas City to the south.

Approximately nine miles of the Council Bluffs interstate system are designated as I-80. I-80 is also a four-lane freeway. Beginning at the bridge spanning the Missouri River, I-80 enters the study area from the west and exits the study area to the northeast. In the urban area, I-80's alignment generally runs east-west. From the metropolitan area, I-80 provides a route to Denver to the west and Des Moines to the east.

A short segment of I-480 is included in the study area. Beginning at the bridge spanning the Missouri River, I-480 (also designated US Highway 6) enters the study area from the west and terminates at the I-29/I-480 System Interchange. From this interchange, Highway 6 continues eastward as West Broadway and Kanesville Boulevard. Eight lanes are provided on the Missouri River bridge to the west of the I-29/I-480 System Interchange.

Approximately three miles of the interstate system are designated as an overlap section of I-29 and I-80. That is, both routes occupy a single alignment. System interchanges serve at the termini of the overlap section. In the remainder of this report, these interchanges are referred to as the West I-80/I-29 System Interchange and the East I-80/I-29 System Interchange.

## 2.2 LOCAL AND SYSTEM INTERCHANGES

The study area includes 14 interchanges. These interchanges are comprised of three system interchanges, seven full interchanges, and four partial interchanges. The type of interchange and the degree of access provided are summarized in Table 1 below for each interchange in the system.

*TABLE 1 - Interchange Summary*

| Interchange | Description |
|---|---|
| I-80 and Highway 6 (Kanesville Blvd.) | Diamond interchange - Full access |
| I-80 and Madison Avenue | Diamond interchange - Full access |
| East I-80/I-29 System Interchange | Fully directional "Y" system interchange |
| I-29 and Highway 275/92 | Partial cloverleaf - Partial access |
| I-80/I-29 and South Expressway | Partial cloverleaf - Full access |
| I-80/I-29 and S. 24th Street | Diamond interchange - Full access |
| West I-80/I-29 System Interchange | Fully directional "Y" system interchange |
| I-29 and Nebraska Avenue | Partial cloverleaf - Full access |
| I-29 and 9th Avenue | Diamond interchange - Full access |
| I-29/I-480 System Interchange | Fully directional "Y" system interchange |
| I-29 and Avenue G | Partial cloverleaf - Partial access |
| I-29 and N. 35th Street | Half diamond interchange - Partial access |
| I-29 and N. 25th Street | Diamond interchange - Full access |
| I-29 and Highway 192 (N. 16th Street) | Three leg interchange - Partial access |

## 2.3 SYSTEM HISTORY

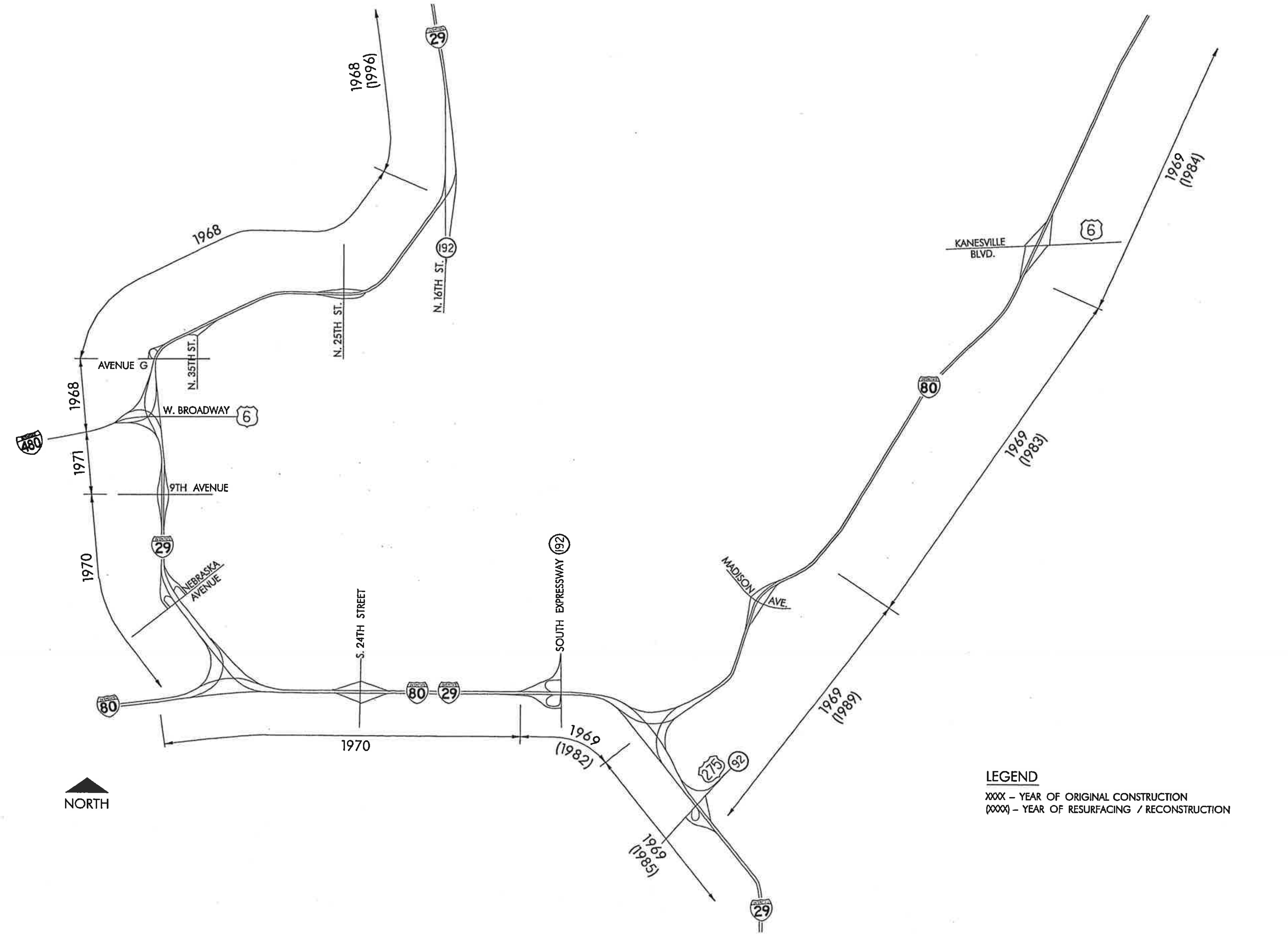
Most of the Council Bluffs interstate system was constructed in the late 1960's and early 1970's. As such, the majority of original interstate pavement is approaching 30 years of age. Resurfacing of portions of the interstate was completed in the early 1980's. A portion of the system, near the north study area limits was reconstructed in 1996. Exhibit 2 summarizes the construction history of the Council Bluffs interstate system.

## 2.4 EXISTING TRAFFIC VOLUMES

Existing (1996) two-way daily traffic volumes on the Council Bluffs Interstate System are shown in Exhibit 3. The volumes range from 15,700 vehicles per day (vpd) on I-29 to the south to 63,300 vpd on I-80/I-29 just east of the West I-80/I-29 System Interchange.

## 2.5 ADJACENT LAND USES

Land uses adjacent to the interstate system vary considerably. Industrial/commercial land uses predominate in the core of the study area. Some residential areas abut the interstate system, primarily north of 9th Street and near the South Expressway. Other notable land uses include two riverboat casinos/hotels near 9th Avenue and Nebraska Avenue, the greyhound race track near S. 24th Street that was expanded to include gaming, a regional shopping center near Madison Avenue and major retail developments near the South Expressway. The Western Historic Trails Center and City Sports Complex located south of I-80/I-29 and between the West I-80/I-29 System Interchange and S. 24th Street are expected to be completed in 1997.

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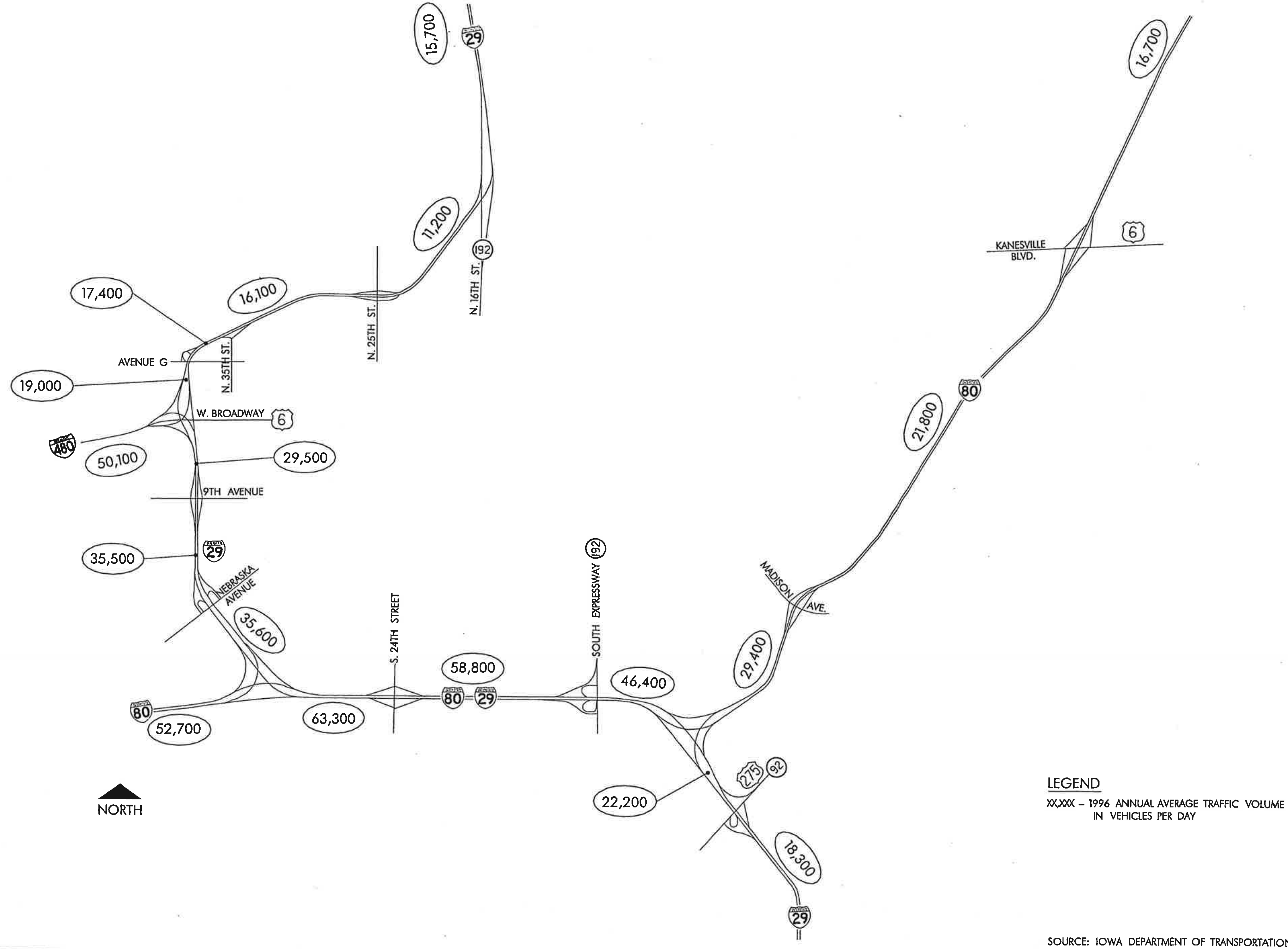
PHASE 1 REPORT

SEPTEMBER 1997

**CONSTRUCTION HISTORY**

EXHIBIT 2

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PHASE 1 REPORT SEPTEMBER 1997

# 1996 ANNUAL AVERAGE TRAFFIC VOLUMES

EXHIBIT
3

# CHAPTER 3: INVENTORY OF EXISTING CONDITIONS

## 3.1 DATA PROVIDED BY OTHERS

Much of the data presented in this report were provided by participating agencies. Sources of the various types of data that were gathered as part of this study are summarized below:

***Metropolitan Area Planning Agency***
- Digital version of arterial street map
- Historical traffic flow maps

***Iowa Department of Transportation***
- 1990-1996 summaries of average daily traffic volumes (ADT's) on freeway mainline and ramps for total traffic, single unit trucks and combination vehicles
- Intersection turning movement counts at 10 intersections for total traffic, single unit trucks and combination vehicles
- 1996 24-hour classification counts at 16 mainline and ramp locations
- Recent and historical data from the Automatic Traffic Recorder (ATR) located on I-80/I-29 between S. 24th Street and the South Expressway
- Partial inventory of freeway guide signs
- 1991-1995 accident data
- As-built plans
- Aerial photography
- Bridge sufficiency ratings
- Pavement sufficiency ratings
- Right-of-way plans

***City of Council Bluffs***
- Digital version of city street map
- Traffic signal timing summaries

## 3.2 FIELD REVIEWS

Extensive field reviews to verify and supplement the data provided by the participating agencies were conducted. Field data collected are summarized below. Traffic volume data collected are summarized in the next section.

- Photo log of all freeway ramp junctions
- Photo log of approaches to ramp terminal intersections
- Photo log and field sketches of all freeway guide signs
- Video log of all mainline segments, ramps and cross streets
- Intersection summaries including type of traffic control (signal, stop, yield), channelization (number of through, right-turn and left-turn lanes) and characteristics of signalized intersections (presence of turn arrows, number of phases)

## 3.3 TRAFFIC DATA COLLECTION

Traffic data provided by IaDOT was supplemented with traffic data collected by the project team. These included:

- AM peak period (7:00-9:00) and PM peak period (4:00-6:00) intersection turning movement counts at the following ramp terminal intersections:
  - I-80 and Highway 6 (Kanesville Boulevard) - 2 intersections
  - I-80 and Madison Avenue - 2 intersections
  - I-80/I-29 and South Expressway - 2 intersections
  - I-480 and 41st Street - 2 intersections
  - I-29 and Avenue G
  - I-29 and N. 25th Street - 2 intersections
- AM and PM peak period samples (15-minute) of traffic volumes at the three major diverges of the West I-80/I-29 System Interchange. These volumes were utilized in the development of peak hour traffic flow maps.

## 3.4 DEVELOPMENT OF TRAFFIC FLOW MAPS

Directional traffic volumes for the AM and PM peak hour were developed by the project team for the entire interstate system including the freeway mainline, ramps and ramp terminal intersections. The hourly volumes were developed based on the freeway and ramp ADT's, classification counts, intersection turning movement counts, ATR data, and field observations described above.

Most of the traffic data provided by IaDOT were collected in 1996, while the supplemental intersection turning movements conducted by the project team were performed in May-June of 1997. However, no adjustments were made to convert the existing data from one year to another. Such adjustments were considered unnecessary for a difference of just one year given the inherent fluctuations in traffic volumes throughout a typical year.

In general, hourly traffic volumes on the ramps and mainlines have been balanced (i.e., mainline and ramp volumes can be added and subtracted to determine the volume at any other mainline or ramp location). This is not necessarily true of the relationship between ramp volumes and intersection turning movements. This is due to the fact that intersection turning movements reflect the peak hour of the intersection as a whole rather than the peak hour of any particular ramp approach or ramp departure.

The hourly traffic volumes are shown graphically in Appendix A as part of the exhibits which summarize performance measures.

# CHAPTER 4: EVALUATION OF EXISTING CONDITIONS

## 4.1 EVALUATION CRITERIA

The evaluation of existing conditions in the Council Bluffs interstate system was conducted as the first step in determining the need for improvements. As such, the results of this assessment will be used as input to the development and assessment of alternatives.

The following list of criteria and considerations were evaluated:

***Physical Conditions***
- Pavement
- Highway Structures

***Geometric Features***
- Horizontal alignment
- Vertical alignment
- Stopping sight distance
- Cross section
- Decision sight distance
- Exit and entrance ramp design

***Operational Features***
- Basic number of lanes
- Lane and route continuity
- Lane balance
- Ramp sequence and spacing
- Guide signing
- Safety

***Performance Measures***
- Freeway level of service
- Weaving level of service
- Ramp junction level of service
- Signalized intersection level of service
- Unsignalized intersection level of service

Each of these measures were evaluated based on the 1990 AASHTO Policy on Geometric Design of Highways and Streets, the 1994 Highway Capacity Manual, various Iowa Department of Transportation design manuals and policies and other widely accepted published standards and guidelines on highway design and traffic operations.

Output from the assessment of the performance measures includes a descriptive rating referred to as "level of service" (LOS). LOS ranges from "A" (best) to "F" (worst). For most other measures that were assessed, ratings were applied as a means of describing the quality of the measure. These ratings consisted of "good", "fair" and "poor".

Features or measures rated "good" meet or exceed current design standards, guidelines or operational criteria; or in the case of physical condition show no signs of deterioration or are not in need of repair. A rating of "fair" reflects characteristics that are near or close to minimum standards, guidelines or criteria. Features or measures rated "poor" are clearly substandard with respect to these same standards, guidelines or criteria.

## 4.2 EVALUATION SUMMARY

The assessment of existing conditions relative to the measures identified in the previous section are summarized in the remaining sections of this chapter. For each measure, a summary of the methodologies, definitions and assumptions that were utilized is provided. These are followed by the criteria that were used to apply "good/fair/poor" ratings, where appropriate, to the results of the assessment. The results of the assessment are then presented.

Finally, exhibits which graphically summarize the results of the assessment are included in Appendix A. These exhibits which graphically depict the "good/fair/poor" ratings used to describe the quality of the physical, geometric and operational measures. Also included are exhibits which provide detailed traffic input data and output from the assessment of the performance measures.

### 4.2.1 Pavement

Pavement condition is a measure of the quality of the roadway surface. It was evaluated as part of the assessment of the overall physical condition of the interstate system.

***Methodology/Definitions/Assumptions***

The existing pavement condition of the freeway system was evaluated based on the 1997 Iowa Primary Road Sufficiency Log provided by IaDOT. The sufficiency log provided information on structural adequacy, safety and service features. A breakdown of the structural adequacy components was also provided. A copy of Iowa's Pavement Management Information System (PMIS) was also obtained to identify specific structural deficiencies once the poor pavement areas were identified using the sufficiency log.

The overall pavement condition was based directly on the structural adequacy number compiled on the PMIS. The structural adequacy rating includes four items including the wearing surface, base and subbase, drainage, and maintenance economy. The condition of the bridge decks were not reviewed as part of the pavement condition assessment but were reviewed in the Highway Structures section.

*Rating Criteria*

An overall rating of the existing pavement condition was determined based on the following criteria:

**CRITERIA FOR PAVEMENT CONDITION**

| Rating | Structural Adequacy Rating |
|---|---|
| GOOD | IaDOT Rating of 25 to 20<br>1. Uniform riding surface and slight cracking<br>2. Good lateral support with no soft spots<br>3. Below average maintenance costs |
| FAIR | IaDOT Rating of 19 to 15<br>1. Pavement showing distress with some full depth patching<br>2. Some unevenness and warping of roadbed<br>3. Average maintenance costs |
| POOR | IaDOT Rating of 14 to 10<br>1. Extensive pavement distress requiring speed reduction<br>2. Soft spots and/or breakup areas common<br>3. Above average maintenance costs |

*Results*

The existing pavement analysis results indicate that most of interstate pavement in the study area is in fair to poor condition. Pavement on I-80 from the Missouri River Bridge to the East I-80/I-29 System Interchange, and on I-29 from I-80 north to 9th Avenue was rated poor. Further review of the sufficiency ratings indicates these sections of interstate just met tolerable levels for wearing surface and drainage.

The remainder of the system was rated fair except for I-29 from N. 25th Street to the north city limits, which was rated good. Approximately 0.4 miles south of the Highway 192 interchange north to the city limits was reconstructed in 1996. The Iowa Pavement Management System confirmed the results obtained from the sufficiency ratings.

The majority of original interstate pavement is approaching 30 years of age. Resurfacing of portions of the interstate was completed in the early 1980's. Overall, the interstate pavement in the Council Bluffs area is nearing the end of its useful life.

An overall assessment of pavement condition is provided graphically in Appendix A using the rating system described above.

### 4.2.2 Highway Structures

The condition of highway structures in the study area was also evaluated as part of the assessment of the physical condition of the interstate system.

*Methodology/Definitions/Assumptions*

The existing condition of highway structures was determined based on the Structural Inventory and Appraisal (SI&A) data provided by IaDOT. The SI&A ratings include the existing material, physical condition of the deck, superstructure and substructures as well as the appraisal rating. Individual bridge inspection reports were also provided by IaDOT to verify the SI&A analysis results.

The SI&A ratings are based on the FHWA criteria for evaluating the existing conditions of a National Bridge program. The overall structure condition was based directly on the SI&A ratings. The SI&A ratings address structural adequacy and safety, serviceability and functional obsolescence.

*Rating Criteria*

An overall rating of the existing condition of highway structures was determined based on the following criteria:

**CRITERIA FOR HIGHWAY STRUCTURE CONDITION**

| Rating | Structural Inventory and Appraisal Rating |
|---|---|
| GOOD | SI&A Rating of 80 to 100 and<br>All bridge items in good condition with only minor deterioration |
| FAIR | SI&A Rating of 60 to 79 and<br>All primary structural elements are sound but may have minor section loss, cracking, spalling or scour. |
| POOR | SI&A Rating of 59 or less and/or<br>Advanced section loss, deterioration, spalling or scour. |

*Results*

The existing condition of highway structures is relatively good. Of the 45 structures reviewed a total of 8 were rated poor. These include:

- EB I-80 over RR and pond, east of the East I-80/I-29 System Interchange
- EB and WB I-80 over Old Highway 375
- EB and WB I-80 over abandoned RR, south of Madison Avenue
- I-480 over 41st Street
- West-to-North I-480 ramp over SB I-29
- NB I-29 over SB Highway 192

An overall assessment of highway structure condition is provided graphically in Appendix A using the rating system described above.

### 4.2.3 Horizontal Alignment

Horizontal alignment is one of the key components of geometry and is critical to providing a safe and efficient freeway facility. The horizontal alignment of the Council Bluffs interstate system was evaluated using as-built construction plans provided by IaDOT.

***Methodology/Definitions/Assumptions***

The ratings for this portion of the study involved reviewing the mainline horizontal curves from the as-built plans, and comparing these values to design values recommended by AASHTO. AASHTO bases design speed for horizontal alignment on a maximum degree of curvature at the chosen design speed and superelevation rate. Maximum degree of curvature and superelevation rate are defined as follows:

- ***Maximum Degree of Curvature.*** The limiting value of degree of curvature for a given design speed and maximum superelevation rate, recommended by AASHTO, for safe travel along a horizontal curve.
- ***Superelevation.*** The rate at which a roadway is inclined around a horizontal curve toward the center of the curve.

The values for degree of curve were based on a maximum superelevation rate of 0.08, the recommended value for rural highways. The rural highway criteria for superelevation was used in lieu of the urban highway criteria (maximum superelevation rate of 0.06) because elements of the interstate system reflect the design of a rural highway more closely than that of an urban highway. A rating of good was assigned to horizontal curves designed for a design speed of 70 mph, with ratings of fair and poor assigned to design speeds of 60 mph and 50 mph, respectively.

***Rating Criteria***

An overall rating of the existing horizontal alignment was determined based on the following criteria:

**CRITERIA FOR HORIZONTAL ALIGNMENT**

| Rating | Design Speed | Degree of Curvature |
|---|---|---|
| GOOD | 70 mph | Equal to or less than 3° 00’ |
| FAIR | 60 mph | 3° 01’ - 4°45’ |
| POOR | 50 mph | Greater than 4° 45’ |

Reference: Table III-10, p. 168, 1990 AASHTO Policy of Geometric Design

***Results***

Results of the study indicate that a majority of the horizontal curves along the Council Bluffs interstate system meet or exceed the criteria to achieve a design speed of 70 mph, except at the three system interchanges. Good ratings were assigned to all of the horizontal curves in the study area, excluding the system interchanges, except for the following two areas:

- The horizontal alignment along the northbound lane of I-29 near the Highway 192 on ramp was rated fair based on a 3°30’ degree curve.
- The horizontal alignment of both the northbound and southbound lanes of I-29 just north of the Avenue G interchange was rated poor based on a 5°00’ curve.

At the two I-80/I-29 system interchanges, and at the I-480/I-29 interchange, about half of the horizontal curves received a rating of either fair or poor. Although most of the horizontal curves in these areas are on entrance and exit lanes between the respective freeways, it was decided to include these areas in this section. This decision was based on the assumption that the horizontal curves at system interchanges should meet or exceed a design speed of 70 mph.

An overall assessment of horizontal alignment is provided graphically in Appendix A using the rating system described above.

### 4.2.4 Vertical Alignment

Vertical alignment is another key component of geometry. As-built construction plans were again used to evaluate the quality of the existing vertical alignment of the interstate system.

***Methodology/Definitions/Assumptions***

Two factors were used to determine the adequacy of the vertical alignment in the study area:

- ***Grade.*** The centerline grades of the interstate mainline were compared to recommended values from AASHTO.
- ***Speed Reduction of Heavy Trucks.*** The combined effects of grade and length of grade on reduction in speed for heavy trucks were compared to recommended values from AASHTO.

The entire study area was assumed to fall under the AASHTO category of rolling terrain. Design speeds of 70, 60, and 50 mph were assigned ratings of good, fair, and poor, respectively, for vertical alignment based on grade. These design speeds were used to obtain the AASHTO recommended values for vertical alignment shown below. For the combined grade and length of grade criteria, a reduction in speed of less than 10 mph received a good rating. A fair rating was assigned for a reduction in speed between 10 and 15 mph, with reductions in speed greater than 15 mph rated as poor.

*Rating Criteria*

An overall rating of the existing vertical alignment was determined based on the following criteria:

**CRITERIA FOR VERTICAL ALIGNMENT**

| Rating | Grade | Effect of Grade/Length of Grade on Speed |
|---|---|---|
| GOOD | Less than or equal to 4% | Reduction in speed less than 10 mph |
| FAIR | 4% to 5% | Reduction in speed between 10 and 15 mph |
| POOR | Greater than 5% | Reduction in speed greater than 15 mph |

Reference: Table VIII, p. 585 and Figure III-31, p. 238, 1990 AASHTO Policy on Geometric Design

*Results*

Evaluation of vertical alignment along the interstate mainline within the study area, based on the criteria mentioned previously in this section, indicates that the interstate meets or exceeds AASHTO design criteria , with just one area of concern. The entire mainline vertical alignment along the mainline received a rating of good, based on grade only. When combining the effects of grade with length, a 3,000-ft. stretch of I-80, eastbound from McPherson Avenue, received a rating of poor. This stretch of road was designed with a constant upgrade of 3%, which, when combined with the length, results in a reduction in speed for heavy trucks of over 15 mph.

An overall assessment of vertical alignment is provided graphically in Appendix A using the rating system described above.

### 4.2.5 Stopping Sight Distance

Stopping sight distance is the length of roadway ahead visible to the driver. According to AASHTO, the minimum sight distance available on a roadway should be sufficient to allow a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path.

*Methodology/Definitions/Assumptions*

Stopping sight distance in the study area was evaluated using as-built plans. Both crest vertical curves and sag vertical curves were analyzed. Several factors are used to determine the adequacy of sag vertical curves including rider comfort, drainage control and headlight sight distance. All existing interstate sag vertical curves in the Council Bluffs area easily meet these design criteria and therefore were not analyzed further.

At crest vertical curves, the algebraic difference in grade is used to determine the existing stopping sight distance. This difference was calculated at each crest vertical curve along the mainline of the interstate. Calculation of the stopping sight distance was accomplished by entering the length of curve and algebraic difference in grade into equations given on page 283 of the 1990 AASHTO Policy on Geometric Design.

Design speeds of 70, 65, and 60 mph were assigned ratings of good, fair, and poor, respectively, for evaluation of the stopping sight distance along the interstate mainline. These design speeds were used to choose the appropriate values of stopping sight distance, based on recommended values from AASHTO. These values are summarized below.

*Rating Criteria*

An overall rating of the stopping sight distance was determined based on the following criteria:

**CRITERIA FOR STOPPING SIGHT DISTANCE**

| Rating | Stopping Sight Distance | K |
|---|---|---|
| GOOD | Greater than 625 feet | Greater than 290 |
| FAIR | 550-625 feet | 230-290 |
| POOR | Less than 550 feet | Less than 230 |

Reference: Table III-1, p.120, 1990 AASHTO Policy on Geometric Design

*Results*

A review of the stopping sight distances encountered at crest vertical curves along the interstate mainline indicates that over half of the curves do not meet the AASHTO criteria established for 70 mph design. The analysis of stopping sight distance revealed the following:

- Of the 45 crest vertical curves, 18 were rated good, 10 were rated fair, and 17 were rated poor.
- Fourteen of the curves rated poor were at or near the I-29/I-480 interchange.

In summary, the majority of the interstate system outside of the I-29/I-480 interchanges meets the 70-mph design criteria for stopping sight distance. Several relatively short vertical curves scattered throughout the system fall into the fair to poor category.

An overall assessment of stopping sight distance is provided graphically in Appendix A using the rating system described above.

### 4.2.6 Cross Section

The cross section of a roadway refers to the spatial relationship between the travel lanes, shoulders, medians, side slopes, and roadside obstacles. Field review, office review of videotapes and review of as-built plans were used to evaluate the existing cross-section of the system.

*Methodology/Definitions/Assumptions*

The review focused on features of a typical interstate cross section that, when designed to meet recommended standards, provide an adequate level of safety for vehicular travel. The cross section features used in the evaluation of the study area were:

- Lane width,
- Shoulder width, both right and left,
- Median width, and
- Roadside embankment design.

IaDOT Standard Road Plans were used in conjunction with recommended values from AASHTO to evaluate the quality of the existing cross section design. For lane widths, shoulder widths, and median widths, a rating of good, fair, or poor was assigned by comparing the recommended widths from IaDOT and AASHTO to the typical cross sections from the as built plans.

The evaluation of the roadside embankment was more complex, and required engineering judgment when assigning ratings to the existing design. Guidelines for determining adequate sideslopes in relation to fill height are not clearly defined in the 1990 AASHTO Policy on Geometric Design. The IaDOT Road Design Manual establishes definite heights of fill in relation to steepness of slope. This criteria was used in establishing ratings of good, fair, and poor for roadside embankment design.

As-built plans did not clearly define height or steepness of foreslopes, at the system interchanges and I-29 between Nebraska Avenue and the I-29/I-480 System Interchange. A complete field review would have been necessary to fully evaluate these areas. However, this was not possible due to time constraints. Ratings of these areas were based on interpreting the available data, limited field review, and engineering judgment.

***Rating Criteria***

An overall rating of the existing cross section was determined based on the following criteria:

**CRITERIA FOR CROSS SECTION**

| Rating | Cross Section Criteria |
|---|---|
| GOOD | Lane width of 12 feet<br>Right shoulder width of at least 10 feet<br>Left shoulder width of at least 6 feet<br>Median width of at least 40 feet<br>Foreslope: 6:1, 4:1 for fill heights greater than 5 feet |
| FAIR | Lane width of 12 feet<br>Right shoulder width of at least 10 feet<br>Left shoulder width of 4 to 6 feet<br>Foreslope: 4:1 for fill heights of 0-5 feet, 3:1 for fill heights greater than 15 feet |
| POOR | Lane width less than 12 feet<br>Right shoulder width less than 10 feet<br>Left shoulder width less than 4 foot<br>Foreslope less than 3:1 |

The current IaDOT foreslope standard for Interstate Freeway is 6:1. The design manual states:

> Use 6:1 foreslope to 5 feet fill or beginning of "Barn Roof" section
> Use 4:1 for 5 feet to 15 feet of fill
> Use 3:1 over 15 feet of fill

A modified version of this current IaDOT standard was used to rate the existing foreslope. The AASHTO Roadside Design Guide states that a 4:1 foreslope is recoverable, although a 6:1 foreslope is desirable. Although a 4:1 foreslope is not ideal, it was rated as "good" for fill heights over 5 feet since recovery is usually possible.

***Results***

Based on review of as-built typical sections, the entire study area met the criteria for a good rating for lane, shoulder and median width. The controlling criteria for the cross section analysis was the embankment or foreslope design (which was generally not available from as-built plans) and was, therefore, based on limited information and engineering judgment. The three system interchanges generally did not have enough information to evaluate the foreslope design. Field review by the project team indicated that the majority of the foreslopes in these areas were at 3:1 in excess of 15 feet, resulting in a rating of fair.

The vast majority of the study area, except for I-80 east of Madison Avenue, is relatively flat, with shallow 4:1 foreslopes. The controlling criteria in these areas were the height of the foreslope. Areas where the foreslope was in excess of 5 feet received a rating of good, with areas at less than 5 feet receiving a rating of fair. The review of foresopes is summarized below:

- I-29 from the I-29/I-480 System Interchange north to N. 25th Street was rated good to fair.
- I-29 from N. 25th Street to the north limits of the study area was fair, due to shallow foreslopes at 4:1.
- I-29 from the I-29/I-480 System Interchange south to the West I-80/I-29 System Interchange was split about even between good and fair, based on the height of the embankment design at a slope of 4:1. An exception to this is the bridge approach at Harveys Boulevard where a poor rating was given due to sideslopes at 2½:1
- I-80 from the Missouri River to Madison Avenue was rated mostly fair with some isolated poor areas.
- I-29 from the East I-80/I-29 System Interchange to the south limits of the study area was rated as fair due to shallow sideslopes at 4:1.
- The typical section on I-80 east of Madison Avenue changed due to the rolling terrain of this area. A good portion of the interstate in this area is depressed, with shallow 4:1 foreslopes leading to a narrow drainage ditch, with 3:1 backslopes of varying height. In these areas, the controlling criteria was again the height of the foreslope. Most of this area was rated fair, with small stretches north of the Highway 6 interchange receiving good ratings.

Overall, the existing interstate cross-section in the study area rated good based on the lane, shoulder and median width. The ratings were then adjusted down if the existing foreslope is less then current design standards. A 4:1 foreslope is considered recoverable but if the fill is less than 5 feet deep a fair rating is assigned based on current interstate design guidelines. This foreslope criteria is rather restrictive and doesn't take existing guardrail into consideration.

An overall assessment of the cross section in the study area is provided graphically in Appendix A using the rating system described above.

### 4.2.7 Decision Sight Distance

According to AASHTO, decision sight distance is the distance required for a driver to detect an unexpected object or situation in the roadway, recognize the hazard or its threat potential, select an approprate speed and path, and initiate and complete the required safety maneuver safely and efficiently. Because it includes an element for decision-making, its values are substantially greater than stopping sight distance. Decision sight distance on the interstate system in Council Bluffs was evaluated using construction as-built plan and profiles, and a review of the video log.

***Methodology/Definitions/Assumptions***

Three steps are involved in the process used by drivers when confronted with an unexpected situation:

1. The driver must detect and recognize the unexpected situation.
2. The driver then makes a decision, and responds to the situation.
3. The driver executes the proper maneuver to avoid the situation.

The following complex situations that a driver encounters were evaluated in the study for adequate decision sight distance:

- The distance required in advance of interchanges;
- The distance required in advance of lane drops; and
- The distance required in advance of diverge areas.

Ratings of good, fair and poor were assigned to speeds of 70, 60, and 50 mph, respectively. The times required to perform the three steps involved are summarized below These times are used by AASHTO to compute the values summarized in the rating criteria section.

| Design Speed | Detection & Recognition | Decision & Response | Maneuver |
|---|---|---|---|
| 70 mph | 2.0-3.0 sec. | 4.7-7.0 sec. | 4.0 sec. |
| 60 mph | 2.0-3.0 sec. | 4.7-7.0 sec. | 4.5 sec. |
| 50 mph | 1.5-3.0 sec. | 4.2-6.5 sec. | 4.5 sec. |

***Rating Criteria***

An overall rating of decision sight distance in the study area was determined based on the following criteria:

**CRITERIA FOR DECISION SIGHT DISTANCE**

| Rating | Design Speed | Decision Sight Distance |
|---|---|---|
| GOOD | 70 mph | Greater than 1,450 feet |
| FAIR | 60 mph | 1,025-1,450 feet |
| POOR | 50 mph | Less than 1,025 feet |

Reference: Table III-3, p.127, 1990 AASHTO Policy on Geometric Design

***Results***

Results of the assessment indicate that the decision sight distance is adequate at a majority of the critical locations evaluated along the interstate system. Overall, 33 locations along the study area were analyzed for adequate decision sight distance, of which 28 received a rating of good, three received a rating of fair, and two received a rating of poor. All of the areas analyzed on I-80 received a good rating. The following locations along I-29 were determined not to meet the 70 mph design for decision sight distance:

Areas Rated "Fair":

- I-29 northbound approach to Nebraska Avenue
- I-29 southbound approach to 9th Avenue
- I-29 southbound approach to I-480

Areas Rated "Poor":

- I-29 northbound approach to 9th Avenue
- I-29 northbound approach to N. 25th Street

In summary, the assessment revealed that I-80 through Council Bluffs is adequately designed for decision sight distance. The majority of Interstate 29 also meets the 70-mph design criteria for decision sight distance, with the exception of the areas mentioned above.

An overall assessment of decision sight distance in the study area is provided graphically in Appendix A using the rating system described above.

### 4.2.8 Exit and Entrance Ramp Design

Exit and entrance ramp design refers to the rate of taper or diverge/merge angle that is provided. Proper design of these are critical to the operational efficiency of the ramps.

*Methodology/Definitions/Assumptions*

The design of exit and entrance ramps was evaluated using as-built plans. Key elements used in evaluating the condition of the exit and entrance ramps were:

- The acceleration length required to merge from an entrance ramp onto the interstate;
- The deceleration length required to merge from the interstate mainline to an exit ramp;
- The length of taper or divergence angle required at entrances onto or exits from the interstate mainline; and
- The design speed of the entrance and exit ramps.

The following definitions are provided:

- ***Acceleration Length:*** The length required to accelerate from the design speed of the entrance ramp to the average running speed of the interstate mainline, less 5 mph. The acceleration length starts at the end of the last curve along the entrance ramp and terminates where the taper section onto the interstate reaches a lane width of 12 feet.

- ***Deceleration Length:*** The length required to decelerate from the average running speed of the interstate to the design speed of the exit ramp. The deceleration length starts where the taper section exiting the interstate reaches a lane width of 12 feet, and terminates at the start of the first horizontal curve along the exit ramp.

- ***Parallel Lane Design:*** an exit ramp terminal design that utilizes a short taper section combined with a 12 feet lane to carry traffic from the interstate through lane to the ramp. The adequacy of a parallel lane design is based on the length of taper that proceeds the 12 feet lane.

- ***Tapered Design:*** An entrance or exit ramp terminal design that utilizes a long smooth taper to join the interstate through lane to the ramp. The adequacy of the design is based on the length of taper for entrance ramps and the divergence angle of the taper section for exit ramps.

- ***Ramp Terminal:*** The merge section on an entrance ramp or diverge section on an exit ramp that provides a transition from the interstate through lane to the ramp.

In analyzing the condition of the existing entrance and exit ramps, the design speed of the ramp was determined based on the worst case degree of curvature along the ramp. Once the design speed of the ramp was established, lengths required to accelerate onto, or decelerate off of the interstate mainline were determined based on tables from the AASHTO design guide. Taper lengths or divergence angles were scaled from or recorded directly from as built plans at each entrance and exit ramp, and compared to recommended values from AASHTO.

To establish criteria for rating the exit and entrance ramps, a design speed of 70 mph was assumed along the interstate mainline for the entire study area. The design speed of ramps was determined by entering Table III-6 from the 1990 AASHTO. This table correlates the degree of curvature to a design speed based on the superelevation rate along the curve. Superelevation rates for most of the ramps were not included on the as-built plans. Conservative values of superelevation rate based on the design of the ramp were chosen and the corresponding values for design speed were chosen from the table.

*Rating Criteria*

An overall rating of the entrance and exit ramp design was determined based on the following criteria:

**CRITERIA FOR TAPER DESIGN**

| Rating | Exit Ramp | Entrance Ramp |
|---|---|---|
| GOOD | Taper Design: Less than 4° diverge<br>Parallel Lane: 20:1 taper or greater | 50:1 taper or greater |
| FAIR | Taper Design: 4-5° diverge<br>Parallel Lane: 15:1 to 20:1 taper | 40:1 to 50:1 taper |
| POOR | Taper Design: Greater than 5° diverge<br>Parallel Lane: Less than 15:1 taper | Less than 40:1 taper |

Reference: P-982-998, 1990 AASHTO Policy on Geometric Design.

**CRITERIA FOR ACCELERATION/DECELERATION LANE**

| Rating | Exit Ramp | Entrance Ramp |
|---|---|---|
| GOOD | Deceleration length equal to or greater than length required to decelerate from 70 mph to the design speed of the ramp | Acceleration length equal to or greater than length required to accelerate from the design speed of the ramp to 70 mph |
| FAIR | Deceleration length equal to or greater than length required to decelerate from 70 mph to the design speed of the ramp + 10 mph | Acceleration length equal to or greater than length required to accelerate from the design speed of the ramp to 60 mph |
| POOR | Deceleration length equal to or greater than length required to decelerate from 70 mph to the design speed of the ramp + 20 mph | Acceleration length equal to or greater than length required to accelerate from the design speed of the ramp to 50 mph |

Reference: Table X-4, Page 986, and Table X-6, Page 991, 1990 AASHTO Policy on Geometric Design.

*Results*

Of the 42 ramps analyzed, 19 received a rating of good, 8 received a rating of fair, and 15 received a rating of poor based on the criteria outlined in the previous section. An in depth breakdown of the data revealed the following trends in exit/entrance design:

- All of the exit ramps analyzed in the study meet or exceed the criteria to receive a good rating based on the taper length. Downgrading of exit ramps was due to inadequate deceleration lengths. This occurred at exit ramps that had a loop, or cloverleaf style design.

- A majority of the entrance ramps analyzed received a rating of fair or poor. Many of the taper lengths for entrance ramps were designed at or below 40:1, downgrading them to fair or poor. The acceleration lengths were adequate for most entrance ramps, except for the ramps with a loop or cloverleaf type design, which received a poor rating due to inadequate acceleration lengths.

- Based on the design speed established using the worst case horizontal curve, all loop and cloverleaf ramps in the study area do not have the adequate acceleration or deceleration lengths required to merge to/from the design speed of the interstate.

Design of exit ramps along the interstate mainline, excluding cloverleaf types, are adequate. A majority of the entrance ramps, based on both taper length and/or acceleration length, are inadequately designed.

An overall assessment of exit and entrance ramp design is provided graphically in Appendix A using the rating system described above.

### 4.2.9 Basic Number of Lanes

At least two lanes should be provided in each direction of a freeway, exclusive of auxiliary lanes. Where traffic volumes justify additional lanes, it is desirable to provide a constant number of lanes over significant lengths of freeway. The basic number of lanes of a freeway is defined as a minimum number of lanes designated or maintained over a significant length of a route irrespective of localized changes in traffic volume and irrespective of the requirements for lane balance (see Section 4.2.11).

An increase in the basic number of lanes is required where traffic builds sufficiently to justify an extra lane and where such a lane is justified for a significant length. To accommodate localized variations in traffic volumes, auxiliary lanes should be provided. The basic number of lanes may be decreased where traffic is reduced sufficiently to drop a basic lane, provided there does not exist a need to again add the basic lane downstream.

*Methodology/Definitions/Assumptions*

The basic number of lanes was reviewed for all portions of the Council Bluffs interstate system. The assessment did not address whether sufficient lanes exist to provide an acceptable level of service. The assessment of the quality of traffic operations is addressed Section 4.2.15 - Freeway Level of Service. Rather, the assessment of the basic number of lanes was performed to determine if the minimum the number of lanes are provided and if changes to the basic number of lanes follow the principles described above.

*Rating Criteria*

Ratings were not applied to the basic number of lanes in study area. As such, the results of the analysis have not been shown graphically in the Appendix. A discussion of the results of the assessment is provided below.

*Results*

There are no violations of the principles of basic number of lanes within the study area. Two basic lanes are provided in each direction throughout the study area. Additional lanes are provided in some segments of the study area. However, these lanes represent auxiliary lanes in that they are not of substantial length and they are provided to serve traffic moving to and from local and system interchanges. Specifically, the following auxiliary lanes are provided:

- Southbound I-29 between Avenue G and the I-29/I-480 System Interchange
- Southbound I-29 between the I-29/I-480 System Interchange and 9th Avenue
- Southbound I-29 between Nebraska Avenue and the West I-80/I-29 System Interchange
- Eastbound I-80/I-29 just east of the West I-80/I-29 System Interchange
- Eastbound I-80/I-29 between the South Expressway and the East I-80/I-29 System Interchange
- Westbound I-80/I-29 between the East I-80/I-29 System Interchange and the South Expressway
- Northbound I-29 between Highway 275/92 and the East I-80/I-29 System Interchange

### 4.2.10 Route Continuity

Route continuity refers to the provision of a directional path along a designated route. When route continuity is provided, drivers are able to remain on a designated route without changing lanes and without exiting the freeway. This is generally accomplished by allowing through traffic to stay to the left of all other traffic. Merging, diverging and weaving operations should occur to the right of through traffic.

*Methodology/Definitions/Assumptions*

As noted in the previous section, two basic lanes are provided everywhere in the study area. Route continuity was evaluated by reviewing each directional path (e.g., Eastbound I-80) to determine if through vehicles in either of the two basic lanes provided are required to change lanes to continue on the intended path and if the these through vehicles could remain to the left of other traffic operations such as merging, diverging, weaving, etc.

***Rating Criteria***

An overall rating of lane and route continuity was determined based on the following criteria:

**CRITERIA FOR LANE AND ROUTE CONTINUITY**

| Rating | Lane and Route Continuity Criteria |
|---|---|
| GOOD | Section has lane and route continuity |
| FAIR | This rating not used for this evaluation measure |
| POOR | Section lacks lane/route continuity |

***Results***

In general, relatively good route continuity is provided for each directional path. Exceptions to this are summarized below.

- Southbound I-29 traffic must merge with Eastbound I-80 traffic at the West I-80/I-29 System Interchange to continue along I-29. One I-29 basic lane merges immediately and one basic lane merges several hundred feet downstream.
- Since I-29 merges on the left of Eastbound I-80 traffic, the route continuity principles are violated for Eastbound I-80 traffic as well at this same interchange.
- Approaching the East I-80/I-29 System Interchange, Southbound I-29 traffic in the left-most lane must change one lane to continue on the designated path.
- Downstream of the East I-80/I-29 System Interchange, Northbound I-29 traffic in the left-most lane must change one lane to continue on the designated path due to a left-side lane drop.
- Downstream of the East I-80/I-29 System Interchange, Westbound I-80 traffic in the right-most lane must change one lane to continue on the designated path due to a lane drop at the South Expressway interchange.
- Approaching the West I-80/I-29 System Interchange, Northbound I-29 traffic in the left lane must change one lane to continue on the designated path.

An overall assessment of route continuity is provided graphically in Appendix A using the rating system described above.

### 4.2.11 Lane Balance

Lane balance reflects the need to provide access to and from a freeway while minimizing disruption to through traffic by requiring unnecessary lane changing. Coupled with the principles of basic number of lanes and route continuity, lane balance provides optimal traffic operations to both through traffic and interchanging traffic on a freeway.

***Methodology/Definitions/Assumptions***

The following three principles of lane balance are provided by AASHTO :

1. At entrance ramps the number of lanes beyond the merging of two traffic streams should not be less than the sum of all traffic lanes on the merging roadways minus one.
2. At exit ramps the number of approach lanes on the highway must be equal to the number of lanes on the highway beyond the exit plus the number of lanes on the exit, less one. An exception to this principle would be at cloverleaf loop ramp exits which follow a loop ramp entrance or at exits between closely spaced interchanges; i.e., interchanges where the distance between the end of the taper of the entrance terminal and the beginning of the taper of the exit terminal is less than 1,500 ft and a continuous auxiliary lane between ramps is used. In these cases, the auxiliary lane may be dropped in a single-lane exit with the number of lanes on the approach roadway being equal to the number of through lanes beyond the exit plus the lane on the exit.
3. The traveled way of the highway should be reduced by not more than one traffic lane at a time.

Except as noted in Principle 1 above, the principles of lane balance must be applied in the use of basic lanes and auxiliary lanes alike. All ramp junctions in the study area were reviewed for compliance with the lane balance principles of AASHTO.

***Rating Criteria***

An overall rating for lane balance was determined based on the following criteria:

**CRITERIA FOR LANE BALANCE**

| Rating | Lane Balance Criteria |
|---|---|
| GOOD | Lane balance criteria met by the existing ramp terminal design |
| FAIR | This rating not used for this evaluation measure |
| POOR | Lane balance criteria not met by the existing ramp terminal |

***Results***

Overall, lane balance is generally maintained throughout the Council Bluffs interstate system. Exceptions to this are summarized below.

- Westbound I-80/I-29 off ramp to the South Expressway. Three freeway lanes approach the ramp junction. The right-most auxiliary lane (which was added upstream at the East I-80/I-29 System Interchange) is dropped as a single-lane off ramp. This configuration does not meet the criteria for exception to the principles allowed for auxiliary lanes since the distance to the upstream on ramp is greater than 1,500 feet.

- Eastbound I-80 off ramp to Northbound I-29 at the West I-80/I-29 System Interchange. Two freeway lanes approach the ramp junction. A two-lane off ramp to Northbound I-29 is provided while two freeway lanes continue as Eastbound I-80.
- Southbound I-29 off ramp to 9th Avenue. The right-most auxiliary lane (which was added upstream at the I-29/I-480 System Interchange) is dropped as a single-lane off ramp. However, this configuration meets the criteria for exception to the principles since the distance to the upstream on ramp is less than 1,500 feet.
- Eastbound I-480 split between West Broadway and Northbound/Southbound I-29. Four freeway lanes approach the ramp junction. A two-lane off ramp to Northbound/Southbound I-29 is provided while two lanes continue as West Broadway.
- Southbound I-29 off ramp to Westbound I-480. The right-most auxiliary lane (which was added upstream at the Avenue G Interchange) is dropped as a single-lane off ramp. However, this configuration meets the criteria for exception to the principles since the distance to the upstream on ramp is less than 1,500 feet.

An overall assessment of lane balance is provided graphically in Appendix A using the rating system described above. At the two locations where the exception to the lane balance principles were applied, a rating of "Poor" was still applied based on observations of relatively poor traffic operations in the area.

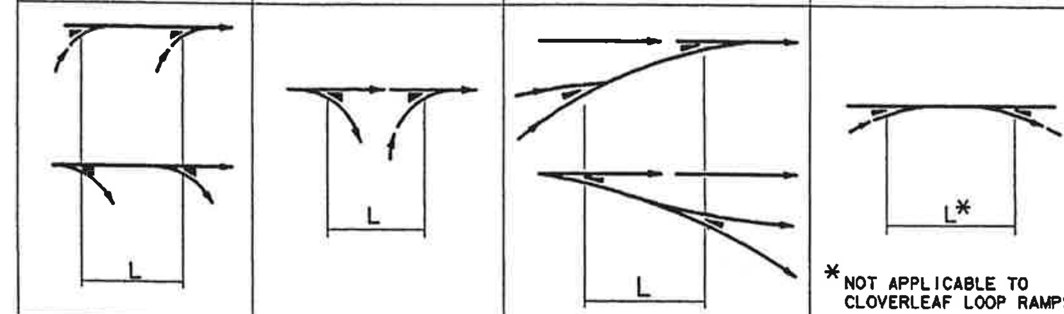
### 4.2.12 Ramp Sequence & Spacing

A reasonable distance between two successive ramps on a freeway is necessary to provide sufficient maneuvering length and adequate space for signing. The minimum spacing between ramps is dependent on the classification of the interchanges involved (i.e., system interchange vs. service or local interchange), the function of the ramps (i.e., entrance ramp or exit ramp), and weaving potential, if applicable.

*Methodology/Definitions/Assumptions*

The spacing between successive ramps in the study area was assessed using the AASHTO criteria shown on the opposite page. AASHTO notes that when a entrance ramp is followed by an exit ramp, the absolute minimum distance between successive noses (expressed in feet) is governed by weaving requirements. A notable exception to this is the distance between the loop entrance ramp and the loop exit ramp of cloverleaf interchanges which is primarily dependent on loop ramp radii and roadway and median widths.

For this analysis the distance between ramps was approximated from aerial photography and reflects the distance between the physical nose of each ramp terminal. In addition, successive ramps within system interchanges were not analyzed, as the AASHTO criteria does not apply.




| EN-EN OR EX-EX | | EX-EN | | TURNING ROADWAYS | | EN-EX (WEAVING) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SYSTEM TO SERVICE INTERCHANGE | | SERVICE TO SERVICE INTERCHANGE | |
| FULL FREEWAY | CDR OR FDR | FULL FREEWAY | CDR OR FDR | SYSTEM INTER-CHANGE | SERVICE INTER-CHANGE | FULL FWY. | CDR OR FDR | FULL FWY. | CDR OR FDR |
| MINIMUM LENGTHS MEASURED BETWEEN SUCCESSIVE RAMP TERMINALS | | | | | | | | | |
| 1000 | 800 | 500 | 400 | 800 | 600 | 2000 | 1600 | 1600 | 1000 |

NOTE: FDR - FREEWAY DISTRIBUTOR ROAD; CDR - COLLECTOR DISTRIBUTOR ROAD; EN - ENTRANCE; EX - EXIT

THE RECOMMENDATIONS ARE BASED ON OPERATIONAL EXPERIENCE AND NEED FOR FLEXIBILITY AND ADEQUATE SIGNING. THEY SHOULD BE CHECKED IN ACCORDANCE WITH THE PROCEDURE OUTLINED IN THE HIGHWAY CAPACITY MANUAL (3) AND THE LARGER OF THE VALUES IS SUGGESTED FOR USE. ALSO, A PROCEDURE FOR MEASURING THE LENGTH OF THE WEAVING SECTION IS GIVEN IN CHAPTER 4 OF THE HIGHWAY CAPACITY MANUAL (3).

Source: A Policy on Geometric Design of Highways and Streets, AASHTO, 1994.

*Rating Criteria*

An overall rating for ramp sequence and spacing was determined based on the following criteria:

**CRITERIA FOR RAMP SEQUENCE AND SPACING**

| Rating | Ramp Sequencing and Spacing Criteria |
|---|---|
| GOOD | Existing spacing between ramp terminals equals or exceeds AASHTO minimum |
| FAIR | This rating not used for this evaluation measure |
| POOR | Existing spacing between ramp terminals is less than AASHTO minimum spacing |

*Results*

The results of the assessment of ramp spacing in the study area is shown in Table 2 on the following page. Of the 46 ramp pairs evaluated, eight pairs were found to have spacing less than the AASHTO minimum. An overall assessment of route continuity is provided graphically in Appendix A using the rating system described above.

*TABLE 2 - Ramp Spacing Summary*

| Freeway | First Ramp | Second Ramp | Distance Between Ramps | AASHTO Minimum Distance | Minimum Met? |
|---|---|---|---|---|---|
| WB I-80 | Off ramp to Hwy. 6 | On ramp from Hwy. 6 | 2,250 | 500 | Yes |
| | On ramp from Hwy. 6 | Off ramp to Madison Ave. | 14,100 | 1,600 | Yes |
| | Off ramp to Madison Ave. | On ramp from Madison Ave. | 2,000 | 500 | Yes |
| | On ramp from Madison Ave. | SB I-29/WB I-80 Diverge | 4,050 | 2,000 | Yes |
| EB I-80 | EB I-80/NB I-29 Merge | Off ramp to Madison Ave. | 4,300 | 2,000 | Yes |
| | Off ramp to Madison Ave. | On ramp from Madison Ave. | 2,000 | 500 | Yes |
| | On ramp from Madison Ave. | Off ramp to Hwy. 6 | 14,400 | 1,600 | Yes |
| | Off ramp to Hwy. 6 | On ramp from Hwy. 6 | 2,250 | 500 | Yes |
| NB I-29 | Off ramp to Hwy. 275 | On ramp from Hwy. 275 | 2,100 | 500 | Yes |
| | On ramp from Hwy. 275 | NB I-29/EB I-80 Diverge | 1,300 | 2,000 | No |
| | NB I-29/EB I-80 Merge | Off ramp to Nebraska Ave. | 2,850 | 2,000 | Yes |
| | Off ramp to Nebraska Ave. | On ramp from Nebraska Ave. | 1,100 | 500 | Yes |
| | On ramp from Nebraska Ave. | Off ramp to 9th Ave. | 1,900 | 1,600 | Yes |
| | Off ramp to 9th Ave. | On ramp from 9th Ave. | 1,600 | 500 | Yes |
| | On ramp from 9th Ave. | NB I-29/WB I-480 Diverge | 1,700 | 2,000 | No |
| | NB I-29/EB I-480 Merge | Off ramp to 35th St. | 2,700 | 2,000 | Yes |
| | Off ramp to 35th St. | On ramp from 35th St. | 1,150 | 500 | Yes |
| | On ramp from 35th St. | Off ramp to 25th St. | 4,300 | 1,600 | Yes |
| | Off ramp to 25th St. | On ramp from 25th St. | 1,750 | 500 | Yes |
| | On ramp from 25th St. | On ramp from Hwy 192 | 5,900 | 1,600 | Yes |
| SB I-29 | Off ramp to Hwy. 192 | Off ramp to 25th St. | 5,350 | 1,600 | Yes |
| | Off ramp to 25th St. | On ramp from 25th St. | 1,650 | 500 | Yes |
| | On ramp from 25th St. | Off ramp to Ave. G | 6,400 | 1,600 | Yes |
| | Off ramp to Ave. G | On ramp from Ave. G | 550 | 500 | Yes |
| | On ramp from Ave. G | SB I-29/WB I-480 Diverge | 900 | 2,000 | No |
| | SB I-29/EB I-480 Merge | Off ramp to 9th Ave. | 1,400 | 2,000 | No |
| | Off ramp to 9th Ave. | On ramp from 9th Ave. | 1,500 | 500 | Yes |
| | On ramp from 9th Ave. | Off ramp to Nebraska Ave. | 2,050 | 1,600 | Yes |
| | Off ramp to Nebraska Ave. | On ramp from Nebraska Ave. | 1,550 | 500 | Yes |
| | On ramp from Nebraska Ave. | SB I-29/WB I-80 Diverge | 2,350 | 2,000 | Yes |
| | SB I-29/WB I-80 Merge | Off ramp to Hwy. 275 | 2,250 | 2,000 | Yes |
| | Off ramp to Hwy. 275 | On ramp from Hwy. 275 | 1,200 | 500 | Yes |
| SB I-29/EB I-80 | SB I-29/EB I-80 Merge | Off ramp to 24th St. | 2,800 | 2,000 | Yes |
| | Off ramp to 24th St. | On ramp from 24th St. | 2,150 | 500 | Yes |
| | On ramp from 24th St. | Off ramp to S. Expressway | 5,150 | 1,600 | Yes |
| | Off ramp to S. Expressway | On ramp from S. Expressway | 900 | 500 | Yes |
| | On ramp from S. Expressway | SB I-29/EB I-80 Diverge | 2,650 | 2,000 | Yes |
| NB I-29/WB I- | NB I-29/WB I-80 Merge | Off ramp to S. Expressway | 2,850 | 2,000 | Yes |
| | Off ramp to S. Expressway | On ramp from S. Expressway | 1,350 | 500 | Yes |
| | On ramp from S. Expressway | Off ramp to 24th St. | 4,750 | 1,600 | Yes |
| | Off ramp to 24th St. | On ramp from 24th St. | 2,100 | 500 | Yes |
| | On ramp from 24th St. | NB I-29/WB I-80 Diverge | 3,000 | 2,000 | Yes |
| EB I-480 | Off ramp to 41st St. | Off ramp to NB I-29/SB I-29 | 800 | 1,000 | No |
| | Off ramp to NB I-29/SB I-29 | NB I-29/SB I-29 Diverge | 500 | 800 | No |
| WB I-480 | NB I-29/SB I-29 Merge | On ramp from NB I-29/SB I-29 | 600 | 800 | No |
| | On ramp from NB I-29/SB I-29 | On ramp from 41st St. | 750 | 1,000 | No |

### 4.2.13 Guide Signing

Proper guide signing is critical to efficient traffic operations and safety in a freeway corridor. In urban conditions, however, signing is often based on that which can be provided under given the spacing and configurations of interchanges.

***Methodology/Definitions/Assumptions***

The assessment of freeway guide signs in the study area focused on several key aspects of signing principles including the delivery of the intended message and the number, sequence and general locations of the signs. Other elements reviewed included sign visibility, message content, and general sign layout. In general, however, elements such as sign supports, illumination, and sign layout details were not addressed and are beyond the scope of this study. As part of the assessment, a photo log of all guide signs in the study was prepared by the project team.

The Manual on Uniform Traffic Control Devices (MUTCD) and other relevant literature were utilized in the evaluation of freeway guide signs in the study area. The MUTCD serves as the primary tool in the design of freeway guide signs and provides standards and guidelines for sign messages, sign layout and sign location.

A summary of some of the guidelines gathered from other literature and used in the assessment is presented below:

- A system interchange should have at least two advance signs.
- Other interchanges should have at least one advance sign.
- There should be no more than three signs side by side per location.
- There should be no more than six messages for a single sign.
- There should be no more than five messages per sign, ten messages total, for two signs located side by side.
- There should be no more than four messages per sign, eleven messages total, for three signs located side by side.

***Rating Criteria***

An overall rating of guide signing was determined based on the following criteria:

**CRITERIA FOR SIGNING**

| Rating | Signing Criteria |
|---|---|
| GOOD | No deficiencies observed |
| FAIR | Minor deficiencies observed |
| POOR | Major deficiencies observed |

***Results***

Guide signing in the Council Bluffs interstate system is a combination of side-mounted signs and overhead signs. The review of guide signs in the study area found that most of the signs meet available guidelines and provide the information necessary for unfamiliar drivers to make informed decisions. Observations from this review are summarized below.

- The gore sign is missing at some exit ramps.
- Route markers and trailblazers are often absent from the system.
- Add-on panels with commercial content cause non-standard sign layouts.
- Signing for Eppley Airfield in Omaha is generally inadequate.

Deficiencies for individual signs were identified and are summarized below:

***Eastbound I-80***
- Exit 1 A - Off ramp to Northbound I-29. Diagrammatic symbol should be used for advance sign(s) for left exit.
- Exit 1 B - Off ramp to S. 24th Street. Advance sign is located only at 3/4 mile upstream of the exit. There is no exit panel on top.
- Exit 4 - Eastbound I-80/Southbound I-29 split. Diagrammatic symbol should be used for advance sign(s) before diverge of two interstate highways.
- Exit 5 - Off ramp to Madison Avenue. Advance sign is located only 1/2 mile upstream of the exit.

***Westbound I-80***
- Exit 4 - Off ramp to Southbound I-29. Diagrammatic symbol should be used for advance sign(s) before diverge of two interstate highways.
- Exit 3 - Off ramp to South Expressway. Two overhead signs on the sign bridge near the gore. The sign for Exit 3 has six messages.

***Northbound I-29***
- Exit 48 - Off ramp to Eastbound I-80. Diagrammatic symbol should be used for advance sign(s) before diverge of two interstate highways.
- Exit 52 - Off ramp to Nebraska Avenue. Lettering is too small for the add-on panel noting Riverboat Casino.
- Exit 52 - Off ramp to Nebraska Avenue. Two of the three overhead signs at the gore have five messages.
- Exit 53 A - Off ramp to 9th Avenue. There is no exit panel on top. Layout is non-standard.
- Exit 53 B - Off ramp to Westbound I-480. Advance signs should be diagrammatic, and action panel at the bottom should not be yellow for non-drop lane exit.
- Exit 54 B - Off ramp to N. 35th Street. Missing exit sign at the gore.
- Exit 55- Off ramp to N. 25th Street. Sign is blocked by trees.

***Southbound I-29***
- Exit 56- Off ramp to Highway 192 (N. 16th Street). Advance signs should use diagrammatic format for route discontinuity (I-29 curves at the exit). Action panels at the bottom should not use yellow for non-drop lane exit. "TO I-80 WEST" on top of the sign is too crowded.
- Exit 56 - Off ramp to Highway 192 (N. 16th Street). Gore sign should be used at the gore rather than double arrow sign.
- Exit 53 B - Off ramp to Westbound I-480. Continuation of mainline I-29 should not use yellow "KEEP LEFT" at bottom of the sign. Lettering on sign for Eppley Airfield is not legible.
- Exit 53 A - Off ramp to 9th Avenue. The advance sign is located only 1/4 mile upstream of the exit. The major message (9th Ave) is dominated by the secondary message (Riverboat Casino). The exit sign should have more lateral clearance.
- Exit 52 - Off ramp to Nebraska Avenue. The advance sign has no exit panel on top.

***Eastbound I-480***
- Exit 1 A&B - Off ramp to Northbound/Southbound I-29. The advance sign farthest upstream has exit panel on top, but the other advance sign and the exit sign do not.
- Exit 1 A-B - Off ramp to Northbound/Southbound I-29. Sign should include the word "TO" before I-29 SOUTH and I-29 NORTH to help to clarify the termination of I-480.
- Exit 1 A-B - Off ramp to Northbound/Southbound I-29. "TO I-80" on top of the immediate advance sign and the exit sign is too small and could be combined with the "I-29 SOUTH" message.
- Exit 1 A-B - Off ramp to Northbound/Southbound I-29. "JCT" sign should be installed on top of the route marker for I-29.

***Westbound I-480***
- No deficiencies identified.

An overall assessment of guide signing is provided graphically in Appendix A using the rating system described above.

### 4.2.14 Safety

Accident experience on a freeway provides an indication of the effect of various physical, geometric and operational features on safety.

***Methodology/Definitions/Assumptions***

The accident history of the freeway system was evaluated using PC-ALAS information provided by IaDOT for the years 1991 through 1995. Although the 1994 accident data is considered incomplete, IaDOT indicated that the missing data was very limited in Pottawattamie County, so it was determined that the 1994 data could be used for this study. The evaluation included two types of analysis for the study area:

- ***Mainline Segments.*** An accident rate was calculated for the main-line interstate system based on the five-year analysis period. Freeway segments were broken into 1-mile increments based on the existing mileposts. This procedure gives an overall idea were problem areas exist in the system. The main-line accident rate is shown on the Physical/Geometric/Operational Conditions exhibits.
- ***Interchanges.*** The second analysis included evaluating each interchange individually for the same five-year period. This evaluation showed where problem interchanges currently exist within the Council Bluffs system.

Accident rates for the five-year analysis period were calculated using the IaDOT 1996 balanced ADT assignment and the 1994 average weekday traffic volumes compiled by MAPA.

The following definitions are provided:

- ***Section Accident Rate:*** Total number of annual accidents, which have occurred per million vehicle miles traveled.
- ***Intersection (Interchange) Accident Rate:*** Total number of annual accidents, which have occurred per million entering vehicles.
- ***AADT:*** Average annual daily traffic (vehicles per day).
- ***HMVM:*** Hundred million vehicle miles traveled.
- ***MEV:*** Million entering vehicles.

Accident rates were calculated using the following equations:

$$\text{Section Accident Rate} = \frac{\text{Total \# of Accidents} \times 1{,}000{,}000{,}000}{\text{Average Annual Vehicle Miles of Travel}}$$

$$\text{Interchange Accident rate} = \frac{\text{Total \# of Accidents} \times 1{,}000{,}000}{\text{Average Annual Entering Vehicles}}$$

The average Municipal (urban) accident rate in 1995 for the State Interstate System is 151 accidents per hundred million vehicle miles (HMVM). The rural rate is 55 accidents per HMVM. A statewide average annual accident rate for interstate interchanges is not available. Therefore, ratings were not applied. However, the interchange accident rate generated does provide a good comparison between interchanges in the Council Bluffs interstate system.

***Rating Criteria***

An overall rating for safety (i.e., accident rate for mainline segments) was determined based on the following criteria:

**CRITERIA FOR MAINLINE ACCIDENT RATES**

| Rating | Accident Rate |
|---|---|
| GOOD | Less than 55 Accidents per HMVM |
| FAIR | Between 55 and 151 Accidents per HMVM |
| POOR | Greater than 151 Accidents per HMVM |

***Results***

The following observations summarize the mainline accident rates:

- The I-29/I-80 corridor has an accident rate mostly in the fair category.
- The areas that were rated as "good" tend to be more rural in nature. The "good" areas are located on I-80 east of Madison Avenue, on I-29 south of the East I-80/I-29 System Interchange and I-29 north of the I-29/I-480 System Interchange.
- The areas that were ranked as "poor" are as follows:

  * Eastbound I-80 at Madison Avenue
  * Westbound I-80 at the East I-80/I-29 System Interchange
  * Northbound I-29 at the I-29/I-480 System Interchange
  * Eastbound and Westbound I-480

The following were concluded from the mainline accident analysis:

- The accident rate tends to increase at the system interchanges. This is somewhat expected due to left handed entrance/exit ramps and increased decision requirements.
- I-480 is currently experiencing the highest main-line accident rate in the system. This can probably be attributed to the relatively high traffic volumes and closely spaced ramps.

Table 3 on the following page summarizes the interchange accident rates for the study area. In comparing the interchange accident rates, the I-29/Avenue G and I-480/41st Street interchanges have the two highest interchange accident rates. Although the Avenue G interchange has relatively low traffic volumes the existing geometrics are less than ideal. The 41st Street interchange also has relatively low traffic volumes but the proximity to the I-29/I-480 System Interchange may have an adverse affect on the accident rate.

### 4.2.15 Freeway Level of Service

A comprehensive assessment of freeway traffic operations was performed for the existing morning and afternoon peak hours. Separate analyses were performed for basic freeway segments, ramp junctions and weaving sections. The basic freeway segment analysis is summarized in this section. The analysis of ramp junctions and weaving sections is summarized in subsequent sections.

*TABLE 3 - Interchange Accident Rate Summary*

| Interchange | Average Daily Entering Vehicles | Total Accidents 1991 – 1995 | Accident Rate (Acc./MEV) |
|---|---|---|---|
| I-480 & 41st St. | 3,100 | 20 | 8.94 |
| I-29 & Ave. G | 2,900 | 37 | 7.08 |
| I-29/I-80 & S. 24th St. | 22,100 | 112 | 2.77 |
| I-29/I-80 & S. Expressway | 32,600 | 142 | 2.38 |
| I-29 & Nebraska Ave. | 9,700 | 30 | 1.70 |
| I-29 & 9th Ave. | 17,700 | 50 | 1.65 |
| I-80 & Madison Ave. | 30,600 | 86 | 1.54 |
| I-29 & Hwy 275 | 13,200 | 33 | 1.37 |
| I-80 & Hwy 6 | 11,000 | 28 | 1.38 |
| I-29 & N. 35th St. | 3,900 | 8 | 1.12 |
| I-29 & N. 16th St. | 18,300 | 32 | 0.96 |
| I-29/I-480 | 49,000 | 76 | 0.85 |
| I-29 & N. 25th St. | 8,300 | 13 | 0.85 |
| I-80/I-29 (East) | 49,000 | 53 | 0.59 |
| I-29/I-80 (West) | 75,800 | 79 | 0.57 |

***Methodology/Definitions/Assumptions***

Level of service (LOS) analyses were performed following Chapter 3 procedures (Basic Freeway Segments) of the Highway Capacity Manual (HCM). The Highway Capacity Software (HCS), a computerized analytical tool based on the HCM, was utilized to evaluate the operational characteristics of the freeway segments of the system.

Geometric and channelization information was obtained from aerial photos and as-built plans provided by IaDOT and then verified and supplemented with field visits by the project team. Other input included traffic volumes and other traffic characteristics provided by IaDOT and supplemented with field data.

For freeway segments, the LOS is defined in terms of traffic stream density over a certain distance. LOS A through F are described on the opposite page.

By definition, basic freeway segments are segments of the freeway that are not affected by merging or diverging movements at nearby ramps or by weaving movements. Given that freeway ramps have an influence distance of 1,500 feet upstream or downstream, and weaving sections have an influence distance of 2,500 feet, only freeway segments over 2,000 feet in length were evaluated as basic freeway segments.

| LOS | Maximum Density (pc/mi/ln) |
|---|---|
| A | 10 |
| B | 16 |
| C | 24 |
| D | 32 |
| E* | 36.7 (4-lane freeway) |
| | 39.7 (6-lane freeway) |
| F | Beyond LOS E |

* For free flow speed of 70 mph

Other assumptions for basic freeway segment analyses included:

- Free flow speed is 70 mph
- Peak hour factor is 0.95 (by HCS default)
- RV's and other heavy vehicles are included in trucks
- Lane width is 12 feet (by HCS default)
- Lateral clearance is 6 feet where applicable (by HCS default)
- Driver population factor is 1.0 (by HCS default)

***Rating Criteria***

Ratings such as "Good", "Fair" and "Poor" were not applied to the results of the freeway level of service analysis. Rather, the results are presented below and in Appendix A using the six levels of service (A through F) as defined by the Highway Capacity Manual.

***Results***

Table 4 on the next page summarizes the results of the analysis of basic freeway segments in the study area. Table 4 indicates that most freeway segments in the study area are operating at LOS C or better. Exceptions include Eastbound I-80/I-29 between the West System Interchange and S. 24th Street during the PM peak hour and Eastbound and Westbound I-80/I-29 between S. 24th Street and the South Expressway during both peak hours.

An overall assessment of freeway level of service is provided graphically in Appendix A.

### 4.2.16 Weaving Level of Service

Weavings is defined as the crossing of two or more traffic streams traveling in the same general direction along a significant length of freeway, without the aid of traffic control devices. Six such areas were identified in the study area.

***TABLE 4 - Freeway Segment LOS Summary***

| Freeway | Segment | Direction | LOS AM | LOS PM |
|---|---|---|---|---|
| I-29 | North of Highway 192 | NB | A | A |
| | | SB | A | A |
| | Highway 192 to N. 25th Street | NB | A | A |
| | | SB | A | A |
| | N. 25th Street to N. 35th Street | NB | A | A |
| | | SB | A | A |
| | N. 35th Street to Avenue G | NB | A | A |
| | | SB | A | A |
| | Avenue G to I-480 | NB | A | A |
| | | SB | See Weaving Analysis | See Weaving Analysis |
| | I-480 to 9th Avenue | NB | Not Analyzed | Not Analyzed |
| | | SB | See Weaving Analysis | See Weaving Analysis |
| | 9th Avenue to Nebraska Avenue | NB | B | B |
| | | SB | B | B |
| | Nebraska Avenue to I-80 | NB | B | B |
| | | SB | See Weaving Analysis | See Weaving Analysis |
| | I-80 to Highway 275/92 | NB | See Weaving Analysis | See Weaving Analysis |
| | | SB | Not Analyzed | Not Analyzed |
| | South of Highway 275/92 | NB | A | A |
| | | SB | A | A |
| I-80 | West of I-29 | EB | B | C |
| | | WB | C | C |
| | I-29 to Madison Avenue | EB | A | B |
| | | WB | B | B |
| | Madison Avenue to Highway 6 | EB | A | B |
| | | WB | B | A |
| | North of Highway 6 | EB | A | A |
| | | WB | A | A |
| I-80/I-29 | West System Interchange to S. 24th Street | EB | B | D |
| | | WB | C | B |
| | S. 24th Street to S. Expressway | EB | B | D |
| | | WB | D | C |
| | S. Expressway to East System Interchange | EB | See Weaving Analysis | See Weaving Analysis |
| | | WB | See Weaving Analysis | See Weaving Analysis |

Note: Freeway segments not analyzed are of insufficient length to be classified as basic freeway segments.

***Methodology/Definitions/Assumptions***

Chapter 4 procedures (Weaving Areas) of the HCM and the HCS were utilized to assess the level of service of weaving segments in the study area for the existing morning and afternoon peak hours.

Level of service for weaving operations is expressed in terms of minimum average speed of weaving vehicles and non-weaving vehicles, respectively. LOS A through F are described as follows:

| LOS | Minimum Average Weaving Speed | Minimum Average Non-Weaving Speed |
|---|---|---|
| A | 55 mph | 60 mph |
| B | 50 mph | 54 mph |
| C | 45 mph | 48 mph |
| D | 40 mph | 42 mph |
| E | 35 mph | 35 mph |
| F | < 35 mph | < 35 mph |

Substantial effort was devoted to identifying the weaving areas of the study area and to the distinction between weaving analysis and other types of analyses. That is, not all lane-changing operations are categorized as weaving nor are they all suitable for weaving analysis. For instance, a freeway segment of two lanes with a right hand on ramp followed by a left hand off ramp can easily be mistaken as type "C" weaving, while there is only one lane change taking place. In addition, at locations where the measured weaving length exceeded 2,500 feet, the segment was analyzed as a basic freeway segment.

The percentages for weaving and non-weaving vehicles were calculated for both merging traffic streams based on the proportions of the diverge splits, due to the lack of origin-destination data.

Other assumptions for weaving segment analyses included:

- Peak hour factor is 0.90 (by HCS default)
- RV's and other heavy vehicles are included in trucks
- Lane width is 12 feet (by HCS default)
- Lateral clearance is 6 feet where applicable (by HCS default)
- Driver population factor is 1.0 (by HCS default)

***Rating Criteria***

Ratings such as "Good", "Fair" and "Poor" were not applied to the results of the weaving level of service analysis. Rather, the results are presented below and in Appendix A using the six levels of service (A through F) as defined by the Highway Capacity Manual.

***Results***

Table 5 on the next page summarizes the results of the analysis of weaving segments in the study area. Table 5 indicates that the weaving segment on Southbound I-29 between Avenue G and the I-29/I-480 System Interchange is operating at LOS E in the AM peak hour. In addition, the weaving segment on Northbound I-29 between 9th Avenue and the I-29/I-480 System Interchange is operating at LOS D in the PM peak hour. An overall assessment of weaving level of service is provided graphically in Appendix A.

*TABLE 5 - Weaving LOS Summary*

| Freeway | Segment | Direction | LOS | |
|---|---|---|---|---|
| | | | AM | PM |
| I-29 | Avenue G to I-480 | SB | E | B |
| | I-480 to 9th Avenue | SB | C | D |
| | Nebraska Avenue to I-80 | SB | B | B |
| | I-80 to Highway 275/92 | NB | C | B |
| I-80/I-29 | S. Expressway to East System Interchange | EB | B | C |
| | | WB | C | C |

### 4.2.17 Ramp Junction Level of Service

Ramp junctions refer the merge and diverge areas created by the intersection of a freeway and a ramp. The ramp junctions of all system interchanges and service interchanges in the study area were analyzed, unless weaving analysis procedures were determined to be applicable. Ramp roadways which connect the freeway with another freeway or with a surface street (sometimes referred to as the ramp proper) were not analyzed.

***Methodology/Definitions/Assumptions***

Ramp junction areas were analyzed based on Chapter 5 procedures (Ramps and Ramp Junctions) of the HCM and performed using the HCS.

By definition, the LOS for a typical ramp-freeway junction is primarily measured in vehicular density in the influence area of the ramp. The average speed of vehicles is used as a secondary parameter for the LOS. LOS A through E are described as follows:

| LOS | Max. Density (pc/mi/ln) | Min. Speed (mph) |
|---|---|---|
| A | 10 | 58 |
| B | 20 | 56 |
| C | 28 | 52 |
| D | 35 | 46 |
| E | >35 | 42 |

LOS F indicates a breakdown condition. The limit of the measurement varies depends on the number of lanes on the freeway, and whether it is a merge or diverge area.

The guidelines in the HCM for major merge and major diverge analysis were consulted and evaluated because the HCS does not provide readily available tools. A major merge is formed by two primary multiple-lane freeways merging into one freeway segment. A major diverge is the same but with reversed direction of travel. Both major merge and major diverge exist in the system interchanges in the study area.

The HCM suggests the analysis of major merge be limited to a capacity check, which does not provide quantitative level of evaluations like LOS, as for other locations of the freeway system. The project team adopted a flexible approach using different methods to assess the LOS for those major merge locations. One method to approximate the LOS was to use HCS as one would for regular merges but to specify a two-lane on ramp at its full acceleration length. The "ramp" was assigned to the leg with lighter traffic, and the free flow speed of the ramp was indicated as that of the freeway. The other method was to regard the downstream area as a freeway segment, then compare the calculated LOS with the adjacent ramp influence areas for necessary adjustments. The application of the two methods depended primarily on the geometry and channelization of the ramps.

A simple formula for major diverge analysis is presented in the HCM. It was strictly applied to major diverge analysis in this study. The alternative methods for major merge analysis described above were also used for major diverge in the corresponding terms.

***Rating Criteria***

Ratings such as "Good", "Fair" and "Poor" were not applied to the results of the ramp junction level of service analysis. Rather, the results are presented below and in Appendix A using the six levels of service (A through F) as defined by the Highway Capacity Manual.

***Results***

Table 6 on the next page summarizes the results of the analysis of ramp junctions in the study area. Table 6 indicates that most ramp junctions are operating at LOS C or better during the morning and afternoon peak hours. Exceptions include the Eastbound I-80/I-29 off ramp to the South Expressway which operates at LOS D during the PM peak hour, the Eastbound I-80/I-29 off ramp to S. 24th Street which operates at LOS D during the PM peak hour, and the Westbound I-80/I-29 off ramp to S. 24th Street which operates at LOS D during the AM peak hour. An overall assessment of ramp junction level of service is provided graphically in Appendix A.

### 4.2.18 Signalized Intersection Level of Service

Level of service analyses were performed for each of the corresponding ramp-street junctions in the study area. Ramp-street junctions that are currently signalized are summarized in this section. Ramp-street junctions that are currently unsignalized are summarized in the next section.

***Methodology/Definitions/Assumptions***

Level of service analyses were performed following Chapter 9 procedures (Signalized Intersections) of the HCM. SYNCHRO 3.0, a computerized analytical tool based on the HCM, was utilized to evaluate the operational characteristics of signalized intersections.

*TABLE 6 - Ramp Junction LOS Summary*

| Interchange | Ramp | LOS AM | LOS PM |
|---|---|---|---|
| Highway 6 & I-80 | EB Off Ramp | A | B |
| | EB On Ramp | A | A |
| | WB Off Ramp | A | A |
| | EB On Ramp | B | A |
| Madison & I-80 | EB Off Ramp | A | C |
| | EB On Ramp | A | B |
| | WB Off Ramp | A | A |
| | EB On Ramp | B | B |
| Highway 275/92 & I-29 | NB Off Ramp | A | A |
| | NB On Ramp | See Weaving Analysis | See Weaving Analysis |
| | SB Off Ramp | A | A |
| | SB On Ramp | A | A |
| East I-80/I-29 System Interchange | NB I-29/EB I-80 Diverge | See Weaving Analysis | See Weaving Analysis |
| | WB I-80/SB I-29 Merge | A | A |
| | WB I-80/SB I-29 Diverge | B | B |
| | NB I-29/EB I-80 Merge | A | B |
| | EB I-80/SB I-29 Diverge | See Weaving Analysis | See Weaving Analysis |
| | WB I-80/NB I-29 Merge | See Weaving Analysis | See Weaving Analysis |
| S. Expressway & I-80/I-29 | EB Off Ramp | B | D |
| | EB On Ramp | See Weaving Analysis | See Weaving Analysis |
| | WB Off Ramp | See Weaving Analysis | See Weaving Analysis |
| | WB On Ramp | C | B |
| 24th Street & I-80/I-29 | EB Off Ramp | B | D |
| | EB On Ramp | B | C |
| | WB Off Ramp | D | C |
| | WB On Ramp | B | B |
| West I-80/I-29 System Interchange | NB I-29/WB I-80 Diverge | B | B |
| | EB I-80/SB I-29 Merge | A | C |
| | EB I-80/NB I-29 Diverge | B | C |
| | SB I-29/WB I-80 Merge | B | B |
| | WB I-80/SB I-29 Diverge | See Weaving Analysis | See Weaving Analysis |
| | EB I-80/NB I-29 Merge | B | B |
| Nebraska Avenue & I-29 | NB Off Ramp | B | B |
| | NB On Ramp | B | B |
| | SB Off Ramp | A | B |
| | SB On Ramp | See Weaving Analysis | See Weaving Analysis |
| 9th Avenue & I-29 | NB Off Ramp | B | B |
| | NB On Ramp | B | B |
| | SB Off Ramp | See Weaving Analysis | See Weaving Analysis |
| | SB On Ramp | B | B |
| I-29/I-480 System Interchange | NB I-29/WB I-480 Diverge | B | B |
| | SB I-29/EB I-480 Merge | See Weaving Analysis | See Weaving Analysis |
| | EB I-480/NB&SB I-29 Diverge | A | B |
| | WB I-480/NB&SB I-29 Merge | B | A |
| | SB I-29/WB I-480 Diverge | See Weaving Analysis | See Weaving Analysis |
| | NB I-29/EB I-480 Merge | A | A |

*TABLE 6 (Cont.)*

| Interchange | Ramp | LOS AM | LOS PM |
|---|---|---|---|
| Avenue G & I-29 | SB Off Ramp | A | A |
| | SB On Ramp | See Weaving Analysis | See Weaving Analysis |
| 35th Street G & I-29 | NB Off Ramp | A | A |
| | NB On Ramp | A | A |
| 25th Street & I-29 | NB Off Ramp | A | A |
| | NB On Ramp | A | A |
| | SB Off Ramp | A | A |
| | SB On Ramp | A | A |
| Highway 192 & I-29 | SB Off Ramp | A | A |
| | NB On Ramp | A | B |

Level of service for signalized intersections is defined in terms of average stopped delay per vehicle for a 15-minute analysis period. This delay is a measure of driver discomfort and frustration, fuel consumption, and lost travel time and is dependent upon a number of variables such as quality of progression, the cycle length, the green ratio, and the v/c ratio for a given lane group. LOS A through E are described on the next page.

***Rating Criteria***

Ratings such as "Good", "Fair" and "Poor" were not applied to the results of the signalized intersection level of service analysis. Rather, the results are presented below and in Appendix A using the six levels of service (A through F) as defined by the Highway Capacity Manual.

| LOS | Average Stopped Delay Per Vehicle (sec) |
|---|---|
| A | $\leq 5.0$ |
| B | $> 5.0$ and $\leq 15.0$ |
| C | $> 15.0$ and $\leq 25.0$ |
| D | $> 25.0$ and $\leq 40.0$ |
| E | $> 40.0$ and $\leq 60.0$ |
| F | $> 60.0$ |

***Results***

Table 7 on the next page summarizes the results of the analysis of signalized intersections in the study area. Table 7 indicates that most signalized intersections in the study area are operating at LOS C or better during the AM and PM peak hours. This is generally true for the intersection as a whole and for specific movements. Exceptions include the intersection of the South Expressway with Westbound I-80 ramps where the southbound through movement operates at LOS D during the PM peak hour and at the intersection of the South Expressway with Eastbound I-80 ramps where the Northbound left-turn movement operates at LOS D during the PM peak hour. An overall assessment of signalized intersection level of service is provided graphically in Appendix A.

*TABLE 7 - Signalized Intersection LOS Summary*

| Intersection | | | AM LOS | AM V/C Ratio | AM Delay (s/veh) | PM LOS | PM V/C Ratio | PM Delay (s/veh) |
|---|---|---|---|---|---|---|---|---|
| Madison Avenue & EB I-80 Off Ramp | NB Madison | Thru/Right | B | 0.44 | 8.4 | B | 0.45 | 9.6 |
| | SB Madison | Left | A | 0.07 | 3.5 | A | 0.36 | 4.9 |
| | | Thru | A | 0.17 | 3.8 | B | 0.52 | 6.3 |
| | EB Off Ramp | Left | B | 0.24 | 7.7 | B | 0.57 | 9.5 |
| | | Thru | B | 0.24 | 7.7 | B | 0.57 | 9.5 |
| | | Right | B | 0.12 | 7.3 | B | 0.47 | 8.7 |
| | Intersection Total | | B | 0.29 | 7.3 | B | 0.54 | 8.4 |
| South Expressway & EB I-80/SB I-29 Off Ramp | NB Expressway | Left | B | 0.29 | 6.3 | C | 0.69 | 18.8 |
| | | Thru/Right | B | 0.36 | 11.3 | B | 0.76 | 13.1 |
| | SB Expressway | Left | A | 0.11 | 2.1 | B | 0.05 | 13.9 |
| | | Thru | B | 0.44 | 5.1 | D | 0.87 | 31.6 |
| | EB Off Ramp | Left/Thru | B | 0.64 | 12.4 | C | 0.70 | 22.1 |
| | | Right | B | 0.66 | 7.4 | B | 0.80 | 13.6 |
| | Intersection Total | | B | 0.55 | 8.4 | C | 0.82 | 19.8 |
| South Expressway & WB I-80/SB I-29 Off Ramp | NB Expressway | Left | B | 0.45 | 12.6 | D | 0.66 | 26.2 |
| | | Thru/Right | A | 0.27 | 4.1 | A | 0.43 | 2.2 |
| | SB Expressway | Thru | B | 0.33 | 12.8 | C | 0.70 | 23.0 |
| | EB Off Ramp | Left/Thru | B | 0.25 | 9.7 | C | 0.42 | 22.7 |
| | WB Frontage | Left/Thru/Right | B | 0.08 | 9.1 | C | 0.25 | 21.3 |
| | Intersection Total | | B | 0.39 | 8.9 | B | 0.61 | 14.4 |
| 24th Street & EB I-80/SB I-29 Off Ramp | NB 24th | Thru/Right | B | 0.34 | 7.4 | B | 0.46 | 10.1 |
| | SB 24th | Left/Thru | A | 0.17 | 2.8 | B | 0.43 | 5.6 |
| | EB Off Ramp | Left | B | 0.47 | 11.3 | B | 0.45 | 8.1 |
| | | Thru/Right | B | 0.21 | 10.0 | B | 0.36 | 7.7 |
| | Intersection Total | | B | 0.35 | 7.2 | B | 0.45 | 7.8 |
| 24th Street & WB I-80/SB I-29 Off Ramp | NB 24th | Left/Thru | A | 0.46 | 4.3 | B | 0.61 | 6.0 |
| | SB 24th | Thru/Right | B | 0.44 | 9.5 | B | 0.52 | 9.8 |
| | WB Off Ramp | Left | B | 0.11 | 9.4 | B | 0.14 | 9.2 |
| | | Thru/Right | B | 0.44 | 10.9 | B | 0.33 | 10.1 |
| | Intersection Total | | B | 0.44 | 7.3 | B | 0.45 | 8.1 |
| Nebraska Avenue & NB I-29 Off Ramp | SB Off Ramp | Left | B | 0.13 | 6.0 | B | 0.26 | 9.7 |
| | | Right | A | 0.16 | 2.9 | B | 0.14 | 5.5 |
| | EB Nebraska | Left | B | 0.11 | 5.4 | A | 0.28 | 4.5 |
| | | Thru/Right | B | 0.26 | 6.0 | A | 0.26 | 4.9 |
| | WB Nebraska | Thru/Right | B | 0.46 | 11.3 | B | 0.57 | 10.7 |
| | Intersection Total | | B | 6.80 | 6.8 | B | 0.40 | 7.8 |
| Nebraska Avenue & SB I-29 Off Ramp | NB River | Left | B | 0.05 | 12.1 | B | 0.00 | 7.4 |
| | | Thru/Right | B | 0.05 | 12.1 | B | 0.18 | 12.5 |
| | SB Off Ramp | Left | B | 0.29 | 8.5 | B | 0.31 | 8.5 |
| | | Thru | B | 0.03 | 12.0 | B | 0.01 | 12.0 |
| | | Right | B | 0.08 | 7.8 | B | 0.16 | 8.1 |
| | EB Nebraska | Left | B | 0.07 | 5.3 | B | 0.03 | 5.2 |
| | | Thru/Right | B | 0.23 | 9.6 | B | 0.49 | 11.1 |
| | WB Nebraska | Left | B | 0.07 | 5.2 | B | 0.40 | 6.0 |
| | | Thru/Right | B | 0.14 | 9.2 | B | 0.24 | 9.6 |
| | Intersection Total | | B | 0.24 | 8.5 | B | 0.39 | 9.4 |

*TABLE 7 (Cont.)*

| Intersection | | | AM LOS | AM V/C Ratio | AM Delay (s/veh) | PM LOS | PM V/C Ratio | PM Delay (s/veh) |
|---|---|---|---|---|---|---|---|---|
| 9th Avenue & NB I-29 Off Ramp | NB Off Ramp | Left | B | 0.13 | 8.4 | B | 0.13 | 7.2 |
| | | Thru | B | 0.16 | 8.5 | B | 0.17 | 7.3 |
| | | Right | B | 0.42 | 9.6 | B | 0.61 | 10.4 |
| | EB 9th | Left | A | 0.16 | 3.5 | B | 0.26 | 6.1 |
| | | Thru | A | 0.13 | 3.6 | B | 0.32 | 6.8 |
| | WB 9th | Thru/Right | B | 0.60 | 8.9 | B | 0.48 | 11.2 |
| | Intersection Total | | B | 0.47 | 8.3 | B | 0.52 | 9.4 |
| 9th Avenue & SB I-29 Off Ramp | SB Off Ramp | Left | B | 0.23 | 12.2 | B | 0.45 | 11.8 |
| | | Thru/Right | B | 0.12 | 11.8 | B | 0.24 | 10.7 |
| | EB 9th | Thru/Right | B | 0.30 | 10.7 | B | 0.39 | 8.9 |
| | WB 9th | Left/Thru | A | 0.41 | 3.4 | A | 0.31 | 3.3 |
| | Intersection Total | | B | 0.31 | 5.7 | B | 0.39 | 7.1 |

### 4.2.19 Unsignalized Intersection Level of Service

This section summarizes the level of service analyses that were performed for unsignalized ramp-street junctions in the study area.

***Methodology/Definitions/Assumptions***

Level of service analyses were analyzed based on Chapter 10 procedures (Unsignalized Intersections) of the HCM and performed using the HCS.

Level of service for unsignalized intersections is defined in terms of the average total delay per vehicle for a 15-minute analysis period. Total delay is defined as the total elapsed time from when a vehicle stops at the end of the queue until the vehicle departs from the stop line. The average total delay for any particular minor movement is a function of the service rate or capacity of the approach and the degree of saturation. LOS A through E are described as follows:

| LOS | Average Total Delay Per Vehicle (sec) |
|---|---|
| A | ≤5.0 |
| B | > 5.0 and ≤ 10.0 |
| C | > 10.0 and ≤ 20.0 |
| D | > 20.0 and ≤ 30.0 |
| E | > 30.0 and ≤ 45.0 |
| F | > 45.0 |

### *Rating Criteria*

Ratings such as "Good", "Fair" and "Poor" were not applied to the results of the unsignalized intersection level of service analysis. Rather, the results are presented below and in Appendix A using the six levels of service (A through F) as defined by the Highway Capacity Manual.

### *Results*

Table 8 summarizes the results of the analysis of unsignalized intersections in the study area. Table 8 indicates that most unsignalized intersections in the study area are operating at LOS C or better during the AM and PM peak hours. Exceptions include the intersection of Madison Avenue and the Westbound I-80 ramps where the westbound left turn movement (from the I-80 off ramp) is operating at LOS F during the PM peak hour and the intersection of Highway 275/92 and the intersection Northbound I-29 off ramp where the northbound left turn movement (from I-29 off ramp) is operating at LOS E during the PM peak hour.

An overall assessment of unsignalized intersection level of service is provided graphically in Appendix A.

***TABLE 8 - Unsignalized Intersection LOS Summary***

| Int./Approach/Movement | | | AM | | PM | |
|---|---|---|---|---|---|---|
| | | | LOS | Delay (s/veh) | LOS | Delay (s/veh) |
| Highway 6 & EB I-80 Off Ramp | EB Highway 6 | Left | A | 3.9 | A | 3.0 |
| | NB Off Ramp | Left | C | 13.9 | C | 18.2 |
| | | Right | A | 2.8 | A | 3.4 |
| | Intersection Total | | | 3.6 | | 5.9 |
| Highway 6 & WB I-80 Off Ramp | WB Highway 6 | Left | A | 3.6 | A | 3.9 |
| | SB Off Ramp | Left | C | 13.1 | C | 11.9 |
| | | Right | A | 3.7 | A | 3.5 |
| | Intersection Total | | | 1.4 | | 0.6 |
| Madison Avenue & WB I-80 Off Ramp | NB Madison | Left | B | 6.4 | B | 8.7 |
| | WB Off Ramp | Left | C | 18.9 | **F** | 109.3 |
| | | Right | A | 3.9 | B | 5.6 |
| | Intersection Total | | | 1.4 | | 3.2 |
| Highway 275/92 & NB I-29 Off Ramp | NB Off Ramp | Left | B | 9.4 | E | 36.7 |
| | | Right | A | 2.9 | A | 4.9 |
| | Intersection Total | | | 1.9 | | 1.8 |
| Highway 275/92 & SB I-29 On Ramp | WB 275/92 | Left | A | 2.5 | B | 5.3 |
| | Intersection Total | | | 0.1 | | 0.1 |
| 41st Street & EB I-480 Off Ramp | SB 41st | Left | A | 2.2 | A | 2.2 |
| | EB Off Ramp | Left | A | 4.2 | A | 4.6 |
| | | Thru/Right | A | 3.6 | A | 3.9 |
| | WB S. 37th | Left | A | 3.9 | A | 4.5 |
| | | Right | A | 2.9 | A | 2.9 |
| | Intersection Total | | | 2.3 | A | 3.1 |
| 41st Street & WB I-480 On Ramp | SB Dodge Park | Left | A | 2.2 | A | 2.4 |
| | WB Avenue A | Left/Thru/Right | A | 4.4 | A | 4.2 |
| | NB 41st | Left | A | 2.2 | A | 2.1 |
| | Intersection Total | | | 2.8 | | 1.5 |
| Avenue G & | NB Benson | Left/Thru/Right | A | 4.5 | A | 3.8 |
| SB I-29 Off Ramp | SB Off Ramp | Left/Thru/Right | B | 5.2 | B | 5.1 |
| | EB Avenue G | Left | A | 3.1 | A | 3.0 |
| | WB Avenue G | Left | A | 2.3 | A | 2.4 |
| | Intersection Total | | | 0.6 | | 0.9 |
| 25th Street & NB I-29 Off Ramp | EB Off Ramp | Left | C | 10.5 | B | 6.1 |
| | | Right | A | 3.3 | B | 6.1 |
| | SB 25th | Left | A | 4.5 | A | 3.2 |
| | Intersection Total | | | 1.0 | | 3.8 |
| 25th Street & SB I-29 Off Ramp | WB Off Ramp | Left | C | 19.4 | B | 7.3 |
| | | Right | A | 2.7 | A | 2.7 |
| | NB 25th | Left | A | 3.5 | A | 2.7 |
| | Intersection Total | | | 4.6 | | 2.6 |

# CHAPTER 5: SUMMARY AND CONCLUSIONS

## 5.1 SUMMARY

The results of Phase I - Analysis of Existing Conditions of the Council Bluffs Interstate System Needs Study is summarized below for each of the criteria and considerations that were evaluated.

**Pavement**
The assessment of the existing pavement in the study area indicated that most of interstate pavement is in fair to poor condition. Pavement on I-80 from the Missouri River Bridge to the East I-80/I-29 System Interchange, and on I-29 from I-80 north to 9th Avenue was rated poor. The remainder of the system was rated fair except for I-29 from N. 25th Street to the north city limits, which was rated good.

**Highway Structures**
The existing condition of highway structures is relatively good. Of the 45 structures reviewed a total of 8 were rated poor. These include:

- EB I-80 over RR and pond, east of the East I-80/I-29 System Interchange
- EB and WB I-80 over Old Highway 375
- EB and WB I-80 over abandoned RR, south of Madison Avenue
- I-480 over 41st Street
- West-to-North I-480 ramp over SB I-29
- NB I-29 over SB Highway 192

**Horizontal alignment**
A majority of the horizontal curves in the study area meet or exceed the criteria to achieve a design speed of 70 mph, except at the three system interchanges where about half of the horizontal curves received a rating of either fair or poor. Good ratings were assigned to all other horizontal curves in the study area except for the following two areas:

- The northbound lanes of I-29 near the Highway 192 on ramp were rated fair
- The northbound and southbound lanes of I-29 north of Avenue G were rated poor.

**Vertical alignment**
The entire mainline vertical alignment received a rating of good, based on grade. When combined with the effects of the length of grade, Eastbound I-80, east of McPherson Avenue, received a rating of poor. This section results in a speed reduction for trucks of over 15 mph.

**Stopping sight distance**
The analysis of stopping sight distance was based on AASHTO criteria established for a 70 mph design speed and revealed the following:

- Of the 45 crest vertical curves, 18 were rated good, 10 were rated fair, and 17 were rated poor.
- 14 of the crest curves that were rated poor are located at or near the I-29/I-480 interchange.

**Cross section**
Overall, the existing interstate cross-section in the study area rated good based on the lane, shoulder and median width. The ratings were then adjusted down if the existing foreslope is less then current design standards. Several sections of I-29 and I-80 were rated as fair based on foreslope criteria.

**Decision sight distance**
Decision sight distance is adequate at a majority of the critical locations evaluated along the interstate system. Overall, 33 locations along the study area were analyzed for adequate decision sight distance, of which 28 received a rating of good, three received a rating of fair, and two received a rating of poor. All of the areas analyzed on I-80 received a good rating.

**Exit and entrance ramp design**
The design of exit ramps along the interstate mainline, excluding cloverleaf types, are adequate. All loop and cloverleaf ramps in the study area do not have the adequate acceleration or deceleration lengths required to merge to/from the design speed of the interstate. A majority of the entrance ramps, based on both taper length and/or acceleration length, are inadequately designed.

**Basic number of lanes**
There are no violations of the principles of basic number of lanes within the study area. Two basic lanes are provided in each direction throughout the study area. Additional lanes are provided in some segments of the study area. However, these lanes represent auxiliary lanes in that they are not of substantial length and they are provided to serve traffic moving to and from local and system interchanges.

**Lane and route continuity**
In general, relatively good route continuity is provided for each directional path. Exceptions include the major merge diverge points at the East and West I-80/I-29 System Interchanges where vehicles must make a lane change to continue on their designated path.

**Lane balance**
Overall, lane balance is generally maintained throughout the Council Bluffs interstate system. Exceptions to this include the Westbound I-80/I-29 off ramp to the South Expressway, the Eastbound I-80 off ramp to Northbound I-29 at the West I-80/I-29 System Interchange, the Southbound I-29 off ramp to 9th Avenue, the Eastbound I-480 split between West Broadway and Northbound/Southbound I-29, and the Southbound I-29 off ramp to Westbound I-480.

**Ramp sequence and spacing**
Of the 46 ramp pairs that were evaluated, eight pairs were found to have spacing less than the AASHTO minimum. These include:

- Northbound I-29 between Highway 275/92 and the East I-80/I-29 System Interchange.
- Northbound I-29 between 9th Avenue and the I-29/I-480 System Interchange.
- Southbound I-29 between Avenue G and the I-29/I-480 System Interchange.
- Southbound I-29 between the I-29/I-480 System Interchange and 9th Avenue.
- Eastbound I-480 between 41st Street and the Northbound/Southbound I-29 split
- Westbound I-480 between Northbound/Southbound I-29 merge and 41st Street.

**Guide signing**
The review of guide signs in the study area found that most of the signs are properly designed and provide the information necessary for unfamiliar drivers to make informed decisions. The following observations were made for the study area as a whole:

- The gore sign is missing at some exit ramps.
- Route markers and trailblazers are often absent from the system.
- Add-on panels with commercial content cause non-standard sign layouts.
- Signing for Eppley Airfield is generally inadequate.

**Safety**
The following observations summarize the mainline accident rates:

- The I-29/I-80 corridor has an accident rate mostly in the fair category.
- The areas that were rated as "good" tend to be more rural in nature. The "good" areas are located on I-80 east of Madison Avenue, on I-29 south of the East I-80/I-29 System Interchange and I-29 north of the I-29/I-480 System Interchange.
- The areas that were ranked as "poor" are as follows:
  - Eastbound I-80 at Madison Avenue
  - Westbound I-80 at the East I-80/I-29 System Interchange
  - Northbound I-29 at the I-29/I-480 System Interchange
  - Eastbound and Westbound I-480
- The accident rate tends to increase at the system interchanges. This is somewhat expected due to left handed entrance/exit ramps and increased decision requirements.
- I-480 is currently experiencing the highest main-line accident rate in the system. This can probably be attributed to the relatively high traffic volumes and closely spaced ramps.

**Freeway level of service**
Most freeway segments in the study area are operating at LOS C or better. Exceptions include Eastbound I-80/I-29 between the West System Interchange and S. 24th Street during the PM peak hour and Eastbound and Westbound I-80/I-29 between S. 24th Street and the South Expressway during both peak hours.

**Weaving level of service**
The weaving segment on Southbound I-29 between Avenue G and the I-29/I-480 System Interchange is operating at LOS E in the AM peak hour. In addition, the weaving segment on Northbound I-29 between 9th Avenue and the I-29/I-480 System Interchange is operating at LOS D in the PM peak hour. All other weaving segments are currently operating at LOS C or better.

**Ramp junction level of service**
Most ramp junctions are operating at LOS C or better during the morning and afternoon peak hours. Exceptions include the Eastbound I-80/I-29 off ramp to the South Expressway which operates at LOS D during the PM peak hour, the Eastbound I-80/I-29 off ramp to S. 24th Street which operates at LOS D during the PM peak hour, and the Westbound I-80/I-29 off ramp to S. 24th Street which operates at LOS D during the AM peak hour.

**Signalized intersection level of service**
Most signalized intersections in the study area are operating at LOS C or better during the AM and PM peak hours. This is generally true for the intersection as a whole and for specific movements. Exceptions include the intersection of the South Expressway with Westbound I-80 ramps where the southbound through movement operates at LOS D during the PM peak hour and at the intersection of the South Expressway with Eastbound I-80 ramps where the Northbound left-turn movement operates at LOS D during the PM peak hour.

**Unsignalized intersection level of service**
Most unsignalized intersections in the study area are operating at LOS C or better during the AM and PM peak hours. Exceptions include the intersection of Madison Avenue and the Westbound I-80 ramps where the westbound left turn movement (from the I-80 off ramp) is operating at LOS F during the PM peak hour and the intersection of Highway 275/92 and the intersection Northbound I-29 off ramp where the northbound left turn movement (from I-29 off ramp) is operating at LOS E during the PM peak hour.

## 5.2 CONCLUSIONS

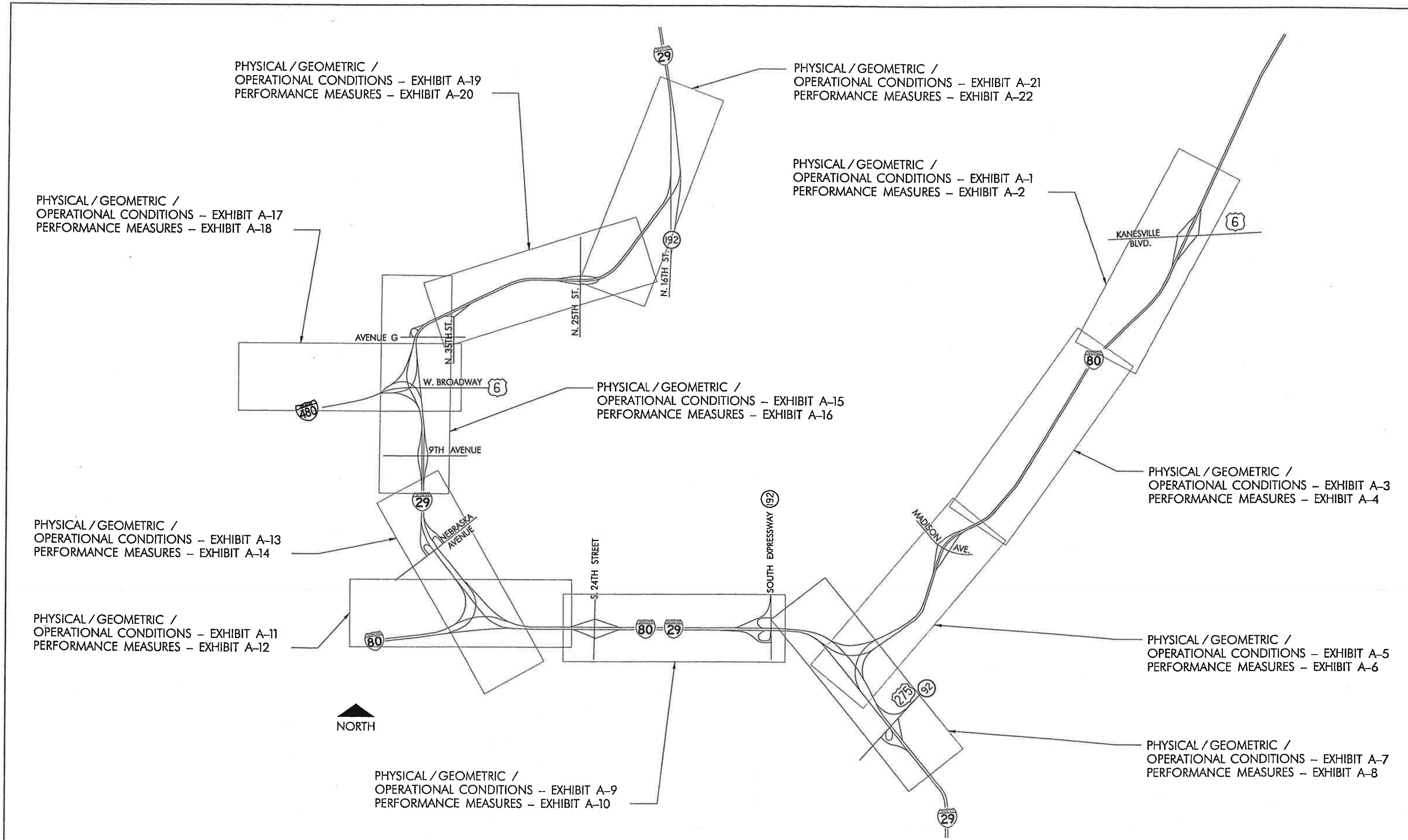
The results of the analysis of existing conditions in the Council Bluffs interstate system indicate that many features of the system do not meet current design standards, guidelines or operational criteria. However, it is recognized that much of the interstate system was designed and built to the standards of the 1960's. The application of current criteria and standards was performed to provide an indication of the problems and deficiencies of the existing system.

This report does not contain or construe any recommendations regarding improvements to the interstate system. Such recommendations will be developed at later stages of this study and will be based on the results of this assessment of existing conditions and a subsequent assessment of future travel demands in the study area.

# APPENDIX A

**Physical/Geometric/Operational Conditions Exhibits**

**Performance Measures Exhibits**

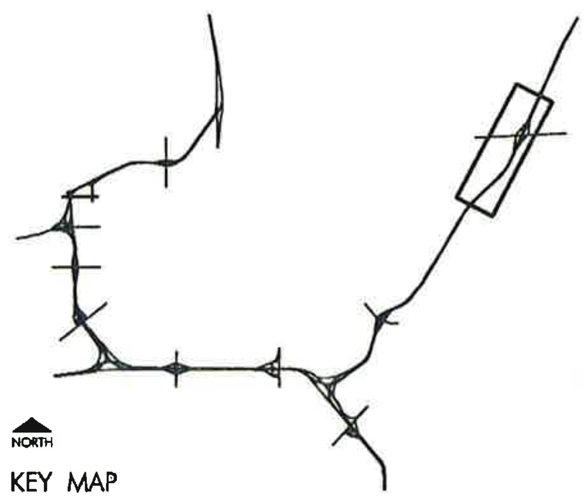


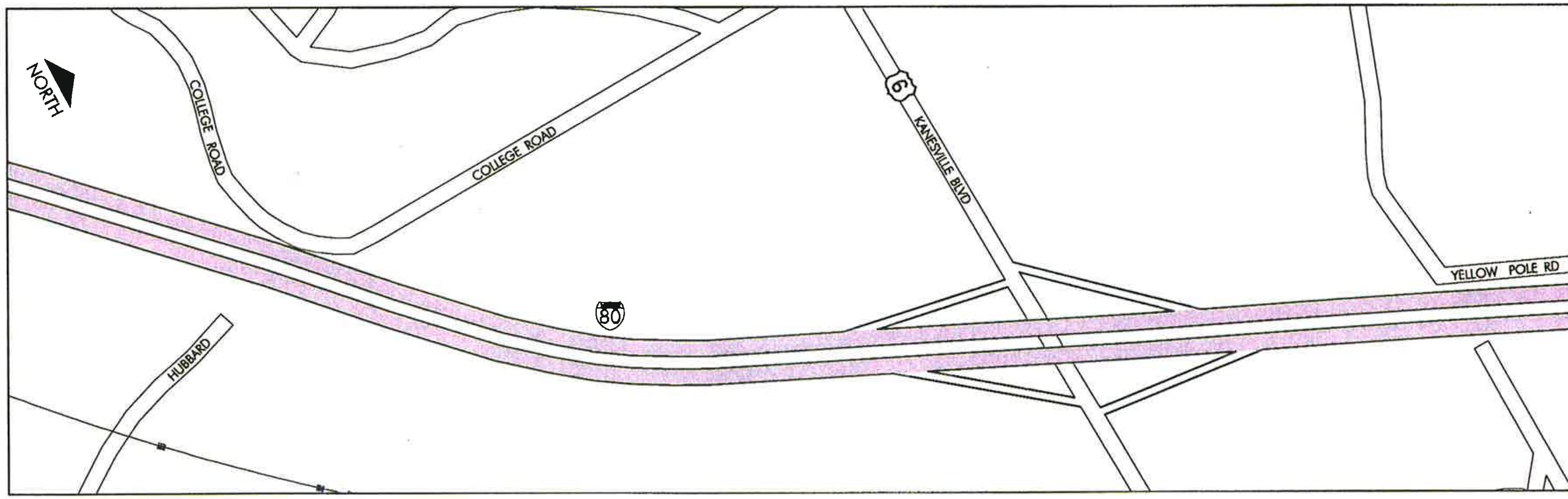

| HDR<br>HDR Engineering, Inc. / hgm ASSOCIATES INC. | Metropolitan Area Planning Agency<br>COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY<br>PHASE 1 REPORT SEPTEMBER 1997 | **KEY MAP** | EXHIBIT<br>– |
|---|---|---|---|

| | | |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SIGNING | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SAFETY | FAIR FAIR 62 ACC/HMVM FAIR FAIR / FAIR FAIR FAIR FAIR 100 ACC/HMVM FAIR FAIR FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD GOOD GOOD |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | GOOD / GOOD GOOD |
| | CROSS SECTION | FAIR FAIR FAIR FAIR FAIR / POOR POOR POOR POOR POOR POOR / GOOD GOOD GOOD |
| | DECISION SIGHT DISTANCE | GOOD GOOD |
| | EXIT & ENTRANCE DESIGN | GOOD / GOOD GOOD |
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | GOOD |
| | PAVEMENT | FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR |

LEGEND

- GOOD — GOOD CONDITIONS
- FAIR — FAIR CONDITIONS
- POOR — POOR CONDITIONS
- NA — NOT APPLICABLE



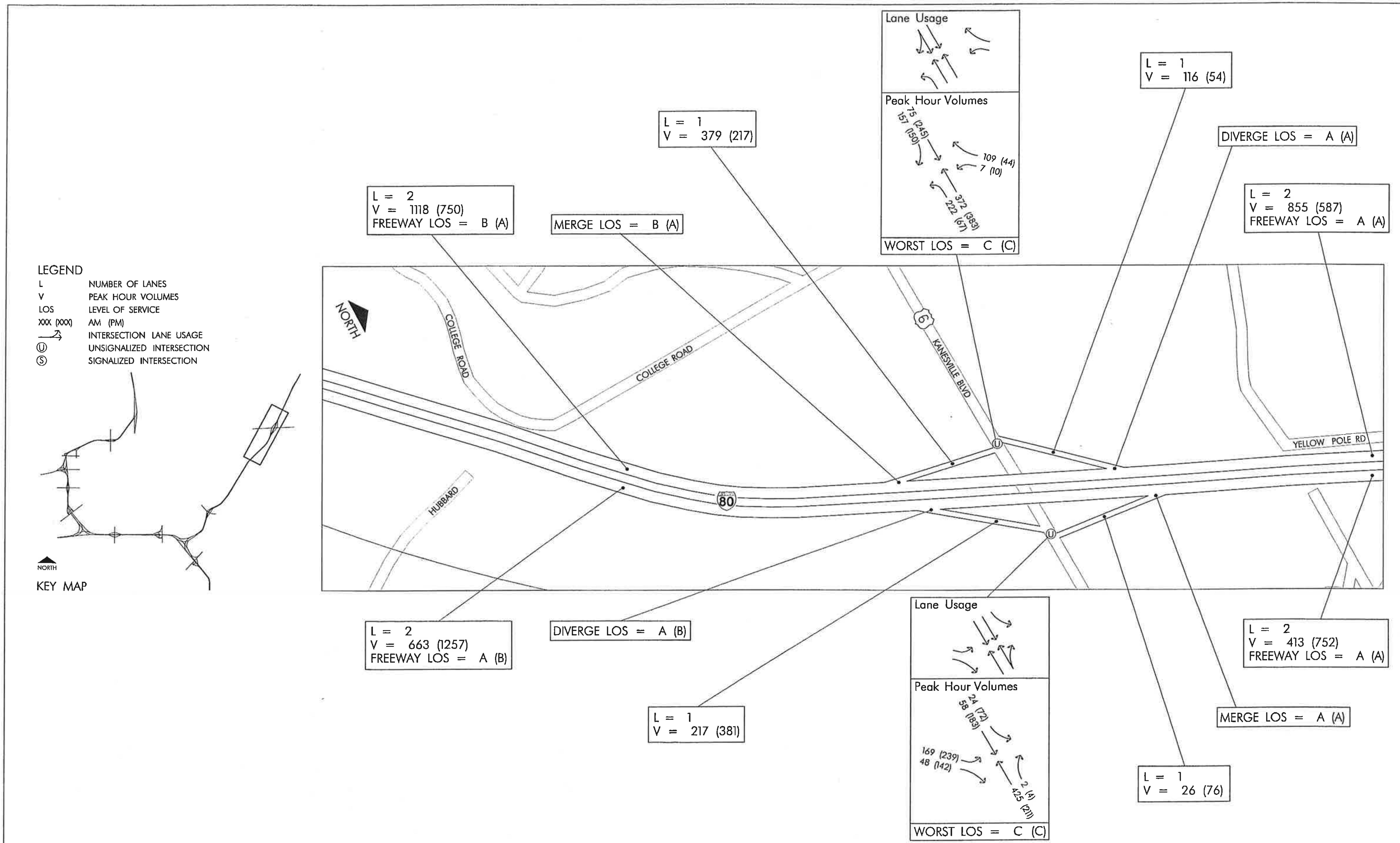

| | | |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | GOOD |
| | PAVEMENT | FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD GOOD GOOD |
| | VERTICAL ALIGNMENT | POOR POOR POOR / GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | GOOD / GOOD GOOD |
| | CROSS SECTION | FAIR FAIR FAIR FAIR FAIR / POOR POOR POOR POOR POOR POOR / GOOD GOOD GOOD |
| | DECISION SIGHT DISTANCE | GOOD GOOD |
| | EXIT & ENTRANCE DESIGN | GOOD GOOD / FAIR FAIR |
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SIGNING | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SAFETY | GOOD GOOD 62 ACC/HMVM GOOD / FAIR FAIR FAIR FAIR 100 ACC/HMVM FAIR FAIR FAIR |



I-80 - COLLEGE ROAD TO US 6

**PHYSICAL /GEOMETRIC/OPERATIONAL CONDITIONS**

EXHIBIT A-1

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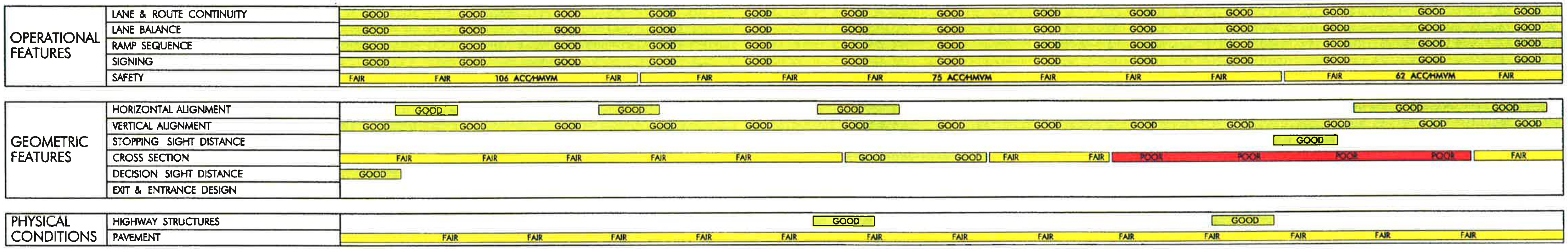
PHASE 1 REPORT SEPTEMBER 1997

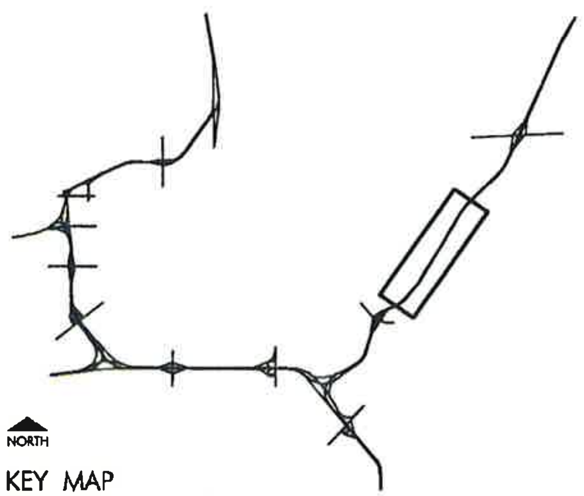
I-80 - COLLEGE ROAD TO US 6
**PERFORMANCE MEASURES**

EXHIBIT A-2

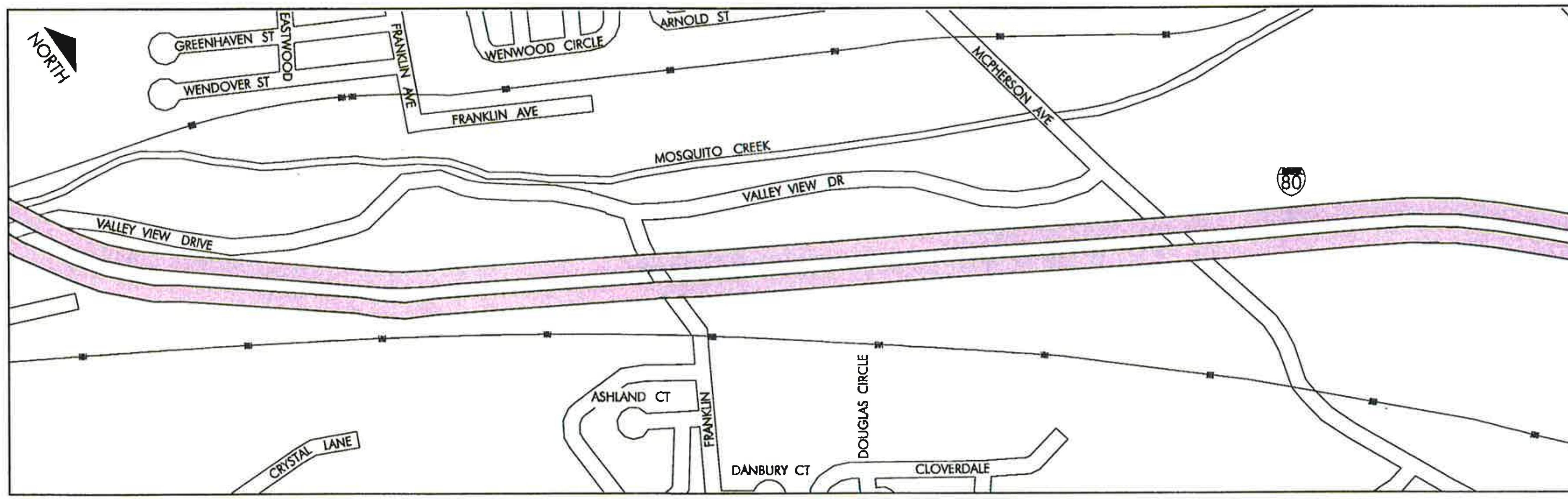


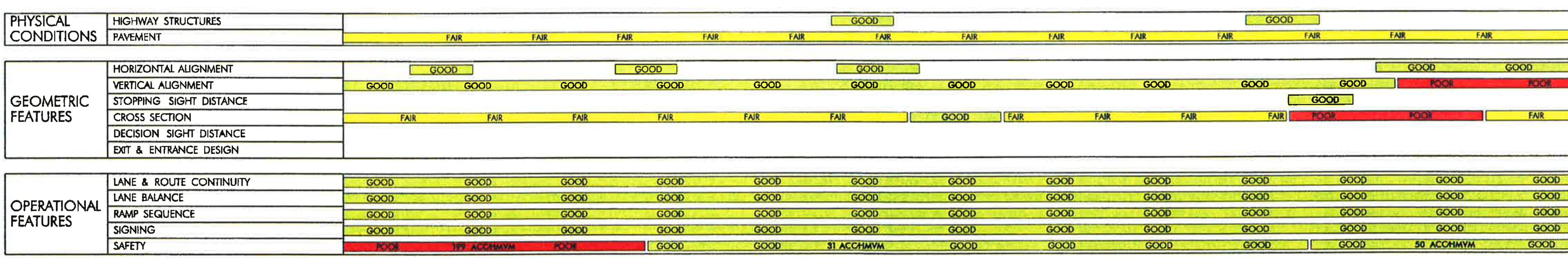

LEGEND

| | |
|---|---|
| GOOD | GOOD CONDITIONS |
| FAIR | FAIR CONDITIONS |
| POOR | POOR CONDITIONS |
| NA | NOT APPLICABLE |




KEY MAP

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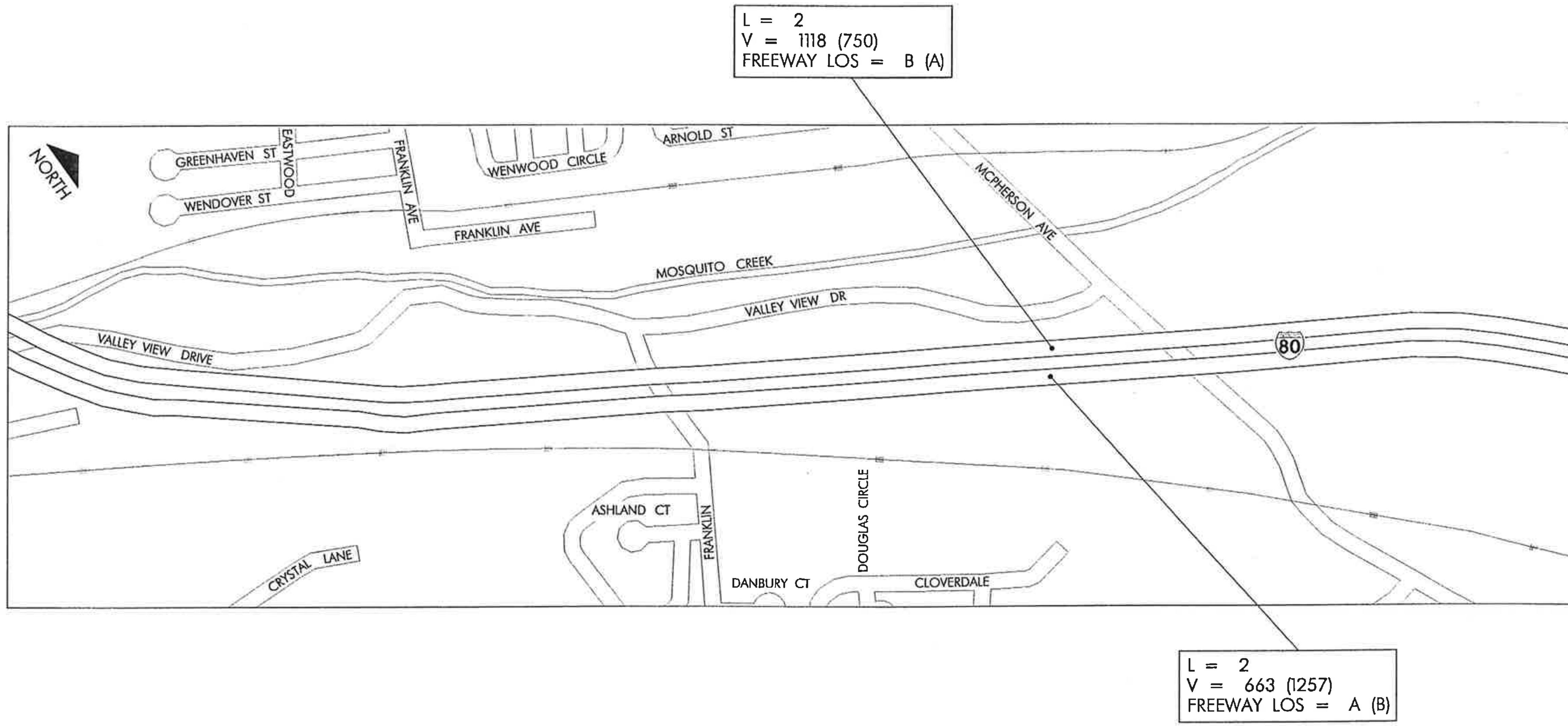
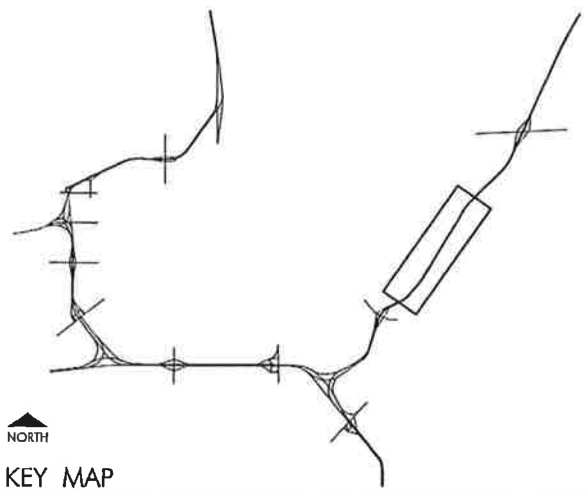
I-80 - VALLEY VIEW DRIVE TO MCPHERSON AVENUE
**PHYSICAL /GEOMETRIC/OPERATIONAL CONDITIONS**

EXHIBIT
**A-3**




LEGEND

| | |
|---|---|
| L | NUMBER OF LANES |
| V | PEAK HOUR VOLUMES |
| LOS | LEVEL OF SERVICE |
| XXX (XXX) | AM (PM) |
| → | INTERSECTION LANE USAGE |
| Ⓤ | UNSIGNALIZED INTERSECTION |
| Ⓢ | SIGNALIZED INTERSECTION |




KEY MAP

HDR Engineering, Inc. | hgm ASSOCIATES INC.

Metropolitan Area Planning Agency
COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY
PHASE 1 REPORT SEPTEMBER 1997

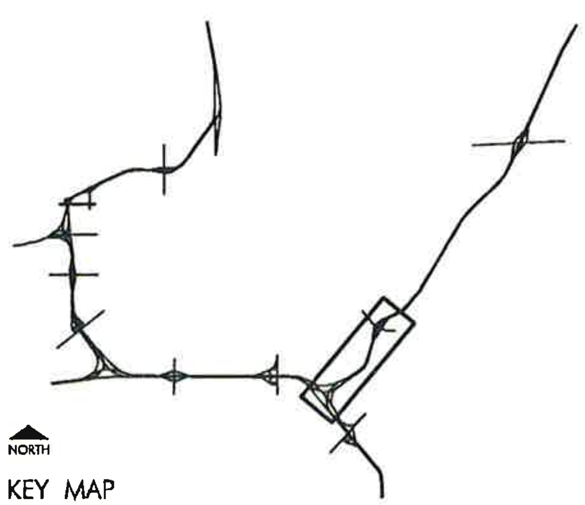
I-80 - VALLEY VIEW DRIVE TO MCPHERSON AVENUE
**PERFORMANCE MEASURES**

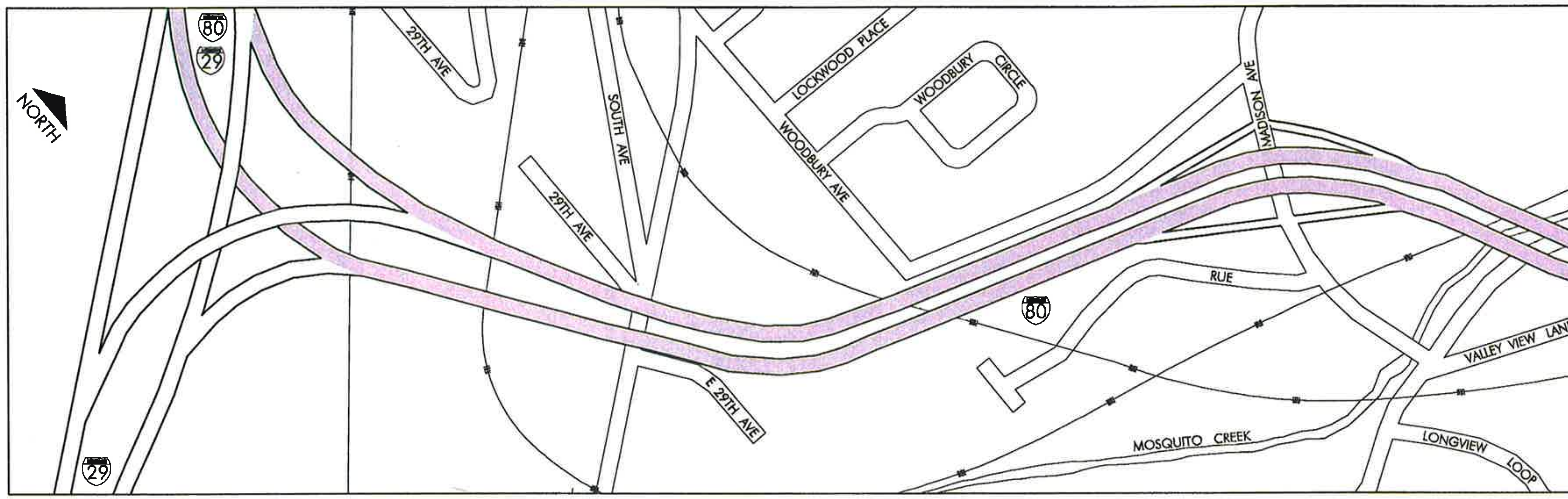
EXHIBIT
A–4

| | | |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SIGNING | GOOD / FAIR FAIR FAIR FAIR FAIR FAIR / GOOD GOOD GOOD GOOD GOOD |
| | SAFETY | POOR POOR 230 ACC/HMVM POOR POOR POOR / FAIR FAIR 106 ACC/HMVM FAIR FAIR FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD / GOOD GOOD / GOOD GOOD |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | FAIR / GOOD / FAIR |
| | CROSS SECTION | FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR |
| | DECISION SIGHT DISTANCE | GOOD GOOD / GOOD GOOD |
| | EXIT & ENTRANCE DESIGN | POOR / GOOD |
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | FAIR FAIR / POOR / POOR / FAIR / FAIR |
| | PAVEMENT | POOR POOR / FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR |

LEGEND

- GOOD — GOOD CONDITIONS
- FAIR — FAIR CONDITIONS
- POOR — POOR CONDITIONS
- NA — NOT APPLICABLE




| | | |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | POOR POOR / POOR / POOR / FAIR / FAIR |
| | PAVEMENT | POOR POOR / FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | FAIR FAIR FAIR / GOOD GOOD / GOOD GOOD |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | GOOD / FAIR |
| | CROSS SECTION | FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR |
| | DECISION SIGHT DISTANCE | GOOD GOOD |
| | EXIT & ENTRANCE DESIGN | GOOD / FAIR |
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SIGNING | GOOD GOOD / FAIR FAIR FAIR FAIR FAIR FAIR FAIR / GOOD GOOD GOOD GOOD |
| | SAFETY | FAIR FAIR 118 ACC/HMVM FAIR FAIR FAIR FAIR / POOR POOR 199 ACC/HMVM POOR POOR |

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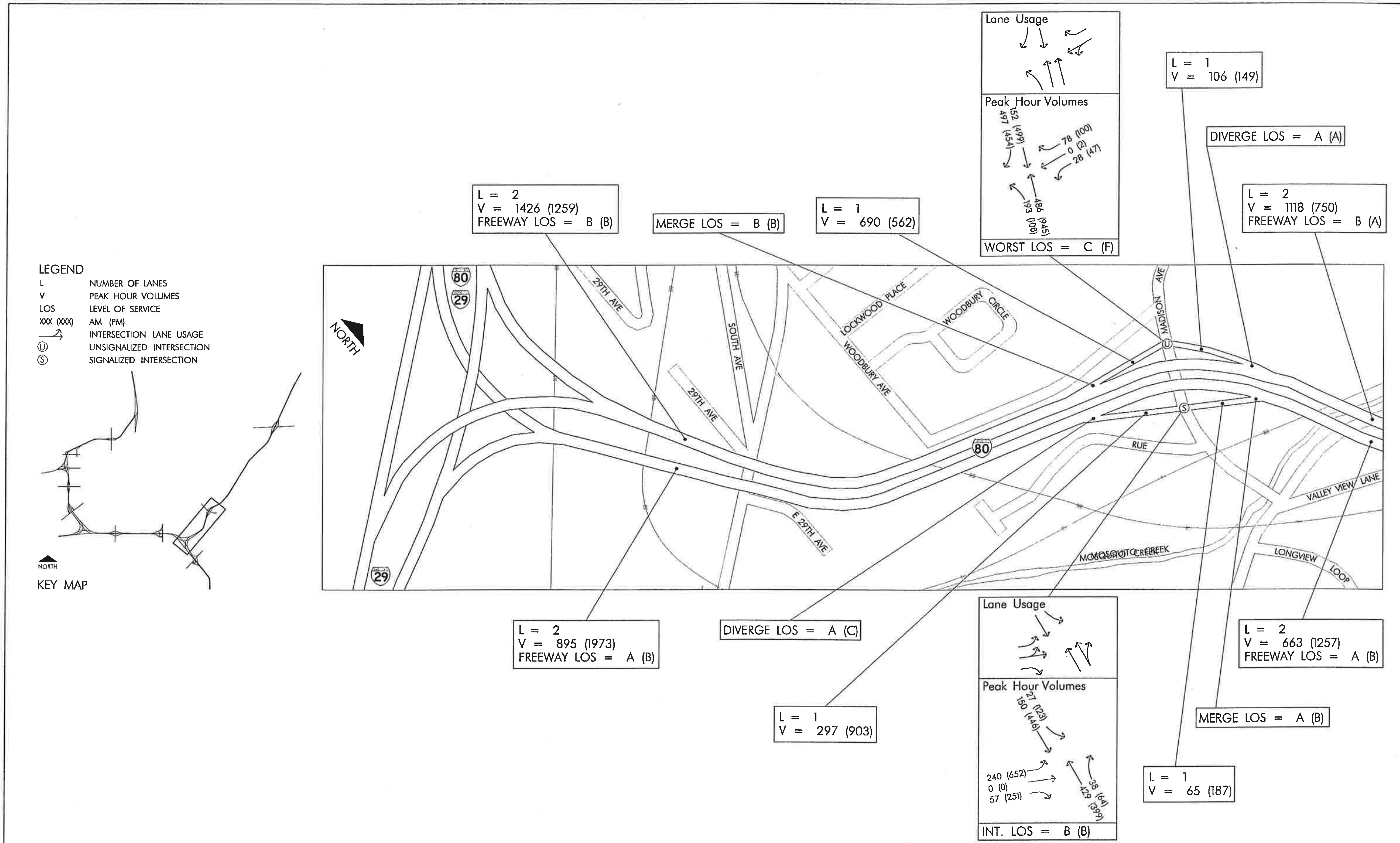
Metropolitan Area Planning Agency
COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY
PHASE 1 REPORT — SEPTEMBER 1997

I-80 - I-29 TO VALLEY VIEW DRIVE
**PHYSICAL /GEOMETRIC/OPERATIONAL CONDITIONS**

EXHIBIT A–5

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Metropolitan Area Planning Agency

COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY

PHASE 1 REPORT SEPTEMBER 1997

I-80 - I-29 TO VALLEY VIEW DRIVE

**PERFORMANCE MEASURES**

EXHIBIT **A–6**

## OPERATIONAL FEATURES

| | |
|---|---|
| LANE & ROUTE CONTINUITY | POOR, POOR, POOR / GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| LANE BALANCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| RAMP SEQUENCE | GOOD, GOOD, GOOD, GOOD, GOOD / POOR, POOR / GOOD, GOOD, GOOD, GOOD |
| SIGNING | GOOD, GOOD, GOOD, GOOD, GOOD / FAIR, FAIR / GOOD, GOOD, GOOD, GOOD |
| SAFETY | FAIR, FAIR, 77 ACC/HMVM, FAIR, FAIR / FAIR, FAIR, FAIR, 90 ACC/HMVM, FAIR, FAIR, FAIR |

## GEOMETRIC FEATURES

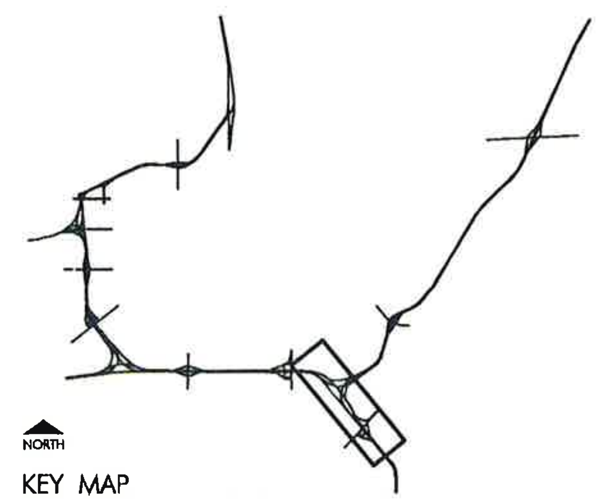
| | |
|---|---|
| HORIZONTAL ALIGNMENT | GOOD, GOOD, GOOD, GOOD, GOOD / GOOD |
| VERTICAL ALIGNMENT | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| STOPPING SIGHT DISTANCE | FAIR, FAIR |
| CROSS SECTION | FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR |
| DECISION SIGHT DISTANCE | GOOD / GOOD, GOOD / GOOD, GOOD / GOOD, GOOD |
| EXIT & ENTRANCE DESIGN | POOR / GOOD |

## PHYSICAL CONDITIONS

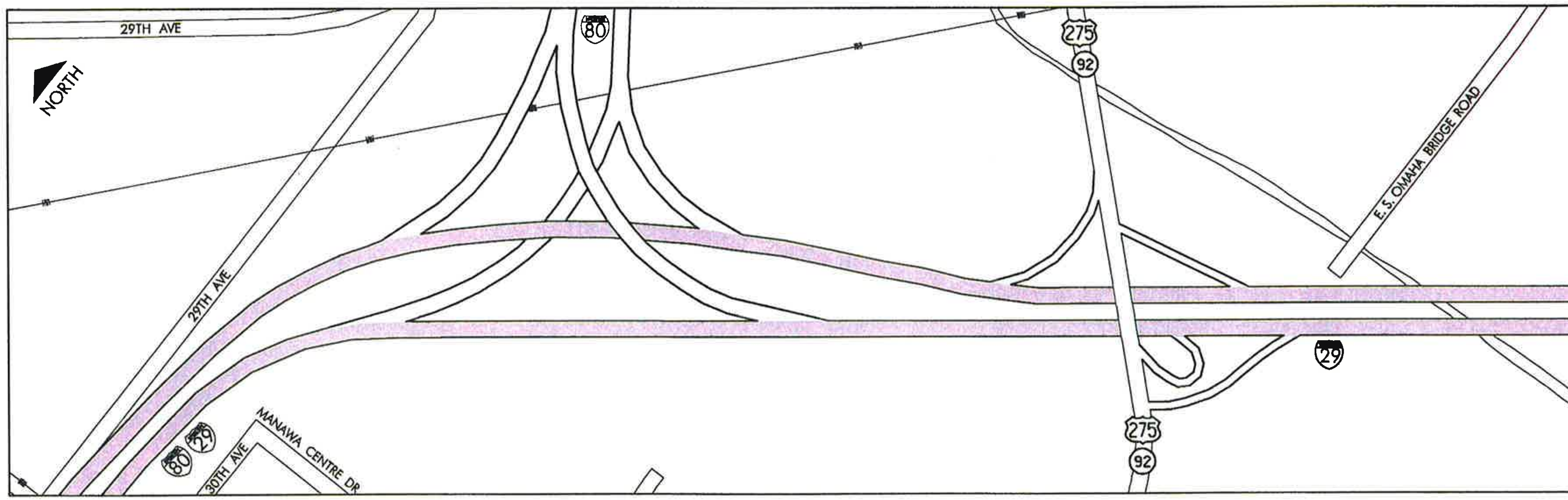
| | |
|---|---|
| HIGHWAY STRUCTURES | GOOD / GOOD |
| PAVEMENT | POOR, POOR, POOR, POOR, POOR, POOR, POOR / FAIR, FAIR / POOR, POOR |

LEGEND

| | |
|---|---|
| GOOD | GOOD CONDITIONS |
| FAIR | FAIR CONDITIONS |
| POOR | POOR CONDITIONS |
| NA | NOT APPLICABLE |




KEY MAP




## PHYSICAL CONDITIONS

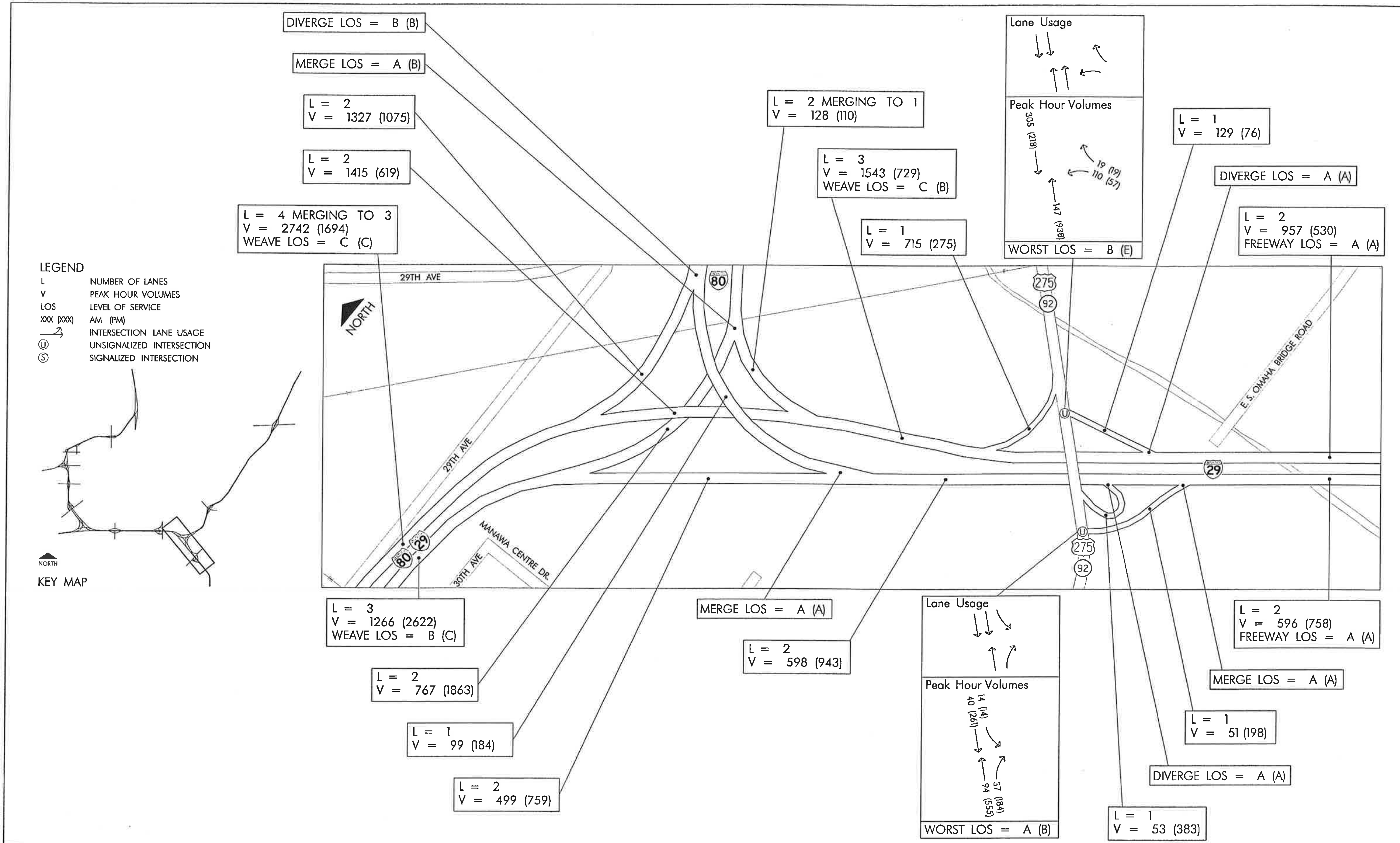
| | |
|---|---|
| HIGHWAY STRUCTURES | GOOD |
| PAVEMENT | POOR, POOR, POOR, POOR, POOR, POOR / FAIR, FAIR / POOR, POOR |

## GEOMETRIC FEATURES

| | |
|---|---|
| HORIZONTAL ALIGNMENT | GOOD, GOOD |
| VERTICAL ALIGNMENT | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| STOPPING SIGHT DISTANCE | |
| CROSS SECTION | FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR |
| DECISION SIGHT DISTANCE | GOOD, GOOD / GOOD, GOOD |
| EXIT & ENTRANCE DESIGN | POOR, POOR |

## OPERATIONAL FEATURES

| | |
|---|---|
| LANE & ROUTE CONTINUITY | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| LANE BALANCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| RAMP SEQUENCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| SIGNING | FAIR, FAIR, FAIR / GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| SAFETY | FAIR, FAIR, 97 ACC/HMVM, FAIR / GOOD, GOOD, GOOD, 50 ACC/HMVM, GOOD, GOOD, GOOD |




HDR Engineering, Inc. | hgm ASSOCIATES INC.

Metropolitan Area Planning Agency
COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY
PHASE 1 REPORT SEPTEMBER 1997

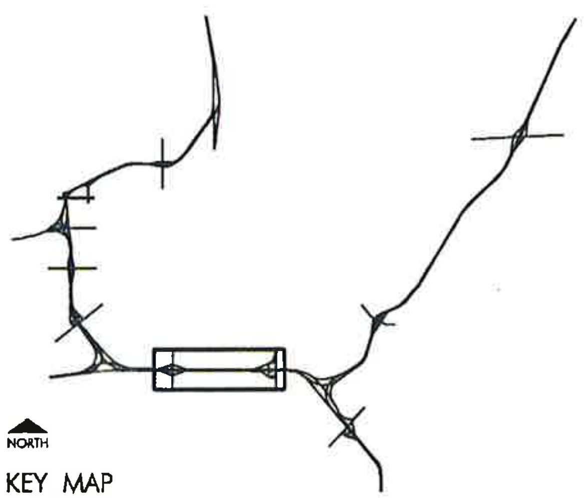
I-80 / I-29 SYSTEM INTERCHANGE (EAST) TO US 275 / IA 92
**PERFORMANCE MEASURES**

EXHIBIT
A-8

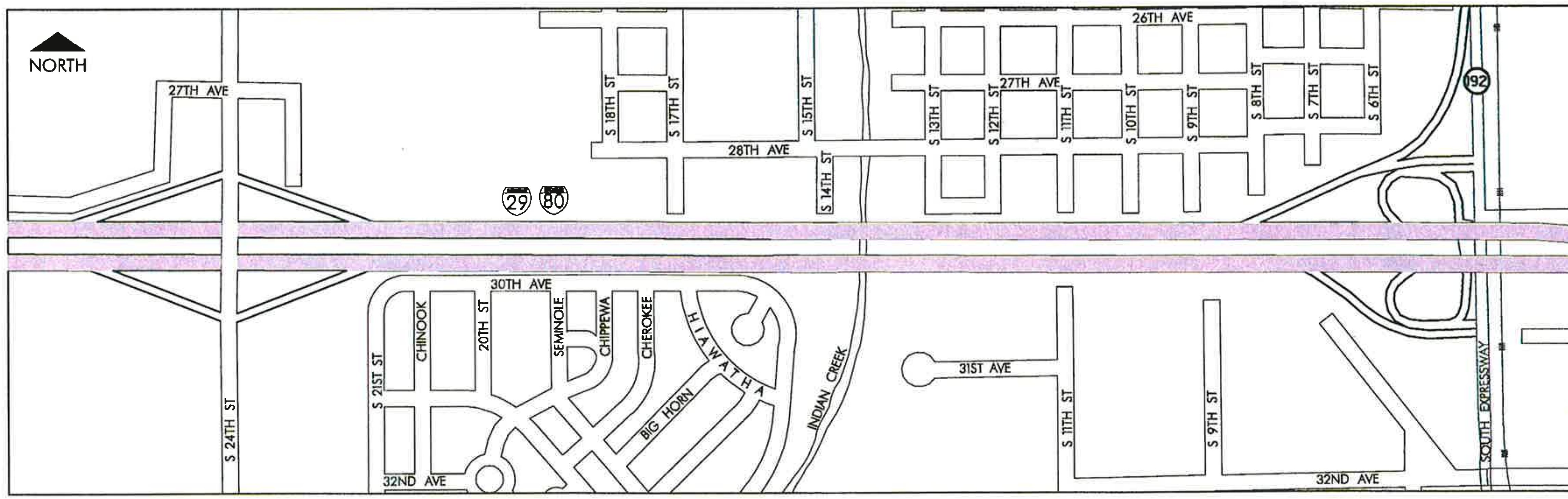
| | | |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, POOR, POOR |
| | LANE BALANCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, POOR, POOR, GOOD |
| | RAMP SEQUENCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | SIGNING | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, FAIR, FAIR, GOOD |
| | SAFETY | FAIR, 142 ACC/MVM, FAIR, FAIR, FAIR, FAIR, FAIR, 90 ACC/MVM, FAIR, FAIR, FAIR, FAIR, 77 ACC/MVM, FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | |
| | VERTICAL ALIGNMENT | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | STOPPING SIGHT DISTANCE | GOOD, GOOD, GOOD, FAIR |
| | CROSS SECTION | FAIR, POOR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR |
| | DECISION SIGHT DISTANCE | GOOD, GOOD, GOOD |
| | EXIT & ENTRANCE DESIGN | FAIR, FAIR, GOOD, POOR, POOR |
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | FAIR, FAIR, FAIR |
| | PAVEMENT | POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR |

LEGEND

- GOOD — GOOD CONDITIONS
- FAIR — FAIR CONDITIONS
- POOR — POOR CONDITIONS
- NA — NOT APPLICABLE




KEY MAP



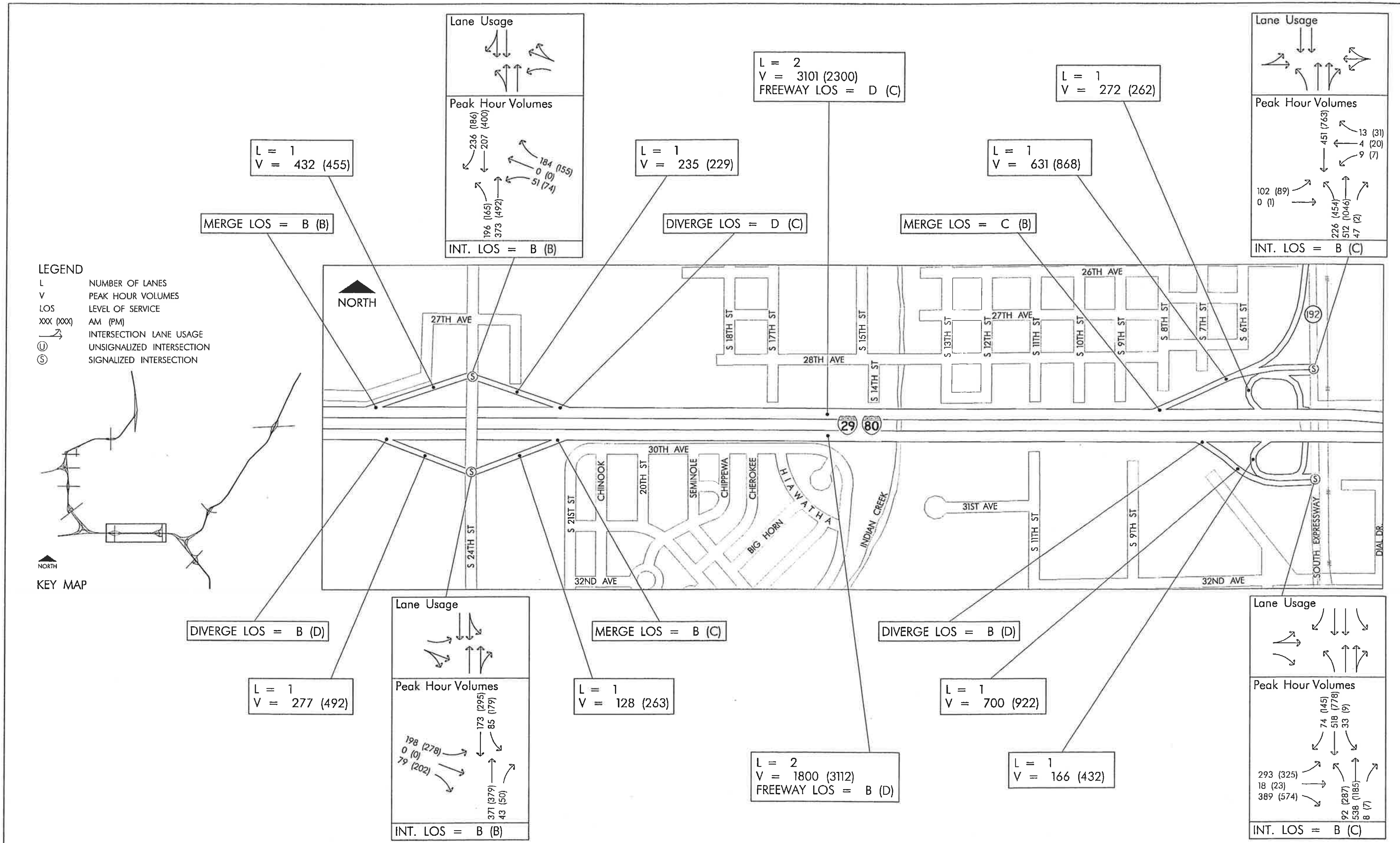

| | | |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | FAIR, FAIR, FAIR |
| | PAVEMENT | POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | |
| | VERTICAL ALIGNMENT | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | STOPPING SIGHT DISTANCE | GOOD, GOOD, GOOD, FAIR |
| | CROSS SECTION | FAIR, POOR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR |
| | DECISION SIGHT DISTANCE | GOOD, GOOD, GOOD |
| | EXIT & ENTRANCE DESIGN | GOOD, FAIR, POOR |
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | LANE BALANCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | RAMP SEQUENCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | SIGNING | FAIR, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, FAIR |
| | SAFETY | FAIR, 105 ACC/MVM, FAIR, FAIR, FAIR, FAIR, FAIR, 80 ACC/MVM, FAIR, FAIR, FAIR, FAIR, 97 ACC/MVM, FAIR |



I-80 / I-29 - S. 24TH STREET TO SOUTH EXPRESSWAY

**PHYSICAL / GEOMETRIC / OPERATIONAL CONDITIONS**

EXHIBIT A-9




HDR Engineering, Inc. | hgm ASSOCIATES INC.

Metropolitan Area Planning Agency
COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY
PHASE 1 REPORT — SEPTEMBER 1997

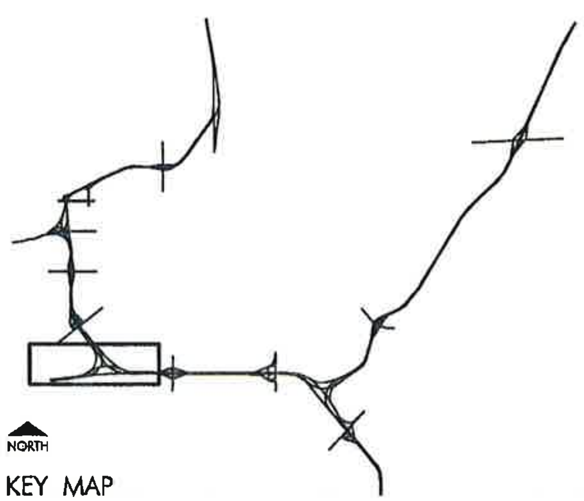
I-80 / I-29 - S. 24TH STREET TO SOUTH EXPRESSWAY
**PERFORMANCE MEASURES**

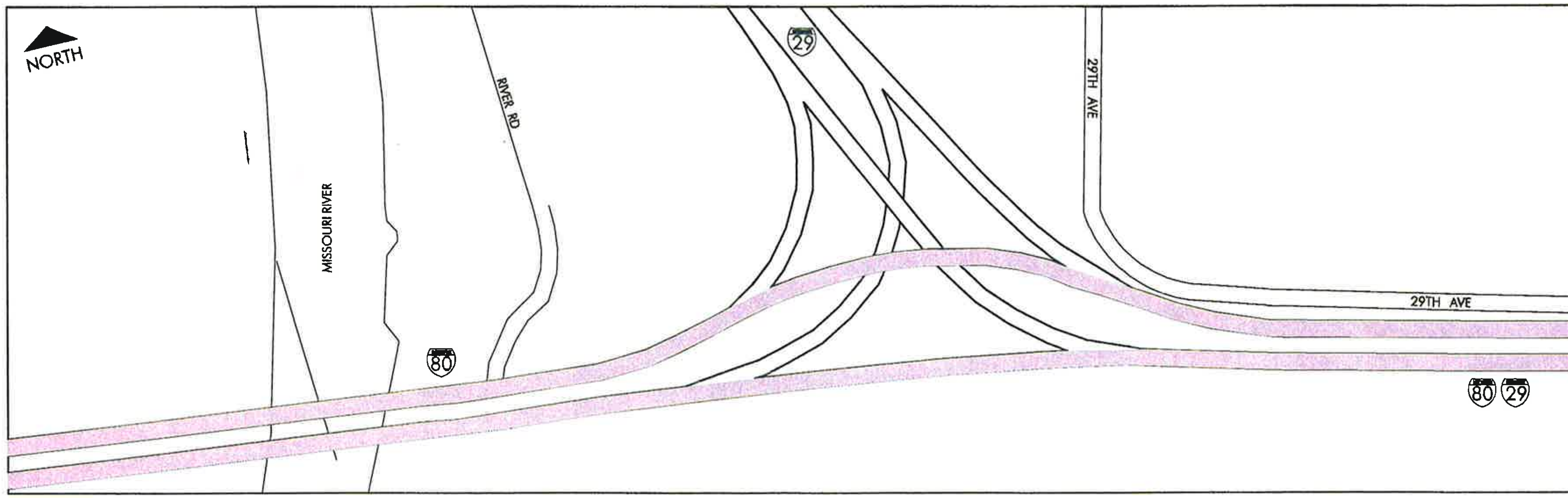
EXHIBIT **A-10**

| | | |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, POOR, POOR, POOR, POOR, GOOD |
| | LANE BALANCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | RAMP SEQUENCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | SIGNING | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | SAFETY | FAIR, FAIR, 118 ACC/HMVM, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, 142 ACC/HMVM, FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | FAIR, GOOD, GOOD, GOOD, GOOD |
| | VERTICAL ALIGNMENT | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | STOPPING SIGHT DISTANCE | FAIR, FAIR |
| | CROSS SECTION | FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR |
| | DECISION SIGHT DISTANCE | GOOD, GOOD |
| | EXIT & ENTRANCE DESIGN | |
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | GOOD, GOOD |
| | PAVEMENT | POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR |

LEGEND

| | |
|---|---|
| GOOD | GOOD CONDITIONS |
| FAIR | FAIR CONDITIONS |
| POOR | POOR CONDITIONS |
| NA | NOT APPLICABLE |

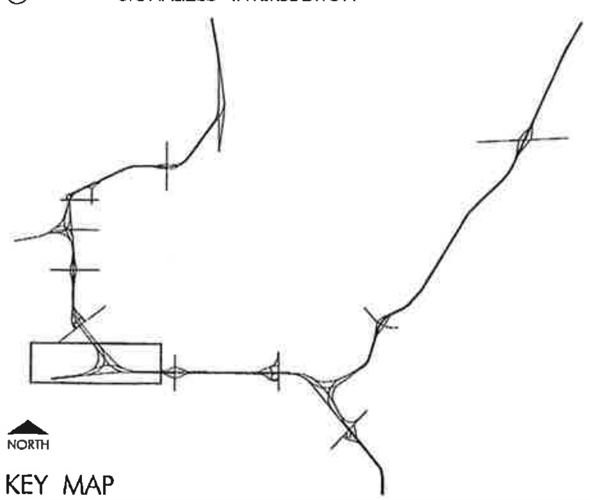


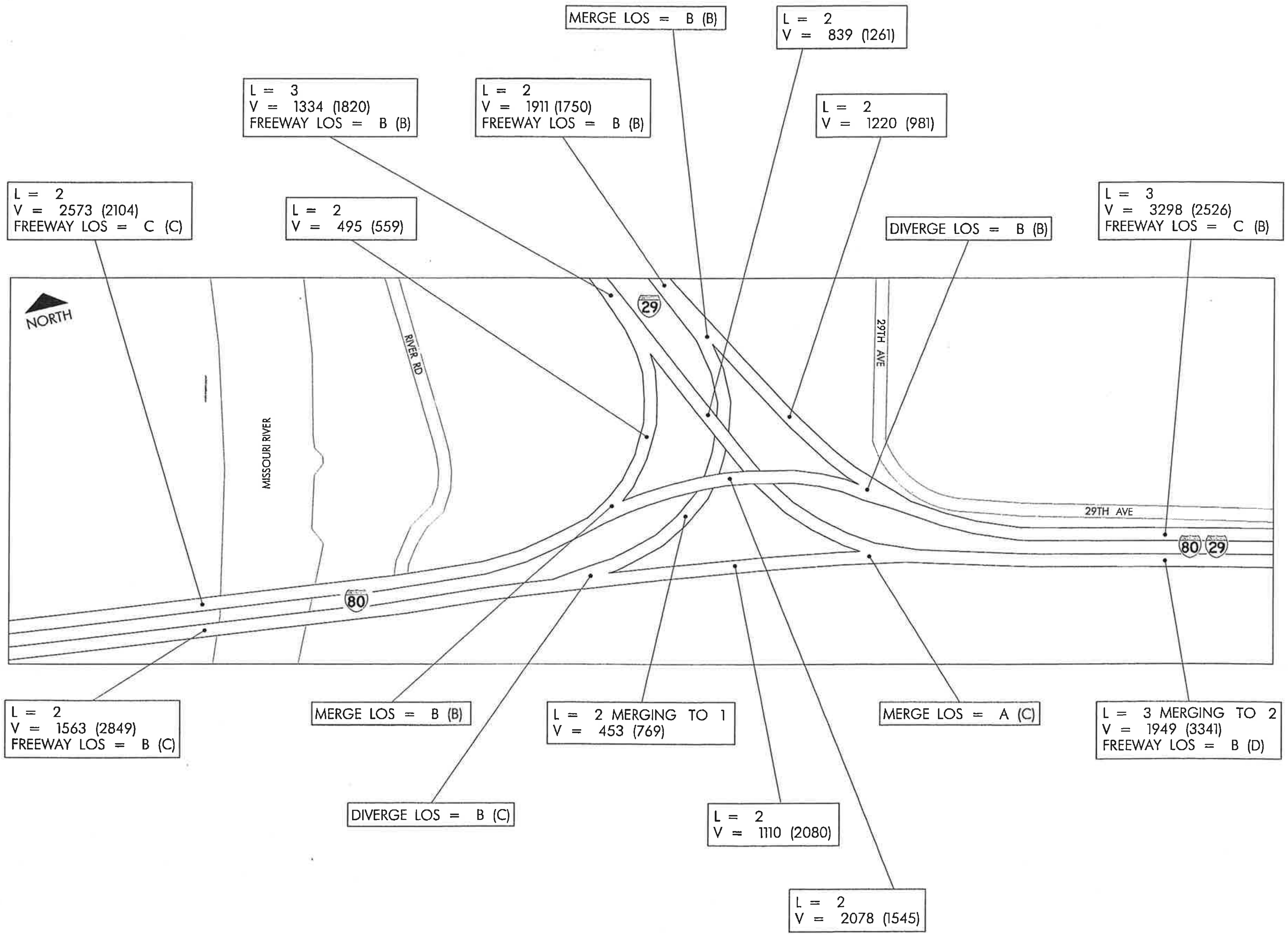

| | | |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | |
| | PAVEMENT | POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR, POOR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD |
| | VERTICAL ALIGNMENT | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | STOPPING SIGHT DISTANCE | |
| | CROSS SECTION | FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR |
| | DECISION SIGHT DISTANCE | GOOD, GOOD, GOOD |
| | EXIT & ENTRANCE DESIGN | |
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, POOR, POOR, POOR, POOR, GOOD |
| | LANE BALANCE | GOOD, GOOD, GOOD, GOOD, GOOD, POOR, POOR, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | RAMP SEQUENCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | SIGNING | GOOD, GOOD, GOOD, FAIR, FAIR, FAIR, FAIR, GOOD, GOOD, GOOD, GOOD, FAIR, FAIR, FAIR |
| | SAFETY | FAIR, FAIR, 114 ACC/HMVM, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, 105 ACC/HMVM, FAIR |

LEGEND

| | |
|---|---|
| L | NUMBER OF LANES |
| V | PEAK HOUR VOLUMES |
| LOS | LEVEL OF SERVICE |
| XXX (XXX) | AM (PM) |
| → | INTERSECTION LANE USAGE |
| Ⓤ | UNSIGNALIZED INTERSECTION |
| Ⓢ | SIGNALIZED INTERSECTION |




KEY MAP

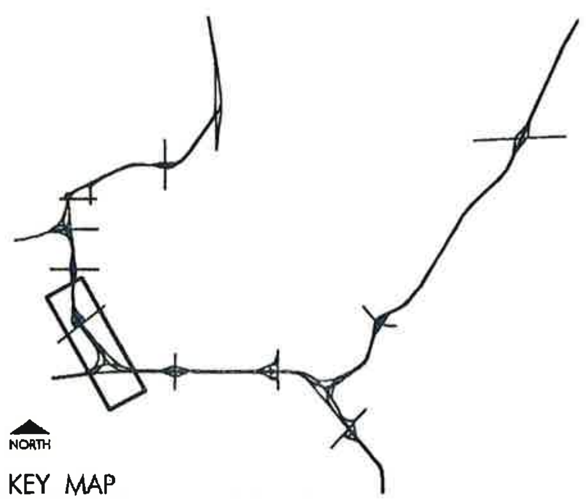



| | | | |
|---|---|---|---|
| HDR<br>HDR Engineering, Inc.<br>hgm<br>ASSOCIATES INC. | Metropolitan Area Planning Agency<br>COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY<br>PHASE 1 REPORT SEPTEMBER 1997 | I-80 / I-29 SYSTEM INTERCHANGE (WEST)<br>**PERFORMANCE MEASURES** | EXHIBIT<br>**A–12** |

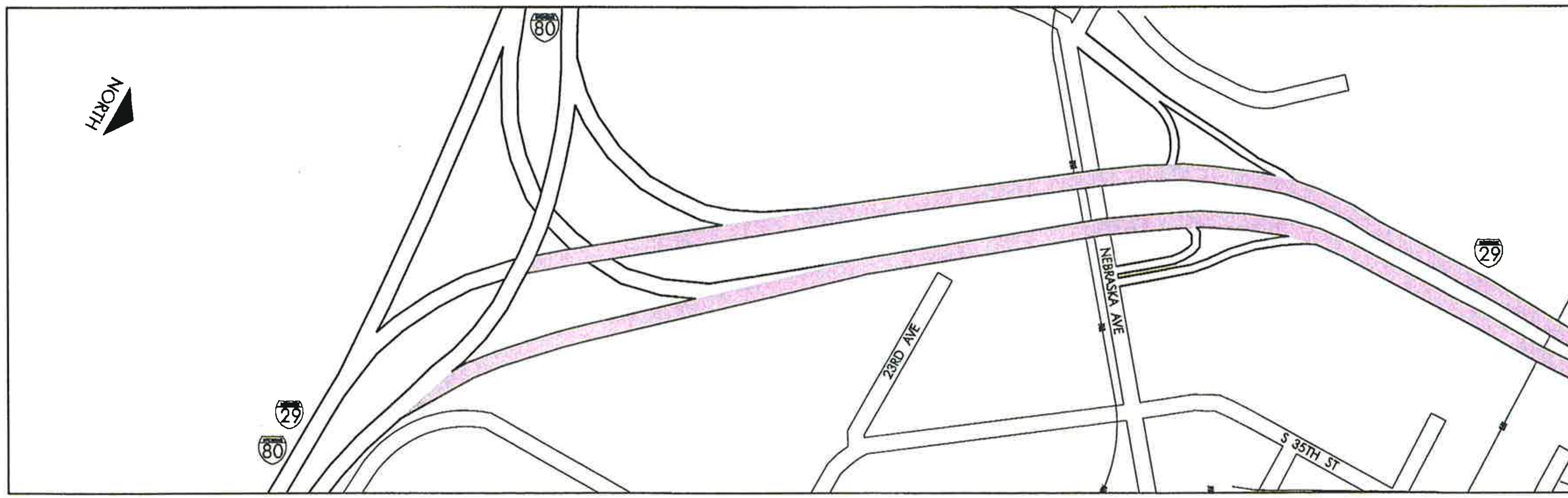
| | | |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SIGNING | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SAFETY | FAIR FAIR FAIR 63 ACC/HMVM FAIR FAIR FAIR / FAIR FAIR 82 ACC/HMVM FAIR FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD GOOD GOOD |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | POOR / FAIR FAIR / POOR |
| | CROSS SECTION | FAIR FAIR FAIR / GOOD GOOD / FAIR FAIR FAIR / GOOD GOOD |
| | DECISION SIGHT DISTANCE | GOOD GOOD / GOOD GOOD |
| | EXIT & ENTRANCE DESIGN | POOR / GOOD GOOD |
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | GOOD / GOOD |
| | PAVEMENT | POOR POOR POOR POOR POOR POOR POOR POOR POOR POOR POOR |

LEGEND

- GOOD — GOOD CONDITIONS
- FAIR — FAIR CONDITIONS
- POOR — POOR CONDITIONS
- NA — NOT APPLICABLE




KEY MAP




| | | |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | FAIR |
| | PAVEMENT | POOR POOR POOR POOR POOR POOR POOR POOR POOR POOR POOR POOR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | FAIR / GOOD GOOD GOOD |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | GOOD / FAIR FAIR / POOR |
| | CROSS SECTION | FAIR FAIR FAIR FAIR / GOOD GOOD GOOD / FAIR FAIR FAIR / GOOD GOOD |
| | DECISION SIGHT DISTANCE | FAIR FAIR |
| | EXIT & ENTRANCE DESIGN | POOR / POOR |
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SIGNING | GOOD GOOD GOOD GOOD GOOD / FAIR FAIR / GOOD GOOD GOOD |
| | SAFETY | FAIR FAIR FAIR FAIR 94 ACC/HMVM FAIR FAIR FAIR / FAIR FAIR 96 ACC/HMVM FAIR FAIR |

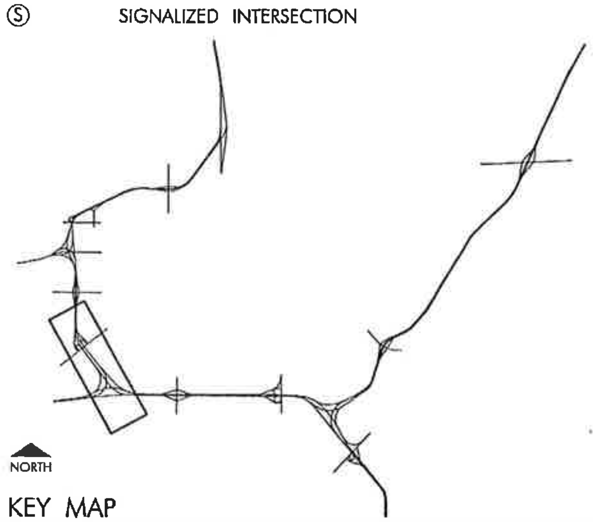


I-29 - I-80 TO NEBRASKA AVENUE

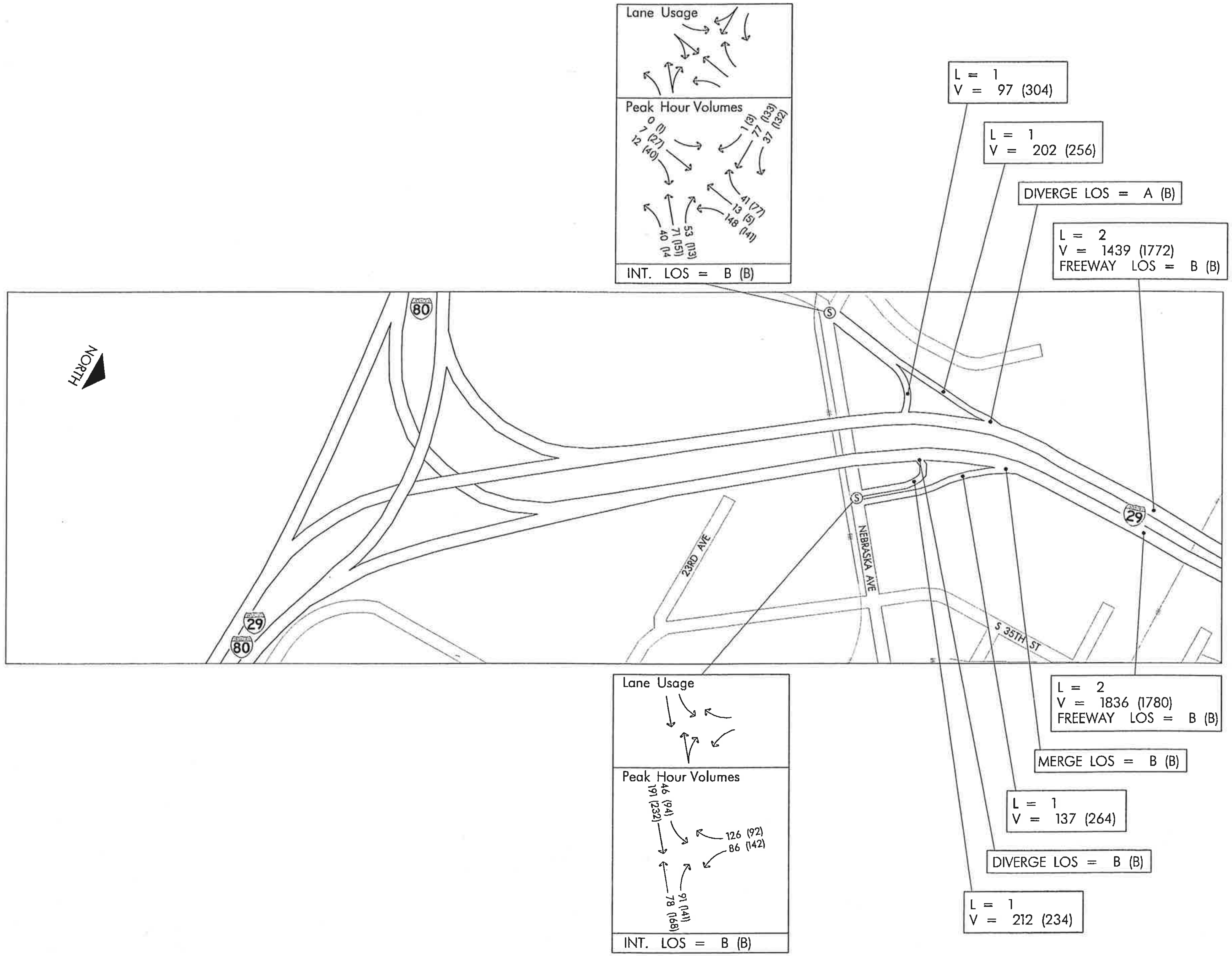
**PHYSICAL /GEOMETRIC/OPERATIONAL CONDITIONS**

LEGEND

| | |
|---|---|
| L | NUMBER OF LANES |
| V | PEAK HOUR VOLUMES |
| LOS | LEVEL OF SERVICE |
| XXX (XXX) | AM (PM) |
| → | INTERSECTION LANE USAGE |
| Ⓤ | UNSIGNALIZED INTERSECTION |
| Ⓢ | SIGNALIZED INTERSECTION |




KEY MAP




HDR Engineering, Inc. | hgm ASSOCIATES INC.

Metropolitan Area Planning Agency
COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY
PHASE 1 REPORT SEPTEMBER 1997

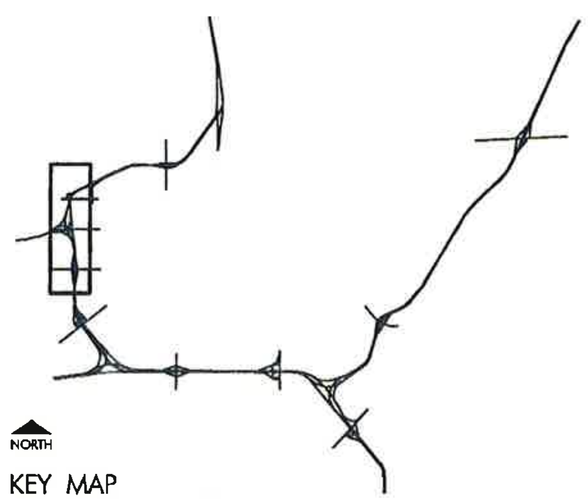
I-29 - I-80 TO NEBRASKA AVENUE
**PERFORMANCE MEASURES**

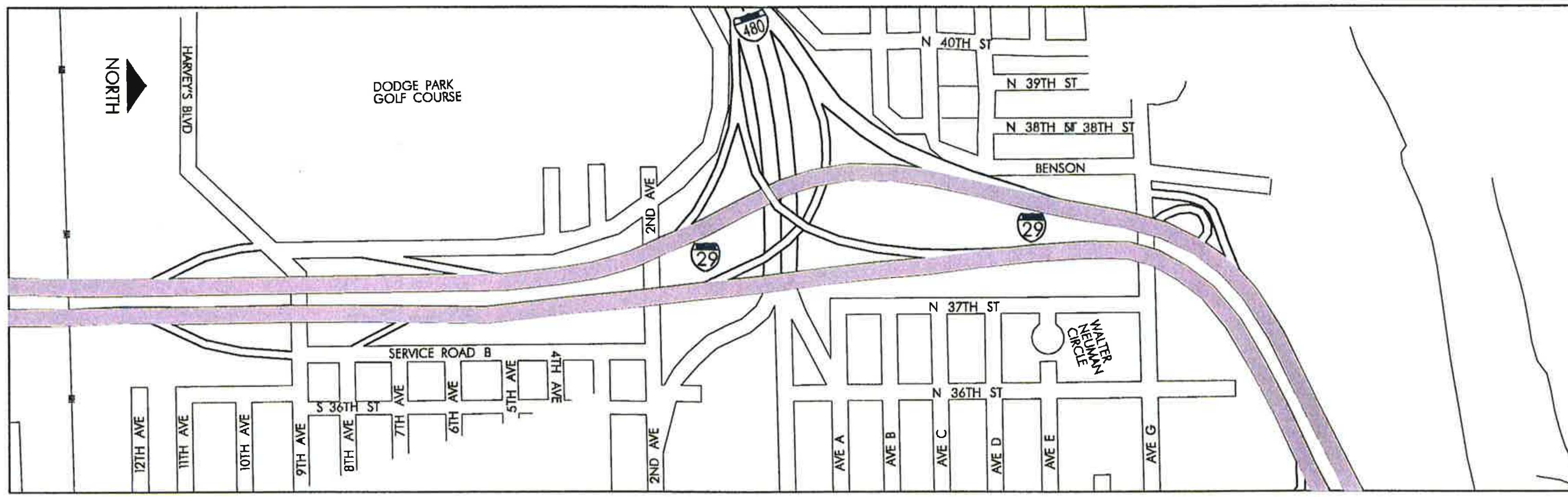
EXHIBIT
A–14

| | | |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD POOR POOR GOOD GOOD POOR POOR GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD POOR POOR GOOD GOOD POOR POOR GOOD |
| | SIGNING | GOOD GOOD GOOD GOOD FAIR FAIR GOOD GOOD FAIR FAIR GOOD |
| | SAFETY | FAIR 82 ACC/HMVM FAIR POOR POOR POOR 160 ACC/HMVM POOR POOR POOR GOOD 14 ACC/HMVM GOOD |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD GOOD GOOD POOR GOOD POOR |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | POOR POOR POOR POOR POOR |
| | CROSS SECTION | GOOD GOOD POOR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR GOOD |
| | DECISION SIGHT DISTANCE | FAIR FAIR FAIR FAIR GOOD |
| | EXIT & ENTRANCE DESIGN | POOR GOOD GOOD POOR |
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | GOOD FAIR FAIR FAIR |
| | PAVEMENT | POOR POOR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR |

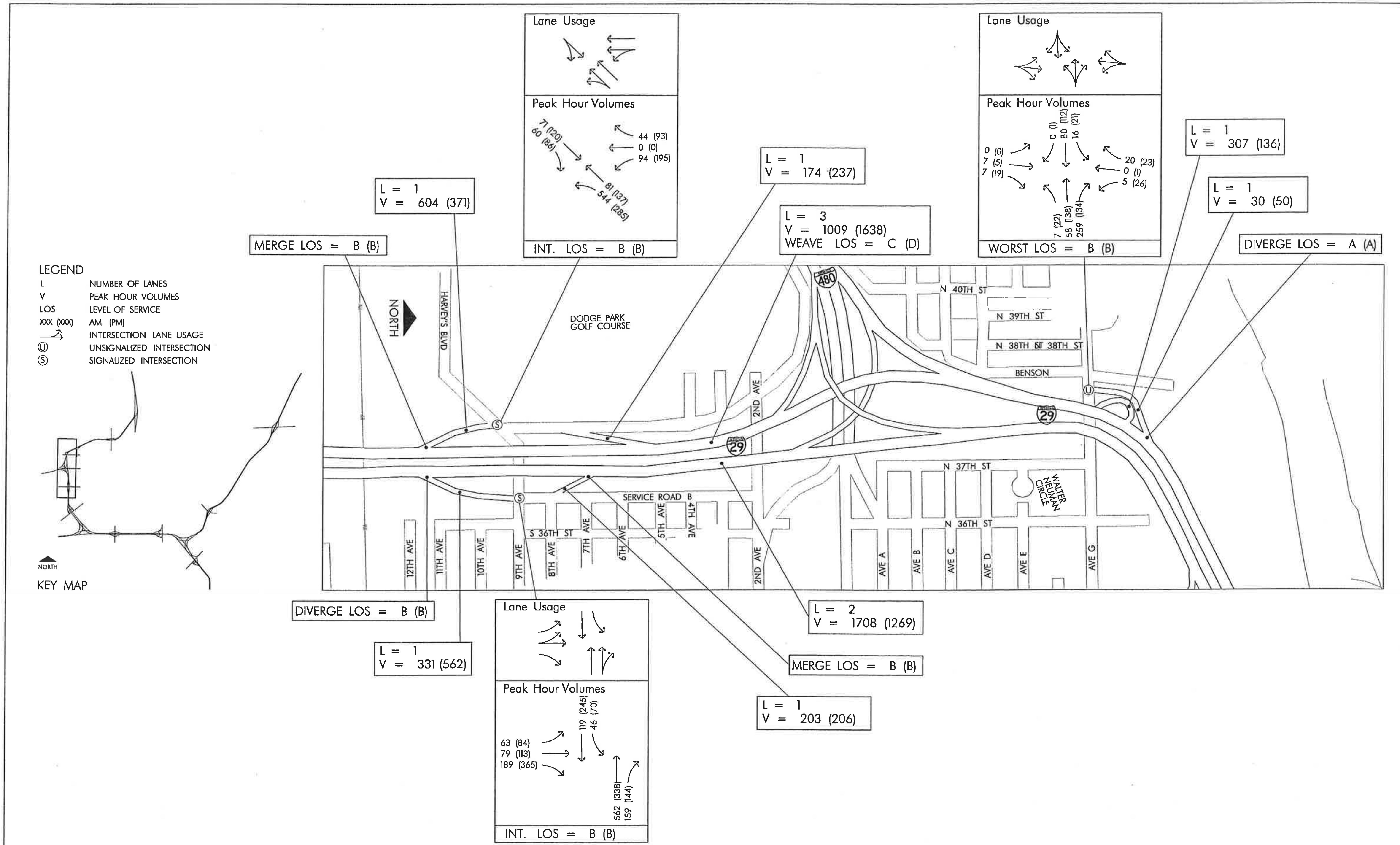
LEGEND

| | |
|---|---|
| GOOD | GOOD CONDITIONS |
| FAIR | FAIR CONDITIONS |
| POOR | POOR CONDITIONS |
| NA | NOT APPLICABLE |




| | | |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | GOOD GOOD FAIR GOOD |
| | PAVEMENT | POOR POOR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD GOOD POOR |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | POOR POOR POOR POOR |
| | CROSS SECTION | GOOD GOOD POOR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR GOOD |
| | DECISION SIGHT DISTANCE | POOR GOOD GOOD GOOD |
| | EXIT & ENTRANCE DESIGN | GOOD POOR |
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD POOR POOR POOR GOOD GOOD GOOD GOOD GOOD |
| | SIGNING | GOOD FAIR FAIR GOOD GOOD FAIR FAIR GOOD GOOD GOOD GOOD GOOD |
| | SAFETY | FAIR FAIR 82 ACC/HMVM FAIR FAIR FAIR FAIR FAIR FAIR 125 ACC/HMVM FAIR FAIR FAIR FAIR 62 ACC/HMVM FAIR |

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COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY

PHASE 1 REPORT

SEPTEMBER 1997

I-29 - 9TH AVENUE TO AVENUE G

**PERFORMANCE MEASURES**

EXHIBIT

**A-16**

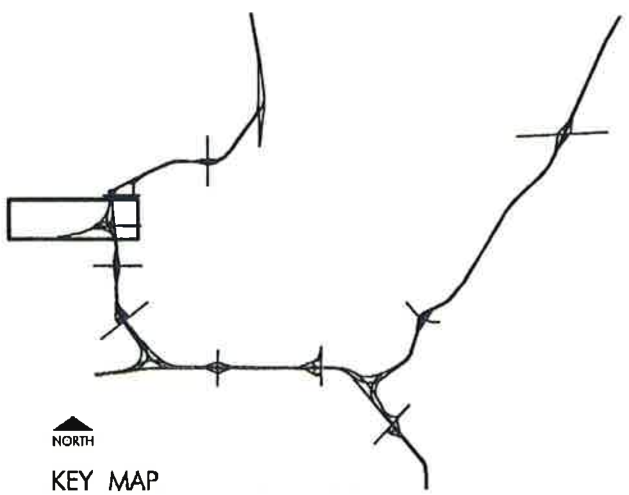
| | | Conditions |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD POOR POOR GOOD |
| | SIGNING | GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SAFETY | POOR POOR 275 ACC/HMVM POOR POOR |

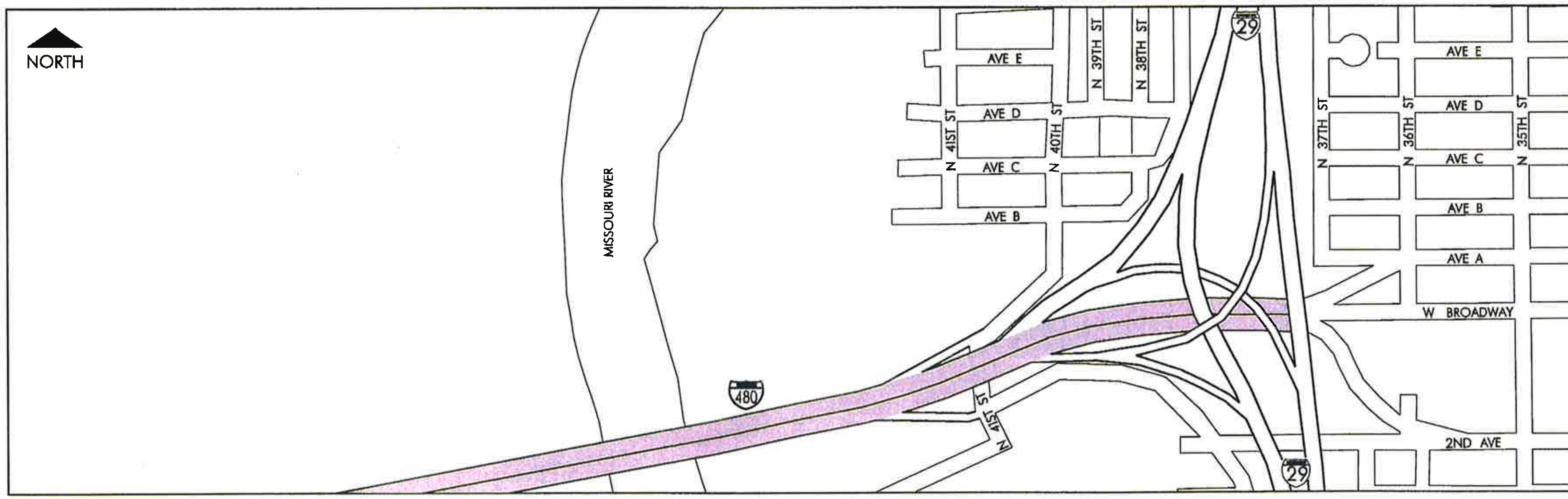
| | | Conditions |
|---|---|---|
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD GOOD FAIR GOOD |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | GOOD |
| | CROSS SECTION | FAIR FAIR FAIR FAIR FAIR |
| | DECISION SIGHT DISTANCE | FAIR FAIR |
| | EXIT & ENTRANCE DESIGN | GOOD GOOD GOOD |

| | | Conditions |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | POOR FAIR |
| | PAVEMENT | FAIR FAIR POOR POOR POOR |

LEGEND

- GOOD — GOOD CONDITIONS
- FAIR — FAIR CONDITIONS
- POOR — POOR CONDITIONS
- NA — NOT APPLICABLE




| | | Conditions |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | POOR POOR |
| | PAVEMENT | FAIR FAIR POOR POOR POOR |

| | | Conditions |
|---|---|---|
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD FAIR FAIR POOR |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | POOR FAIR |
| | CROSS SECTION | FAIR FAIR FAIR FAIR FAIR |
| | DECISION SIGHT DISTANCE | GOOD GOOD GOOD |
| | EXIT & ENTRANCE DESIGN | GOOD GOOD GOOD |

| | | Conditions |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD POOR POOR GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD POOR POOR GOOD |
| | SIGNING | GOOD GOOD FAIR FAIR FAIR FAIR FAIR GOOD |
| | SAFETY | POOR POOR 273 ACC/HMVM POOR POOR |

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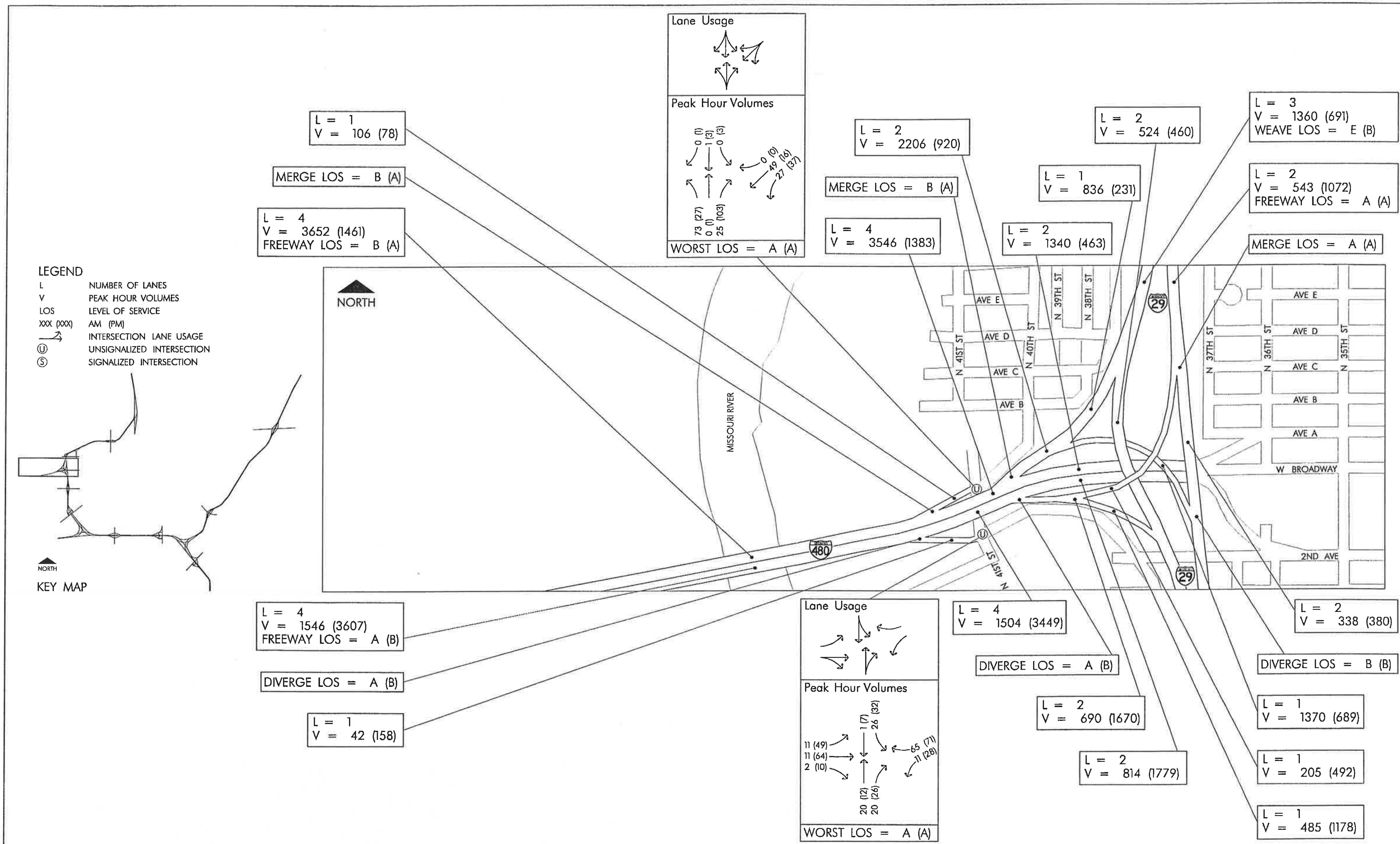
PHASE 1 REPORT
SEPTEMBER 1997

I-480 / I-29 SYSTEM INTERCHANGE
**PHYSICAL / GEOMETRIC/OPERATIONAL CONDITIONS**

EXHIBIT
A-17

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PHASE 1 REPORT
SEPTEMBER 1997

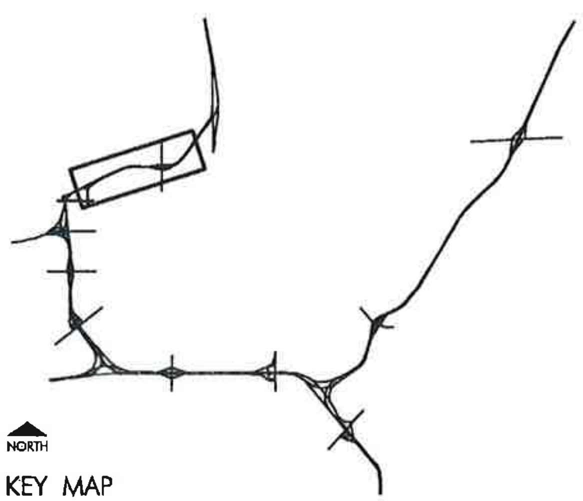
I 480 / I 29 SYSTEM INTERCHANGE
**PERFORMANCE MEASURES**

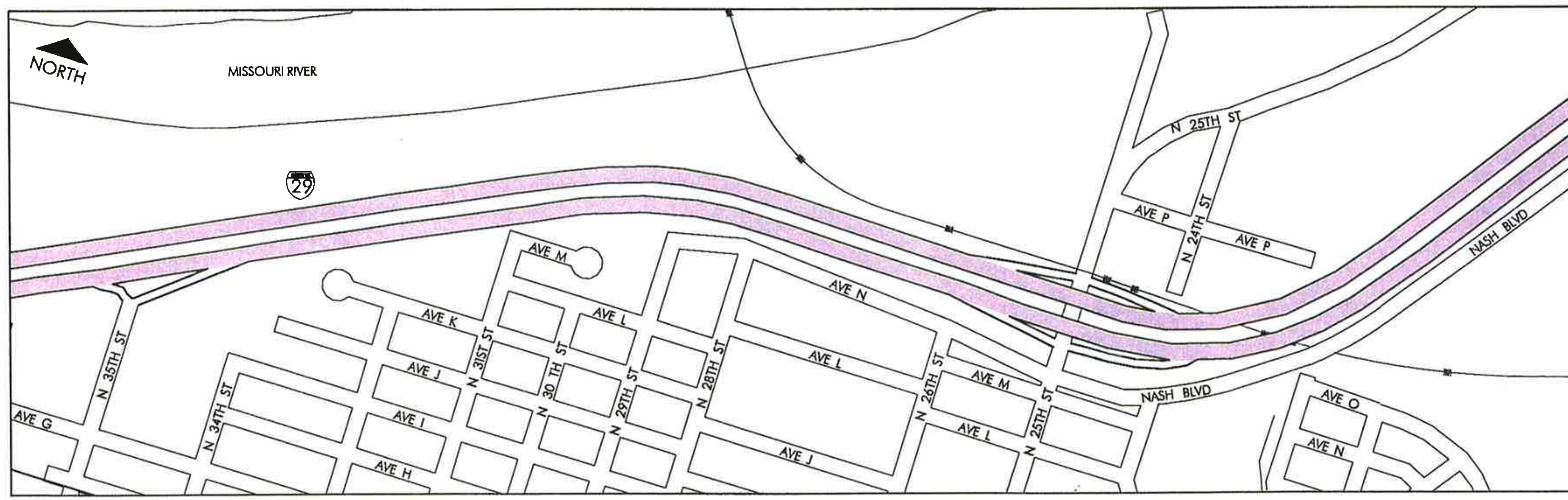
EXHIBIT
**A-18**

| | | |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SIGNING | |
| | SAFETY | GOOD GOOD 14 ACC/HMVM GOOD GOOD / FAIR FAIR FAIR 68 ACC/HMVM FAIR FAIR FAIR FAIR / FAIR FAIR 75 ACC/HMVM FAIR FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD GOOD / FAIR FAIR FAIR |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | GOOD / POOR POOR |
| | CROSS SECTION | FAIR / GOOD GOOD GOOD GOOD / FAIR FAIR / GOOD GOOD GOOD / FAIR FAIR FAIR / GOOD GOOD / FAIR |
| | DECISION SIGHT DISTANCE | POOR POOR |
| | EXIT & ENTRANCE DESIGN | FAIR FAIR / GOOD |
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | GOOD |
| | PAVEMENT | FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR / GOOD GOOD GOOD / FAIR FAIR FAIR |

LEGEND

- GOOD — GOOD CONDITIONS
- FAIR — FAIR CONDITIONS
- POOR — POOR CONDITIONS
- NA — NOT APPLICABLE




| | | |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | FAIR |
| | PAVEMENT | FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR FAIR / GOOD GOOD GOOD / FAIR FAIR FAIR |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD GOOD / FAIR FAIR FAIR |
| | VERTICAL ALIGNMENT | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | STOPPING SIGHT DISTANCE | GOOD / POOR POOR |
| | CROSS SECTION | FAIR / GOOD GOOD / FAIR FAIR / GOOD / FAIR / GOOD GOOD GOOD GOOD GOOD GOOD GOOD / FAIR |
| | DECISION SIGHT DISTANCE | GOOD / GOOD GOOD |
| | EXIT & ENTRANCE DESIGN | FAIR FAIR / GOOD / FAIR FAIR |
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | LANE BALANCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | RAMP SEQUENCE | GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD GOOD |
| | SIGNING | POOR / GOOD GOOD GOOD GOOD GOOD GOOD / FAIR / GOOD GOOD GOOD GOOD GOOD |
| | SAFETY | FAIR FAIR 62 ACC/HMVM FAIR FAIR / GOOD GOOD 27 ACC/HMVM GOOD GOOD GOOD / FAIR FAIR 68 ACC/HMVM FAIR FAIR |

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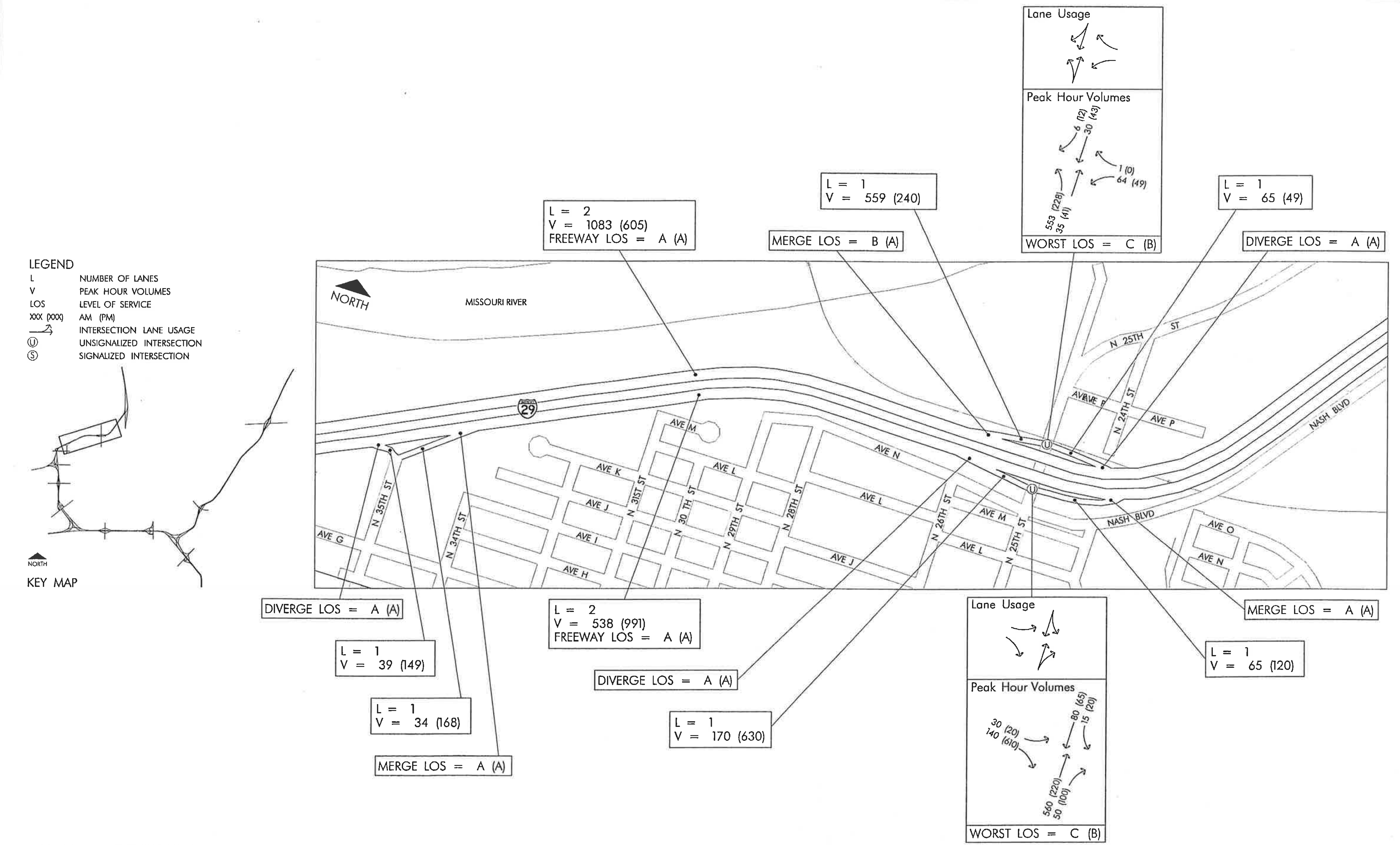
COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY
PHASE 1 REPORT SEPTEMBER 1997

I-29 - N. 35TH STREET TO N. 25TH STREET
**PHYSICAL /GEOMETRIC/OPERATIONAL CONDITIONS**

EXHIBIT A-19

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COUNCIL BLUFFS INTERSTATE SYSTEM NEEDS STUDY
PHASE 1 REPORT SEPTEMBER 1997

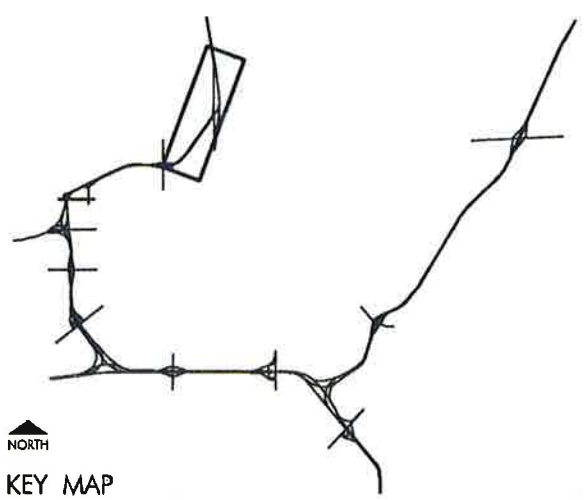
I-29 - N. 35TH STREET TO N. 25TH STREET
**PERFORMANCE MEASURES**

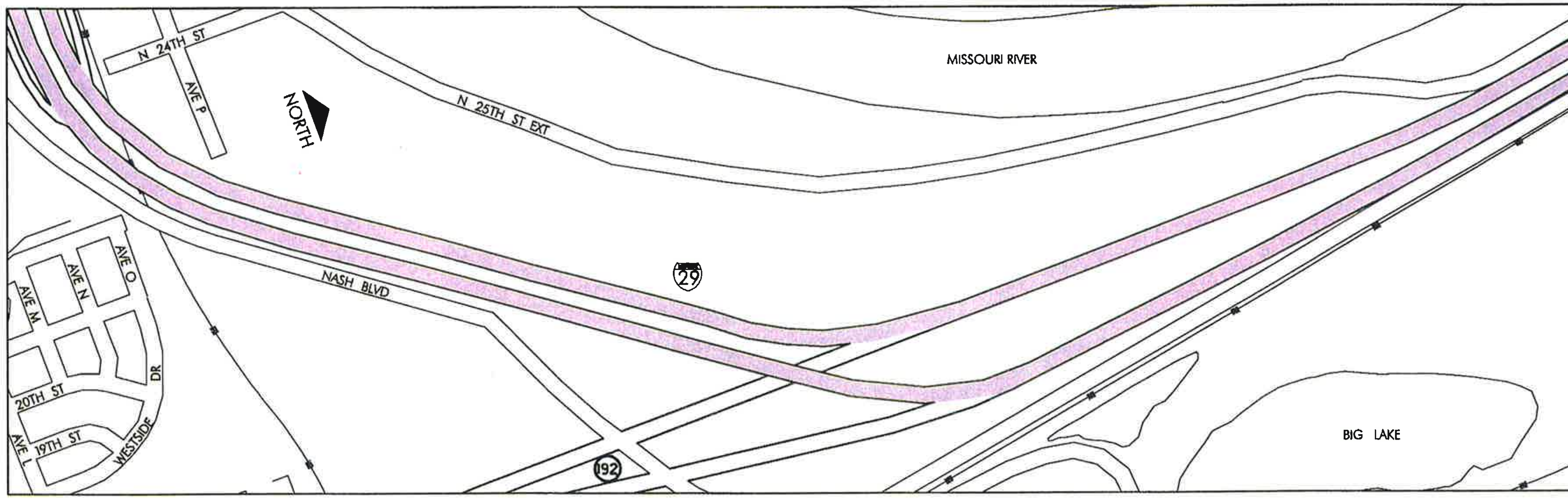
EXHIBIT
**A–20**

| | | |
|---|---|---|
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | LANE BALANCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | RAMP SEQUENCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | SIGNING | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, GOOD |
| | SAFETY | FAIR, FAIR, FAIR, FAIR, 75 ACC/HMVM, FAIR, FAIR, FAIR, GOOD, GOOD, 48 ACC/HMVM, GOOD, GOOD, GOOD |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | GOOD, GOOD |
| | VERTICAL ALIGNMENT | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | STOPPING SIGHT DISTANCE | |
| | CROSS SECTION | FAIR, FAIR, FAIR, FAIR, FAIR, GOOD, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR |
| | DECISION SIGHT DISTANCE | GOOD, GOOD |
| | EXIT & ENTRANCE DESIGN | GOOD, GOOD |
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | FAIR |
| | PAVEMENT | GOOD, GOOD, FAIR, FAIR, FAIR, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |

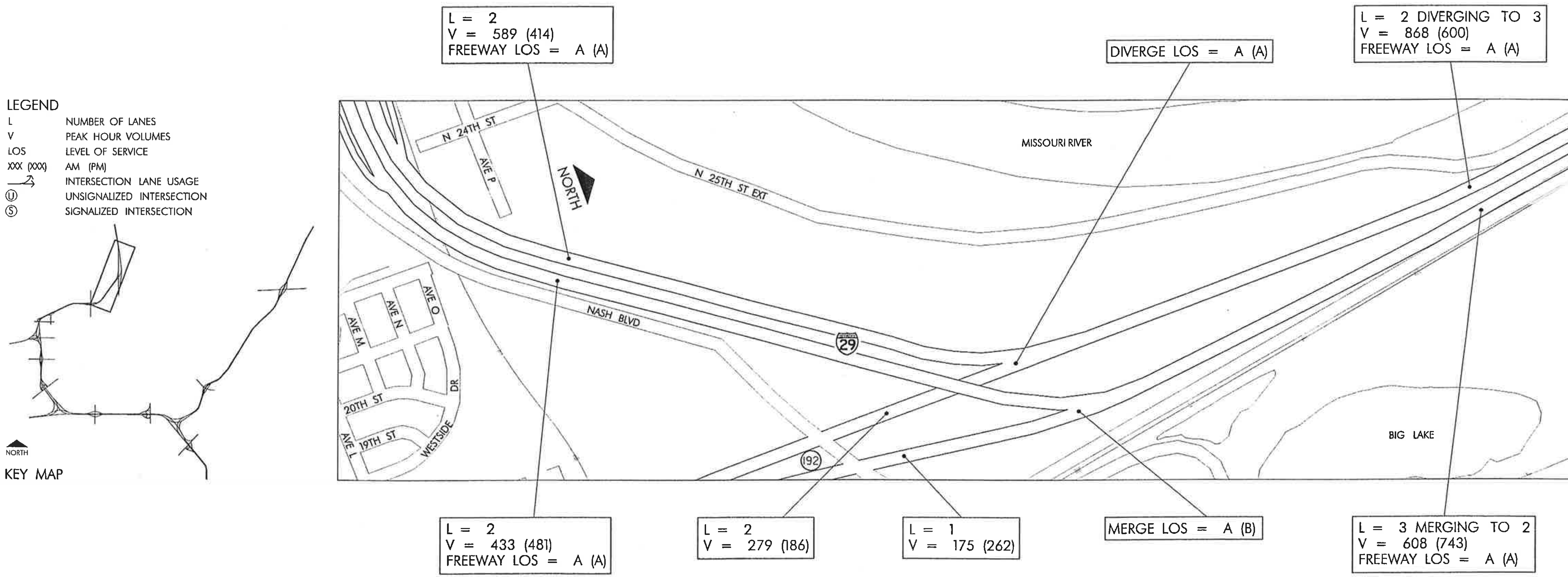
LEGEND

- GOOD — GOOD CONDITIONS
- FAIR — FAIR CONDITIONS
- POOR — POOR CONDITIONS
- NA — NOT APPLICABLE




| | | |
|---|---|---|
| PHYSICAL CONDITIONS | HIGHWAY STRUCTURES | GOOD, POOR |
| | PAVEMENT | GOOD, GOOD, FAIR, FAIR, FAIR, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| GEOMETRIC FEATURES | HORIZONTAL ALIGNMENT | FAIR, FAIR |
| | VERTICAL ALIGNMENT | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | STOPPING SIGHT DISTANCE | POOR |
| | CROSS SECTION | FAIR, FAIR, FAIR, FAIR, FAIR, GOOD, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR, FAIR |
| | DECISION SIGHT DISTANCE | |
| | EXIT & ENTRANCE DESIGN | GOOD, GOOD |
| OPERATIONAL FEATURES | LANE & ROUTE CONTINUITY | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | LANE BALANCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | RAMP SEQUENCE | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | SIGNING | GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD, GOOD |
| | SAFETY | FAIR, FAIR, FAIR, FAIR, 68 ACC/HMVM, FAIR, FAIR, FAIR, GOOD, GOOD, 41 ACC/HMVM, GOOD, GOOD, GOOD |

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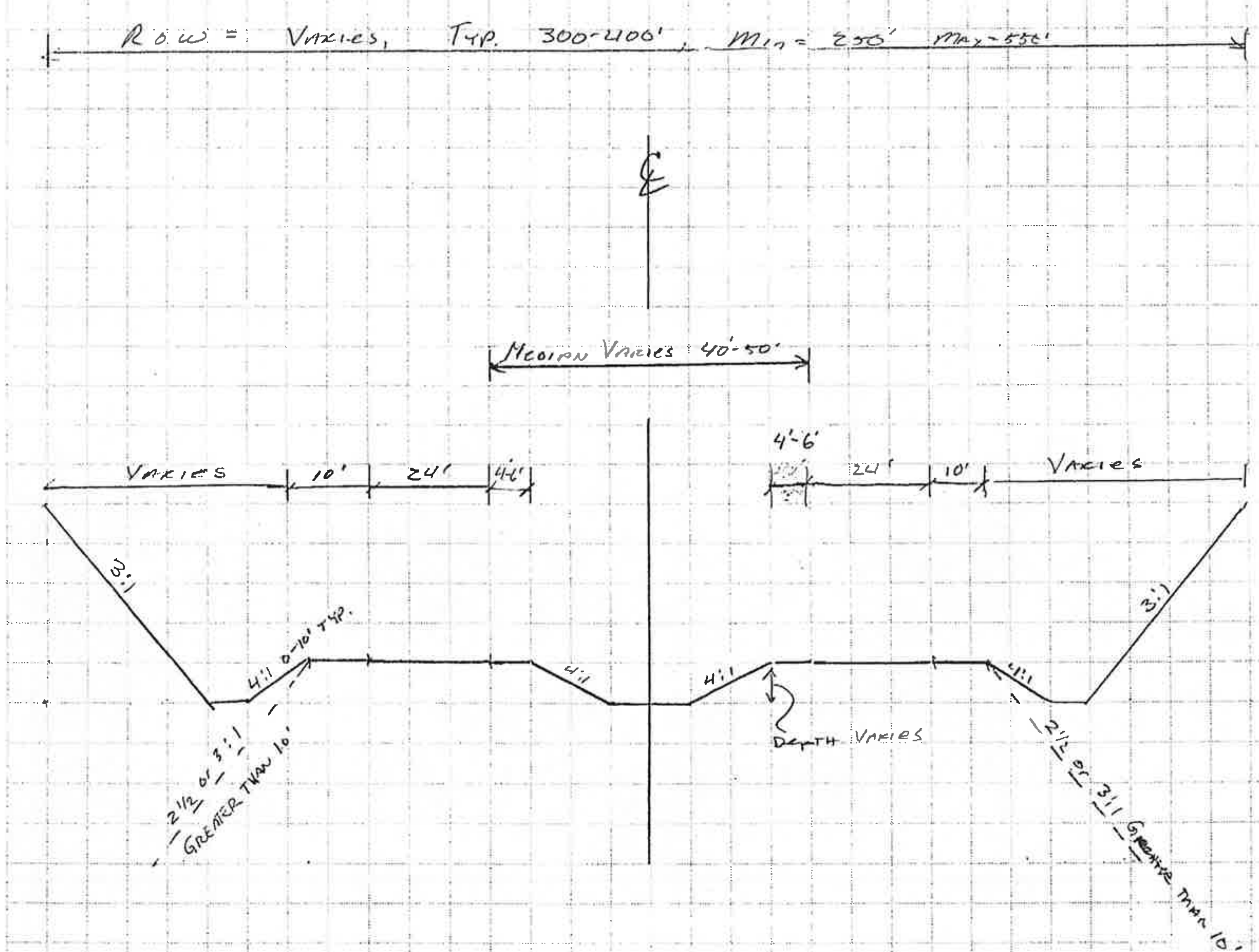
I-29 - N. 25TH STREET TO IA 192 (16TH STREET)

**PERFORMANCE MEASURES**

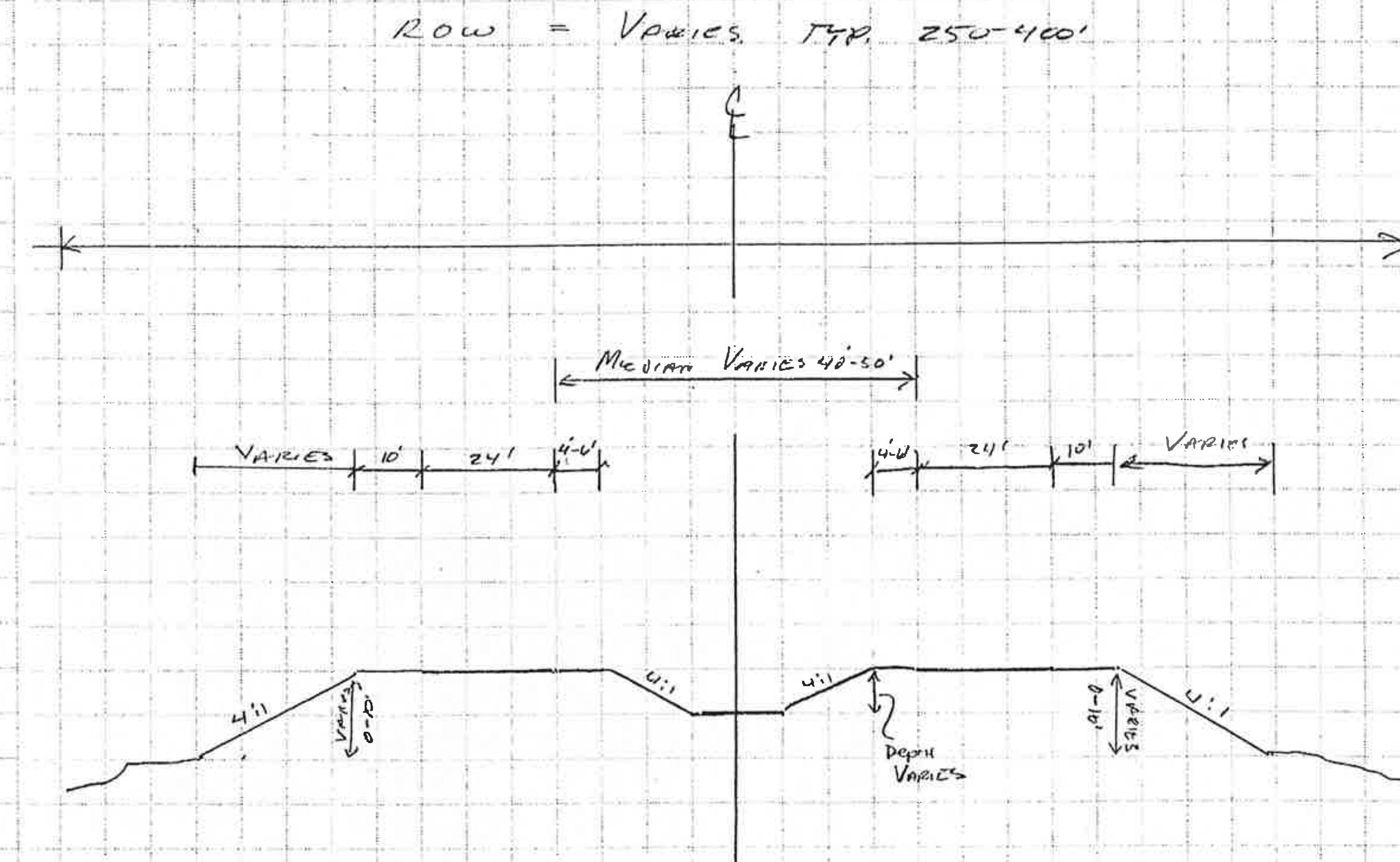
EXHIBIT **A-22**

# APPENDIX B

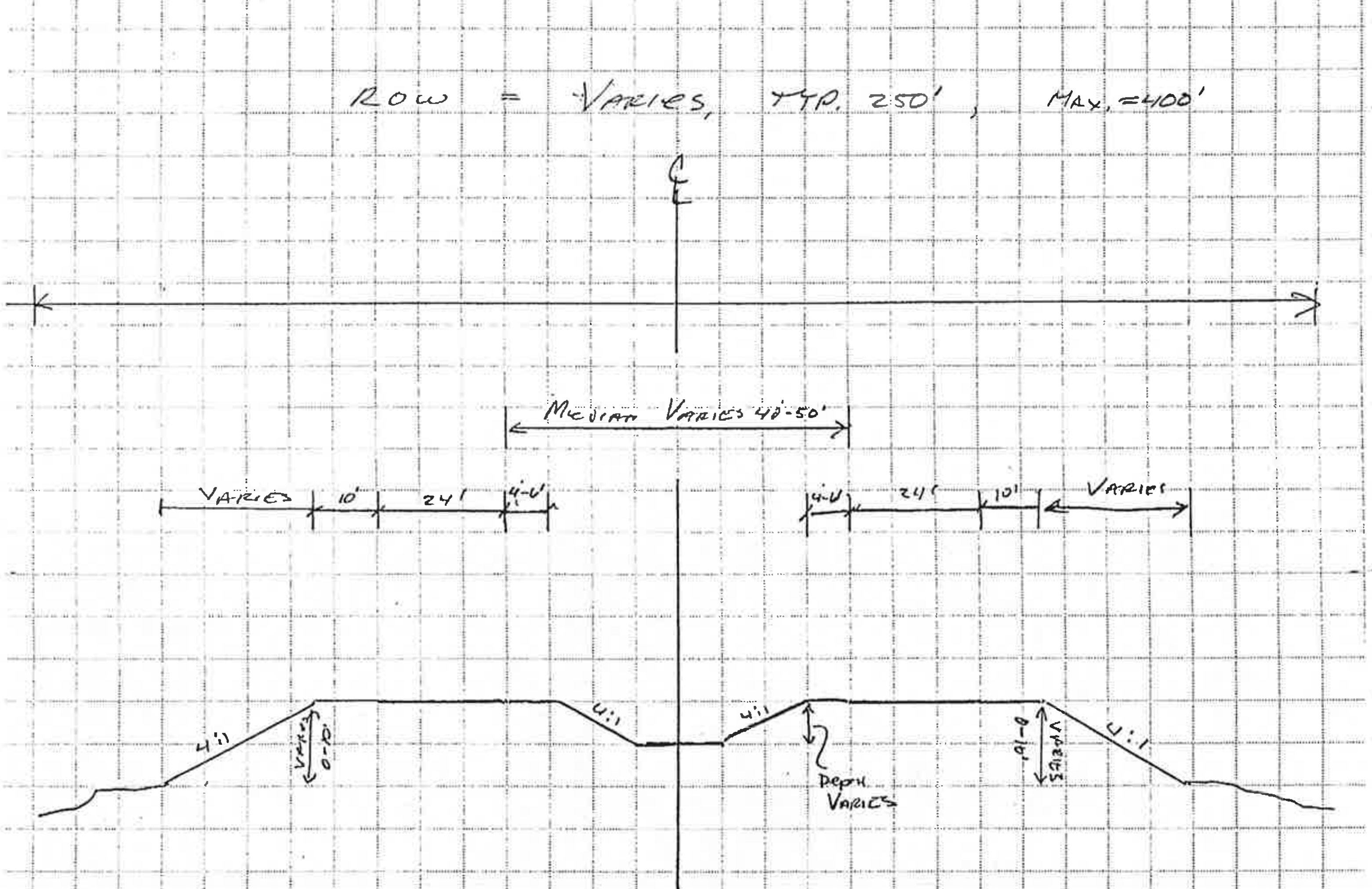
**Other Supporting Material**



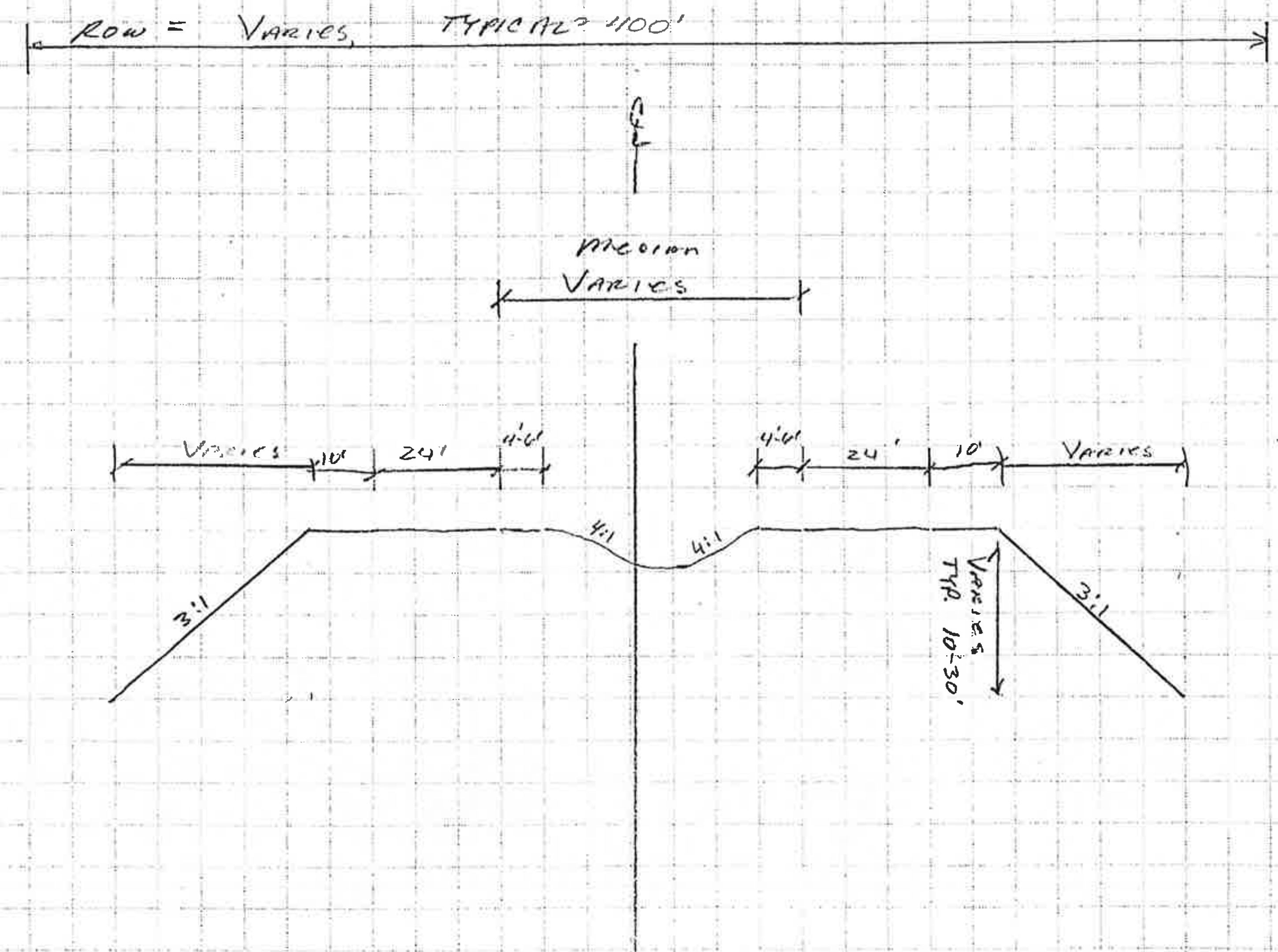

TYP SECTION → I-80 EAST OF MADISON AVE




TYP. SECTION, I-80 MO. RIVER - MADISON




Typ. Section, I-29




TYP. Section, Interchange & Bridge Approaches I-29, I-80, I-480

*Stopping Sight Distance Spreadsheet*

| NUMBER | A | L | S1 (S < L) | S2 (S > L) | ACTUAL S | RATING |
|---|---|---|---|---|---|---|
| 1 | 3.74 | 1100 | **625** | 728 | **625** | G |
| 2 | 4.79 | 1500 | **645** | 889 | **645** | G |
| 3 | 1.55 | 500 | 655 | **679** | **679** | G |
| 4 | 2.29 | 600 | 590 | 590 | **590** | F |
| 5 | 1.92 | 700 | 696 | 696 | **696** | G |
| 6 | 2.77 | 725 | **590** | 602 | **590** | F |
| 7 | 1.22 | 350 | 617 | **720** | **720** | G |
| 8 | 1.46 | 500 | 675 | **705** | **705** | G |
| 9 | 6.29 | 1025 | **465** | 618 | **465** | P |
| 10 | 5.8 | 1450 | **576** | 840 | **576** | F |
| 11 | 1.84 | 400 | 538 | **561** | **561** | F |
| 12 | 0.81 | 600 | 992 | **1120** | **992** | G |
| 13 | 0.6 | 995 | 1485 | **1605** | **1605** | G |
| 14 | 1.56 | 500 | 653 | **676** | **676** | G |
| 15 | 3.36 | 900 | **597** | 648 | **597** | F |
| 16 | 2.63 | 900 | **674** | 703 | **674** | G |
| 17 | 6.63 | 1100 | **470** | 650 | **470** | P |
| 18 | 2.31 | 800 | **678** | 688 | **678** | G |
| 19 | 3.17 | 800 | **579** | 610 | **579** | F |
| 20 | 5.69 | 900 | **458** | 567 | **458** | P |
| 21 | 4.36 | 650 | **445** | 477 | **445** | P |
| 22 | 4.35 | 1100 | **580** | 703 | **580** | F |
| 23 | 3.41 | 848 | **575** | 619 | **575** | F |
| 24 | 5 | 80 | 146 | **173** | **173** | P |
| 25 | 1.28 | 150 | 395 | **594** | **594** | F |
| 26 | 2.34 | 300 | 413 | **434** | **434** | P |
| 27 | 6.32 | 550 | **340** | 380 | **340** | P |
| 28 | 2.03 | 250 | 405 | **452** | **452** | P |
| 29 | 3.85 | 350 | **348** | 348 | **348** | P |
| 30 | 5.39 | 550 | **368** | 368 | **368** | P |
| 31 | 0.44 | 150 | 673 | **1585** | **1585** | G |
| 32 | 4.45 | 650 | **441** | 474 | **441** | P |
| 33 | 3.5 | 350 | **365** | 365 | **365** | P |
| 34 | 0.62 | 200 | **655** | 1172 | **665** | G |
| 35 | 4.76 | 800 | **473** | 540 | **473** | P |
| 36 | 4.04 | 550 | **425** | 439 | **425** | P |