



Client: City of Traverse City  
Project Name: Boardman Lake Avenue Origin  
Destination Study  
Location: Traverse City, Michigan  
Project Number: 12943424  
Issue Date: December 2, 2011

**PROJECT  
MEMORANDUM**

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TO: **Tim Lodge, PE**  
**City of Traverse City**

FROM: **Mike DeVries, PE and Ray Schneider, AICP**

SUBJECT: **Boardman Lake Avenue Origin-Destination Study - FINAL**

**1.0 EXECUTIVE SUMMARY**

The City of Traverse City, Michigan is considering construction of a new road along the west side of Boardman Lake. The City desires to understand the potential volumes that might use the new road—Boardman Lake Avenue—should the new road be built. It is anticipated that some traffic currently using local streets such as Cass Street, Union Street, and Lake Avenue would be diverted to Boardman Lake Avenue.

A detailed origin/destination (O/D) study was conducted in October 2011 to better estimate the amount of traffic that would potentially be diverted to Boardman Lake Avenue. License plates were recorded at key intersections along 8<sup>th</sup> Street and 14<sup>th</sup> Street to determine the amount of “cut through” traffic currently using Cass Street, Union Street, and, to a lesser extent, Lake Avenue. A total of 349 cars using Union Street and Cass Street were found to be “divertable” to a proposed Boardman Lake Avenue in the morning peak hour. Likewise, a total of 500 cars using Union Street and Cass Street were found to be “divertable” to a proposed Boardman Lake Avenue in the afternoon peak hour.

The peak-hour O/D data was projected to daily traffic volumes using standard traffic engineering techniques. The results indicate that the projected Average Daily Traffic volume (ADT) on Boardman Lake Avenue will be approximately 5,300 vehicles per day after the road is opened. Since it is not possible to study every possible O/D combination that exists (although the O/D patterns reviewed were the most logical/high volume patterns), it is estimated that the ADT on Boardman Lake Avenue may approach or exceed 6,000 vehicles per day.

Daily traffic volumes on Cass Street and Union Street will be reduced by more than 30% between 8<sup>th</sup> Street and 14<sup>th</sup> Street. Daily traffic volume between on 8<sup>th</sup> Street between Cass Street and the proposed Boardman Lake Avenue will be reduced by more than 35%.

**Study Recommendations**

1. It is recommended that an eastbound left-turn lane be constructed opposite the westbound left-turn lane at the 14<sup>th</sup> Street/Cass Street intersection as part of the construction of Boardman Lake Avenue.
2. It is recommended that the eastbound-westbound protected left-turn phase at the 8<sup>th</sup> Street/Cass Street intersection be removed and a simple 2-phase signal be implemented. The protected left-turn phase would no longer be needed after Boardman Lake Avenue is open. A simple two-phase signal operation will operate efficiently.
3. With the reduction in traffic on 8<sup>th</sup> Street and Cass Street that is anticipated when Boardman Lake Avenue opens, the City should consider allowing northbound-to-westbound left-turns at the 8<sup>th</sup>

Street/Cass Street intersection (currently prohibited). Minor widening of the northbound approach is recommended in order to provide dedicated left-turn storage, similar to how the southbound approach is currently designed. The existing “No Left Turn Symbol” case sign facing northbound traffic would be removed.

4. Upon the opening of Boardman Lake Avenue, the City should specifically monitor and review whether protected left-turn phasing may be needed for the westbound-to-southbound left-turn movement at the new 8<sup>th</sup> Street/Boardman Lake Avenue intersection. If left-turn volumes are higher than projected in this report, left-turn phasing may be necessary.
5. Upon the opening of Boardman Lake Avenue, it is recommended that traffic signal timings be reviewed and optimized at 8<sup>th</sup> Street/Cass Street, 8<sup>th</sup> Street/Union Street, 14<sup>th</sup> Street/Cass Street, and 14<sup>th</sup> Street/Union Street to account for the changes in traffic patterns.

## 2.0 INTRODUCTION

The City of Traverse City, Michigan is considering construction of a new road along the west side of Boardman Lake. The City desires to understand the potential volumes that might use the new road, Boardman Lake Avenue, should the new road be built. It is anticipated that some traffic currently using local streets such as Cass Street, Union Street, and Lake Avenue would be diverted to Boardman Lake Avenue. A detailed origin/destination (O/D) study was conducted in October 2011 to better estimate the amount of traffic that would potentially be diverted to Boardman Lake Avenue. The study area for the O/D study is bounded by Union Street on the west, 8<sup>th</sup> Street on the north, the west bank of Boardman Lake on the east, and 14<sup>th</sup> Street on the south. The existing study area and proposed Boardman Lake Avenue are shown in **Figure 1**.

## 3.0 EXISTING ROADWAY CONDITIONS

The study area included seven (7) intersections:

- 14<sup>th</sup> Street/Union Street
- 14<sup>th</sup> Street/Cass Street
- 8<sup>th</sup> Street/Union Street
- 8<sup>th</sup> Street/Cass Street
- 10<sup>th</sup> Street/Lake Avenue
- 8<sup>th</sup> Street/Lake Avenue (east junction)
- 8<sup>th</sup> Street/Lake Avenue (west junction)

**Figure 2** depicts the existing laneage for the seven study area intersections. All roadways in the study area have a 25-mph speed limit and have two-lane two-way cross-sections with the exception of the eastbound 8<sup>th</sup> Street approach at Union Avenue, which is a one-lane one-way approach with on-street parking on both sides. A description of the roadways in the study area is detailed below.

- **14<sup>th</sup> Street** is major east-west street, providing access to downtown Traverse City via Union Street and Cass Street. 14<sup>th</sup> Street begins as the east leg of the US-31/M-37/Silver Lake Road/14<sup>th</sup> Street intersection, southwest of downtown Traverse City. 14<sup>th</sup> Street terminates at Lake Ridge Drive. The Average Daily Traffic (ADT) volume of 14<sup>th</sup> Street is approximately 14,900 vehicles per day west of Union Street and 10,400 vehicles per day between Union Street and Cass Street.
- **10<sup>th</sup> Street** is a local east-west street. 10<sup>th</sup> Street begins at US-31/M-37 and terminates at Lake Avenue. The ADT of 10<sup>th</sup> Street is approximately 1,500 vehicles per day west of Lake Avenue.
- **8<sup>th</sup> Street** is major east-west street, providing crosstown access within the City of Traverse City. 8<sup>th</sup> Street begins at US-31/M-37 and terminates at US-31/M-72. The ADT of 8<sup>th</sup> Street is approximately

9,100 vehicles per day between Union Street and Cass Street, 13,300 vehicles per day east of Lake Avenue, and 21,500 vehicles per day between west of Boardman Avenue.

- **Union Street** is major north-south street providing north-south access to and from downtown Traverse City. Union Street begins on the southern edge of the city limits south of 14<sup>th</sup> Street and terminates at US-31/M-72 on the northern edge of downtown. The ADT of Union Street is approximately 6,900 vehicles per day between 14<sup>th</sup> Street and 8<sup>th</sup> Street.
- **Cass Street** is major north-south street providing access to and from downtown Traverse City. Cass Street begins at the southern city limit south of 14<sup>th</sup> Street and terminates at US-31/M-72 on the northern edge of downtown. The ADT of Cass Street is approximately 10,500 vehicles per day south of 14<sup>th</sup> Street and 10,500 vehicles per day between 14<sup>th</sup> Street and 8<sup>th</sup> Street.
- **Lake Avenue** is a two-lane local street in the study area. Lake Avenue is a north-south street between 8<sup>th</sup> Street and 12<sup>th</sup> Street. The ADT of Lake Avenue is approximately 3,900 vehicles per day south of 8<sup>th</sup> Street.

### 3.1 Data Collection

Tube counts, origin/destination (O/D) data, and turning movement counts were collected as described herein.

#### 3.1.1. Tube Counts

URS conducted 24-hour directional tube counts from Tuesday, October 18, 2011 to Wednesday, October 19, 2011 at the following fourteen intersections.

- SB Cass Street (north of 14<sup>th</sup> Street)
- NB Cass Street (south of 8<sup>th</sup> Street)
- SB Cass Street (south of 14<sup>th</sup> Street)
- NB Cass Street (south of 14<sup>th</sup> Street)
- SB Union Street (north of 14<sup>th</sup> Street)
- NB Union Street (south of 8<sup>th</sup> Street)
- SB Lake Avenue (south of 8<sup>th</sup> Street)
- NB Lake Avenue (south of 8<sup>th</sup> Street)
- EB 14<sup>th</sup> Street (west of Union Street)
- WB 14<sup>th</sup> Street (west of Union Street)
- EB 8<sup>th</sup> Street (west of Boardman Avenue)
- WB 8<sup>th</sup> Street (west of Boardman Avenue)
- EB 8<sup>th</sup> Street (east of Boardman Avenue)
- WB 8<sup>th</sup> Street (east of Boardman Avenue)

The results of the 24-hour counts are depicted below, from highest to lowest, in vehicles per day (vpd). The existing 24-hour traffic volumes are also shown in **Figure 2**.

- 8<sup>th</sup> Street west of Boardman Avenue 21,500 vehicles per day (vpd)
- 8<sup>th</sup> Street east of Boardman Avenue 19,000 vpd
- 14<sup>th</sup> Street west of Union Street 14,900 vpd
- Cass Street south of 14<sup>th</sup> Street 10,500 vpd
- Cass Street north of 14<sup>th</sup> Street 10,500 vpd
- Union Street north of 14<sup>th</sup> Street 6,900 vpd
- Lake Avenue south of 8<sup>th</sup> Street 3,900 vpd

#### 3.1.2. Turning Movement Counts

URS conducted peak period turning movement counts on Tuesday, October 18, 2011 from 4:15 to 5:45 PM and on Wednesday, October 19, 2011 from 7:30 to 9:00 AM at the seven study area intersections listed on page 2.

The existing peak hour traffic volumes are shown in **Figure 3**. As with the tube counts, the morning peak hour varied between 7:30 to 8:30 AM and 7:45 to 8:45 AM. The afternoon peak hour was 4:30 to 5:30 PM.

### 3.1.3. Origin/Destination Data Collection

To develop a better understanding of the potential traffic volumes that might use Boardman Lake Avenue, an origin/destination (O/D) study was conducted. The purpose of the study was to assess the extent to which traffic currently using roads like Cass Street, Union Street, and Lake Avenue would be diverted to Boardman Lake Avenue. The details of the O/D study are discussed in Section 5.

## 4.0 EXISTING (2011) CONDITIONS

In order to quantify intersection traffic operations, existing “Level-of-Service” (LOS) values were determined using industry-standard *HCS 2010* software, which incorporates the methodology of the *Highway Capacity Manual* (HCM), 2010 Edition, published by the Transportation Research Board. *HCS 2010* was used to determine existing peak hour “Levels of Service” of the traffic movements at each intersection. The term “Level of Service” (LOS) indicates how well (or poorly) traffic operates based on traffic volumes, lane configurations, and traffic controls. Each level is determined by the average amount of traffic control delay experienced by motorists. LOS “A” represents little or no delays while LOS “F” represents operational failure (extensive delays which may include long vehicular queues). LOS “D” or better is typically considered acceptable during peak hours for urban settings like City of Traverse City. The Level-of-Service criteria, as defined by the HCM, are described in **Table 1** for signalized and unsignalized intersections.

**Table 1. Peak-Hour Level-Of-Service Ranges at Intersections  
 Highway Capacity Manual (2010)**

Level-of-Service	Signalized Intersections Control Delay (sec/veh)	Unsignalized Intersections Control Delay (sec/veh)
A	<10	<10
B	10 – 20	10 – 15
C	20 – 35	15 – 25
D	35 – 55	25 – 35
E	55 – 80	35 – 50
F	>80	>50

Source: 2010 Highway Capacity Manual

### 4.1 Existing (2011) Levels-of-Service

The existing (2011) peak-hour Levels of Service at the study area intersections are depicted in **Figure 3**. A review of Figure 3 reveals that all turning movements operate at Level-of-Service “D” or better except for the Lake Avenue approaches to 8<sup>th</sup> Street which operate at LOS “F” as discussed below.

#### Southbound Lake Avenue Approach

The morning and afternoon peak-hour approach volumes on southbound Lake Avenue are low with a 95<sup>th</sup>-percentile queue of only five (5) vehicles. If a separate southbound left-turn lane was constructed, the

southbound right-turn LOS would improve to “D”, while the southbound left-turn movement (22 vehicles) would remain LOS “F” with a 95<sup>th</sup>-percentile queue of only four (4) vehicles.

#### Northbound Lake Avenue Approach

The morning and afternoon peak-hour approach volumes on northbound Lake Avenue are low with a 95<sup>th</sup>-percentile queue of twelve (12) vehicles. If a separate northbound left-turn lane was constructed, the northbound right-turn LOS would improve to “D”, while the northbound left-turn movement (10 vehicles) would remain LOS “F” with a 95<sup>th</sup>-percentile queue of only two (2) vehicles.

## **5.0 ORIGIN/DESTINATION STUDY**

To develop a better understanding of the potential volumes that might use Boardman Lake Avenue, an origin/destination (O/D) study was conducted. The purpose of the study was to assess the extent to which traffic currently using roads like Cass Street, Union Street, and Lake Avenue would be diverted to Boardman Lake Avenue.

O/D data was collected at twelve locations as depicted in **Figure 4** and as listed below. O/D data was estimated for Station 10 to Station 11 based on actual O/D data collected for Station 2 to Station 8. Likewise, O/D data was estimated for Station 6 to Station 12 based on actual O/D data collected for Station 5 to Station 7.

- |   |  |
|---|--|
| 1 - EB-to-NB left-turn at 14 <sup>th</sup> Street/Union Street  | 8 - NB-to-EB right-turn at 8 <sup>th</sup> Street /Union Street  |
| 2 - NB through at 14 <sup>th</sup> /Union Street                | 9 - SB-to-WB right-turn at 14 <sup>th</sup> Street /Union Street |
| 3 - EB-to-NB left-turn at 14 <sup>th</sup> Street /Cass Street  | 10 - WB-to-SB left-turn at 8 <sup>th</sup> Street /Union Street  |
| 4 - SB-to-WB right-turn at 14 <sup>th</sup> Street /Cass Street | 11 – SB through at 14 <sup>th</sup> Street /Union Street         |
| 5 - NB through at 14 <sup>th</sup> Street /Cass Street          | 12 – SB through at 14 <sup>th</sup> Street /Cass Street          |
| 6 - WB-to-SB left-turn at 8 <sup>th</sup> Street /Cass Street   | 13 - WB-to-SB left-turn at 8 <sup>th</sup> Street /Lake Avenue   |
| 7 - NB-to-EB right-turn at 8 <sup>th</sup> Street /Cass Street  | 14 - WB-to-SB left-turn at 8 <sup>th</sup> Street /Union Street  |

The O/D data was collected by stationing individuals at twelve locations. Each individual used a hand-held digital voice recorder to recite the last three digits/characters of the license plate for those vehicles making the traffic movement of interest. The O/D data was collected during the morning and afternoon peak hour. The peak hours were chosen based on peak hours identified from the 24-hour tube counts. Based on the tube counts, O/D data was collected from 7:40 to 8:50 AM to cover the morning peak hour and from 4:25 to 5:35 PM to cover the afternoon peak hour. Data was collected for the five (5) minutes prior to the five (5) minutes after each peak hour.

After the O/D data was collected, the recordings were transcribed. A time stamp was applied to each license plate. Matching license plates that made the O/D trip of interest were counted. The results are shown in **Table 2** atop the next page.

The results in Table 2 indicate, for example, that 137 vehicles (line 5 of the table) made an eastbound left-turn at the 14<sup>th</sup> Street/Cass Street intersection (Station 3) and then subsequently made a northbound right-turn at the 8<sup>th</sup> Street/Cass Street intersection (Station 7) in the morning peak hour. A total of 349 cars using Union Street and Cass Street were found to be “divertable” to a proposed Boardman Lake Avenue in the morning peak hour. Likewise, a total of 500 cars using Union Street and Cass Street were found to be “divertable” to a proposed Boardman Lake Avenue in the afternoon peak hour.

**Table 2. Origin/Destination Study Results**

Diverted Peak Hour Traffic	O/D Pair <sup>(1)</sup>		O/D Pair Matches (number of vehicles)	
	From Station	To Station	AM Peak Hour	PM Peak Hour
Traffic Divertible from Union Street	1	8	41	31
	2	8	20	7
	10	9	44	125
	10	11	14 <sup>(2)</sup>	42 <sup>(2)</sup>
Traffic Divertible from Cass Street	3	7	137	105
	5	7	28	34
	3	14	27	4
	6	4	45	88
	6	12	15 <sup>(3)</sup>	29 <sup>(3)</sup>
	13	4	5	39
TOTAL			349	500

<sup>(1)</sup> Refer to Figure 4 for the O/D pair locations.

Source: URS Corporation, November 2011

<sup>(2)</sup> Estimated based on results for O/D pairs 2-8.

<sup>(3)</sup> Estimated based on results for O/D pairs 5-7.

## 5.1 Origin-Destination Study Findings

Diverted volumes by movement and peak hour were assessed. The findings in Table 2 reveal the following O/D results:

### 8<sup>th</sup> Street/Union Street

- Approximately two-thirds of the traffic volume that makes the westbound-to-southbound left-turn movement at 8<sup>th</sup> Street/Union Street is “thru” traffic (i.e. turns right onto westbound 14<sup>th</sup> Street or continues south on Union Street) and would use Boardman Lake Avenue.
- Approximately one-half of the traffic volume that makes the northbound-to-eastbound right-turn movement at 8<sup>th</sup> Street/Union Street is “thru” traffic (i.e. from eastbound 14<sup>th</sup> Street or northbound Union Street) and would use Boardman Lake Avenue.

### 8<sup>th</sup> Street/Cass Street

- Approximately one-half of the traffic volume that makes the westbound-to-southbound left-turn movement at 8<sup>th</sup> Street/Cass Street is “thru” traffic (i.e. turns right onto westbound 14<sup>th</sup> Street or continues south on Cass Street) and would use Boardman Lake Avenue.
- Approximately three-fourths of the traffic volume that makes the northbound-to-eastbound right-turn movement at 8<sup>th</sup> Street/Cass Street is “thru” traffic (i.e. from eastbound 14<sup>th</sup> Street or northbound Cass Street) and would use Boardman Lake Avenue.

### 14<sup>th</sup> Street/Union Street

- Approximately one-fourth of the traffic volume that makes the eastbound-to-northbound left-turn movement at 14<sup>th</sup> Street/Union Street is “thru” traffic (i.e. turns right onto eastbound 8<sup>th</sup> Street) and would use Boardman Lake Avenue.
- Approximately one-half of the traffic volume that makes the southbound-to-westbound right-turn movement at 14<sup>th</sup> Street/Union Street is “thru” traffic (i.e. from westbound 8<sup>th</sup> Street) and would use Boardman Lake Avenue.
- Approximately one-half of the traffic volume that makes the northbound through movement at 14<sup>th</sup> Street/Union Street is “thru” traffic (i.e. turns right onto eastbound 8<sup>th</sup> Street from Union Street) and would use Boardman Lake Avenue.

- Approximately one-tenth of the traffic volume that makes the southbound through movement at 14<sup>th</sup> Street/Union Street is “thru” traffic (i.e. from westbound 8<sup>th</sup> Street) and would use Boardman Lake Avenue. This estimate is based on the opposite northbound O/D results at 14<sup>th</sup> Street/Union Street.

#### 14<sup>th</sup> Street/Cass Street

- Approximately one-half of the traffic volume that makes the eastbound-to-northbound left-turn movement at 14<sup>th</sup> Street/Cass Street is “thru” traffic (i.e. turns right onto eastbound 8<sup>th</sup> Street) and would use Boardman Lake Avenue.
- Approximately one-half of the traffic volume that makes the southbound-to-westbound right-turn movement at 14<sup>th</sup> Street/Cass Street is “thru” traffic (i.e. from westbound 8<sup>th</sup> Street) and would use Boardman Lake Avenue.
- Approximately one-eighth of the traffic volume that makes the northbound through movement at 14<sup>th</sup> Street/Cass Street is “thru” traffic (i.e. turns right onto eastbound 8<sup>th</sup> Street at Cass Street) and would use Boardman Lake Avenue.
- Approximately one-tenth of the traffic volume that makes the southbound through movement at 14<sup>th</sup> Street/Cass Street is “thru” traffic (i.e. from westbound 8<sup>th</sup> Street) and would use Boardman Lake Avenue. This estimate is based on the opposite northbound O/D results at 14<sup>th</sup> Street/Cass Street.

#### 8<sup>th</sup> Street/Lake Avenue

- A small percentage of northbound thru traffic at 14<sup>th</sup> Street/Cass Street and 14<sup>th</sup> Street/Union Street used Lake Avenue to reach 8<sup>th</sup> Street. Based on discussions with the City, some drivers destined to 8<sup>th</sup> Street or downtown follow northbound Cass Street, to eastbound 12<sup>th</sup> Street, to Lake Avenue as their route.
- Approximately one-sixth of the traffic volume that makes the northbound-to-eastbound right-turn movement at 8<sup>th</sup> Street/Lake Avenue in the morning peak hour is “thru” traffic and would use Boardman Lake Avenue, while less than 5% of the traffic volume that making this movement in the afternoon peak hour is “thru” traffic and would use Boardman Lake Avenue.
- Approximately one-fifth of the traffic volume that makes the westbound-to-southbound right-turn movement at 8<sup>th</sup> Street/Lake Avenue in the afternoon peak hour is “thru” traffic and would use Boardman Lake Avenue, while less than 5% of the traffic volume making this movement in the afternoon peak hour is “thru” traffic and would use Boardman Lake Avenue.

## 5.2 K-factors

The 24-hour tube counts were used to calculate “K factors”. A “K factor” is the percent of daily traffic volume that occurs in a peak hour. The “K factor” for the morning and afternoon peak hours were applied to the actual morning and afternoon peak hour volumes to project the daily traffic diversion to Boardman Lake Avenue. **Table 3** atop the next page shows 24-hour counts, morning and afternoon peak hour counts, and the resulting average K factors for the morning and afternoon peak hours.

Table 3 reveals that the average morning K factor is 7.1% on study area streets while the afternoon K factor is 9.5% on study area streets. In other words, approximately 7.1% of the daily traffic volume occurs during the morning peak hour, while approximately 9.5% of the daily traffic volume occurs during the afternoon peak hour.

**Table 3. Tube Count Summary and K Factors by Street**

Direction (Location)	Peak Hour Volume		24-Hour Volume	K Factor	
	AM	PM		AM	PM
<b>Cass Street</b>					
SB Cass Street (north of 14 <sup>th</sup> Street)	323	556	5,573	5.8%	10.0%
NB Cass Street (south of 8 <sup>th</sup> Street)	381	380	4,849	7.9%	7.8%
SB Cass Street (south of 14 <sup>th</sup> Street)	364	530	5,548	6.6%	9.6%
NB Cass Street (south of 14 <sup>th</sup> Street)	399	401	4,978	8.0%	8.1%
<b>Union Street</b>					
SB Union Street (north of 14 <sup>th</sup> Street)	173	438	4,978	4.6%	11.7%
NB Union Street (south of 8 <sup>th</sup> Street)	304	253	3,732	10.1%	8.4%
<b>Lake Avenue</b>					
SB Lake Avenue (south of 8 <sup>th</sup> Street)	113	207	3,011	6.0%	10.9%
NB Lake Avenue (south of 8 <sup>th</sup> Street)	148	169	1,895	7.5%	8.5%
<b>14<sup>th</sup> Street</b>					
EB 14 <sup>th</sup> Street (west of Union Street)	552	543	1,980	7.7%	7.6%
WB 14 <sup>th</sup> Street (west of Union Street)	410	710	7,172	5.4%	9.3%
<b>8<sup>th</sup> Street</b>					
EB 8 <sup>th</sup> Street (west of Boardman Avenue)	558	633	7,215	7.7%	8.8%
WB 8 <sup>th</sup> Street (west of Boardman Avenue)	715	1,146	11,635	6.1%	9.8%
<b>TOTAL</b>	<b>4,440</b>	<b>5,966</b>	<b>62,566</b>	<b>7.1%</b>	<b>9.5%</b>

Source: Tube counts by URS Corporation, October 18 and 19, 2011.

### 5.3 Average Daily Traffic (ADT) Projections

The average K factors were applied to the morning and afternoon peak hour volume diversions (in Table 2) to project the ADT of Boardman Lake Avenue and the corresponding reduction in ADT along other city streets. **Table 4** provides a summary of these daily traffic projections. As shown in Table 4, using the afternoon K-factor results in the greatest projection of daily volume (as compared to using the morning K-factor).

**Table 4. Daily Traffic Diversion and Daily Traffic Projection on Proposed Boardman Lake Avenue**

Street	Location	Actual Diverted Peak Hour Traffic Volume		Average K Factor		Estimated Diverted Daily Traffic Volume	
		AM	PM	AM	PM	Using AM K Factor	Using PM K Factor
8 <sup>th</sup> Street	Union Street to Cass Street	-119	-205	7.1%	9.5%	-1,700	-2,150
8 <sup>th</sup> Street	East of Cass Street	-317	-457			-4,450	-4,800
Cass Street	8 <sup>th</sup> Street to 14 <sup>th</sup> Street	-225	-295			-3,100	-3,150
Union Street	8 <sup>th</sup> Street to 14 <sup>th</sup> Street	-119	-205			-1,700	-2,150
14 <sup>th</sup> Street	Cass Street to Union Street	+134	+234			+1,900	+2,450
Proposed Boardman Lake Avenue		+347	+504			+4,900	+5,300

The projected changes in daily traffic was subtracted or added to the actual daily traffic volumes to arrive at the projected ADT of 8<sup>th</sup>, Street, Cass Street, Union Street, and 14<sup>th</sup> Street. The results are shown in **Table 5**.

**Table 5. Existing and Projected ADT  
 with Proposed Boardman Lake Avenue**

Street	Location	Existing ADT	Estimated Change in ADT*	Projected ADT	% Change
8 <sup>th</sup> Street	Union Street to Cass Street	9,100	-2,150	<b>6,950</b>	- 23.7
8 <sup>th</sup> Street	East of Cass Street	13,300	-4,800	<b>8,500</b>	-36.2
Cass Street	14 <sup>th</sup> Street to 8 <sup>th</sup> Street	10,500	-3,150	<b>7,350</b>	-30.2
Union Street	14 <sup>th</sup> Street to 8 <sup>th</sup> Street	6,900	-2,150	<b>4,750</b>	-31.3
14 <sup>th</sup> Street	Union Street to Cass Street	10,400	+2,450	<b>12,850</b>	+23.7
Proposed Boardman Lake Avenue		0	+5,300	<b>5,300</b>	---

\*- using the afternoon K-factor from Table 4.

As shown in Table 5, it is projected that ADT on study area streets would be reduced by approximately 20% to 30% upon the opening of Boardman Lake Avenue, with the exception of 14<sup>th</sup> Street from Cass Street to Union Street, which would increase by approximately 20%. The ADT of the proposed Boardman Lake Avenue is anticipated to be approximately 5,300 vehicles per day based on the different O/D patterns reviewed. Since it is not possible to study every possible O/D combination that exists (although the O/D patterns reviewed were the most logical/high volume patterns), it is estimated that the ADT on the proposed Boardman Lake Avenue may approach or exceed 6,000 vehicles per day.

## **6.0 EXISTING (2011) CONDITIONS WITH BOARDMAN LAKE AVENUE EXTENSION**

An analysis of existing (2011) conditions, assuming the existence of Boardman Lake Avenue, was conducted to determine the impact to control delay and Level of Service at the key intersections along 8<sup>th</sup> Street, 14<sup>th</sup> Street, Cass Street, Union Street, and Lake Avenue. The analysis provides a measurement of the traffic impact created by the proposed Boardman Lake Avenue.

As shown in Figure 1, the current plan for Boardman Lake Avenue is for the proposed roadway to commence as the east leg of the 14<sup>th</sup> Street/Cass Street intersection, following some old railroad lines in a northeast/northerly direction, providing access to 10<sup>th</sup> Street, and terminating at 8<sup>th</sup> Street east of Lake Avenue and west of the Boardman River. The proposed roadway would have a two-lane cross-section, widening to a three lane cross section on the approach to 8<sup>th</sup> Street to provide a dedicated northbound left-turn lane. Also, it is assumed that an eastbound left-turn lane would be constructed at the 14<sup>th</sup> Street/Cass Street intersection. A traffic signal is proposed at the intersection of Boardman Lake Avenue at 8<sup>th</sup> Street. The assumed lane configurations at the 14<sup>th</sup> Street/Cass Street and 8<sup>th</sup> Street/Boardman Lake Avenue intersections are shown in **Figure 5**.

### **6.1 Traffic Re-assignment**

Existing (2011) peak hour traffic was re-assigned from the various O/D stations to Boardman Lake Avenue. Figure 5 depicts the traffic volume re-assignment. Re-assignment assumes no other changes to existing study area roadways or traffic signal timings.

The re-assigned traffic (Figure 5) was applied to existing (2011) peak hour traffic volumes (Figure 3) to estimate the existing (2011) peak hour traffic volumes should Boardman Lake Avenue be constructed. The resulting peak hour volume estimates are shown in **Figure 6**.

As shown in Figure 6, it is projected that approximately 349 vehicles (226 northbound, 123 southbound) vehicles would be diverted in the morning peak hour and 500 vehicles (177 northbound, 323 southbound) vehicles would be diverted in the afternoon peak hour from study area intersections to Boardman Lake Avenue.

A review of Figure 6 also reveals that all turning movements are projected to operate at Level-of-Service “D” or better except for the southbound Lake Avenue approach to 8<sup>th</sup> Street which operates at LOS “E” in the morning peak hour and “F” in the afternoon peak hour, as it does under existing conditions. The reduction in peak hour volumes for several movements at the 8<sup>th</sup> Street/Lake Avenue intersection associated with the construction of Boardman Lake Avenue improves Level of Service of the northbound Lake Avenue approach in the afternoon peak hour from an existing LOS “F” to a projected LOS “C”.

**Table 6** depicts overall intersection LOS, comparing LOS under existing conditions with LOS assuming construction of Boardman Lake Avenue.

**Table 6. Signalized Intersection Level of Service and Delay  
With and Without Boardman Lake Avenue**

Intersection	Existing (2011)				Existing (2011) with Boardman Lake Avenue <sup>(1)</sup>			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
14 <sup>th</sup> Street/Cass Street	C	21.2	C	30.2	B	16.8	B	19.7
14 <sup>th</sup> Street/Union Street	B	17.9	B	19.2	B	18.8	C	23.2
8 <sup>th</sup> Street/Cass Street	C	28.4	C	34.0	C	24.9	C	29.3
8 <sup>th</sup> Street/Union Street	B	16.4	B	17.8	B	16.1	B	16.5
8 <sup>th</sup> Street/Boardman Lake Avenue					B	13.6	B	14.8

<sup>(1)</sup> Assumes no changes to existing signal timings. Assumes Boardman Lake Avenue has same cycle length as other 8<sup>th</sup> Street signalized intersections (80 seconds in morning and afternoon peak hours).

The re-assignment of peak hour traffic volumes to Boardman Lake Avenue results in slightly reduced delays at study area intersections, except at the 14<sup>th</sup> Street/Union Street intersection, which exhibits an insignificant increase in control delay. The overall signalized LOS for the new 8<sup>th</sup> Street/Boardman Lake Avenue intersection is “B” in both the morning and afternoon peak hours, assuming a simple 2-phase signal and 80-second cycle length.

## **7.0 CONCLUSIONS AND RECOMMENDATIONS**

The following conclusions were drawn based on the results of the analyses contained in this report:

### **7.1 Recommendations**

1. It is recommended that an eastbound left-turn lane be constructed opposite the westbound left-turn lane at the 14<sup>th</sup> Street/Cass Street intersection as part of the construction of Boardman Lake Avenue.
2. It is recommended that the eastbound-westbound protected left-turn phase at the 8<sup>th</sup> Street/Cass Street intersection be removed and a simple 2-phase signal be implemented. The protected left-turn phase would no longer be needed after Boardman Lake Avenue is open. A simple two-phase signal operation will operate efficiently.

3. With the reduction in traffic on 8<sup>th</sup> Street and Cass Street that is anticipated when Boardman Lake Avenue opens, the City should consider allowing northbound-to-westbound left-turns at the 8<sup>th</sup> Street/Cass Street intersection (currently prohibited). Minor widening of the northbound approach is recommended in order to provide dedicated left-turn storage, similar to how the southbound approach is currently designed. The existing “No Left Turn Symbol” case sign facing northbound traffic would be removed.
4. Upon the opening of Boardman Lake Avenue, the City should specifically monitor and review whether protected left-turn phasing may be needed for the westbound-to-southbound left-turn movement at the new 8<sup>th</sup> Street/Boardman Lake Avenue intersection. If left-turn volumes are higher than projected in this report, left-turn phasing may be necessary.
5. Upon the opening of Boardman Lake Avenue, it is recommended that traffic signal timings be reviewed and optimized at 8<sup>th</sup> Street/Cass Street, 8<sup>th</sup> Street/Union Street, 14<sup>th</sup> Street/Cass Street, and 14<sup>th</sup> Street/Union Street to account for the changes in traffic patterns. **Table 7** indicates the potential reduction in delay and improvement in LOS if signals were re-timed based on changes in traffic patterns as described in this report. **Figure 7** depicts signalized intersection LOS and delay with optimized timings.

**Table 7. Signalized Intersection Level of Service and Delay  
With Boardman Lake Avenue Without and With Optimized Timings**

Intersection	Existing (2011) with Boardman Lake Avenue Without Re-timings				Existing (2011) with Boardman Lake Avenue With Re-timings			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
14 <sup>th</sup> Street/Cass Street	B	16.8	B	19.7	B	16.7	B	19.6
14 <sup>th</sup> Street/Union Street	B	18.8	C	23.2	B	15.7	B	17.2
8 <sup>th</sup> Street/Cass Street <sup>(1)</sup>	C	24.9	C	29.3	B	15.8	B	17.8
8 <sup>th</sup> Street/Union Street	B	16.1	B	16.5	B	15.4	B	16.0
8 <sup>th</sup> Street/Boardman Lake Avenue					B	13.6	B	14.8

<sup>(1)</sup> Assumes removal of eastbound /westbound left-turn phase as well as optimized timings.

## 7.2 Conclusions

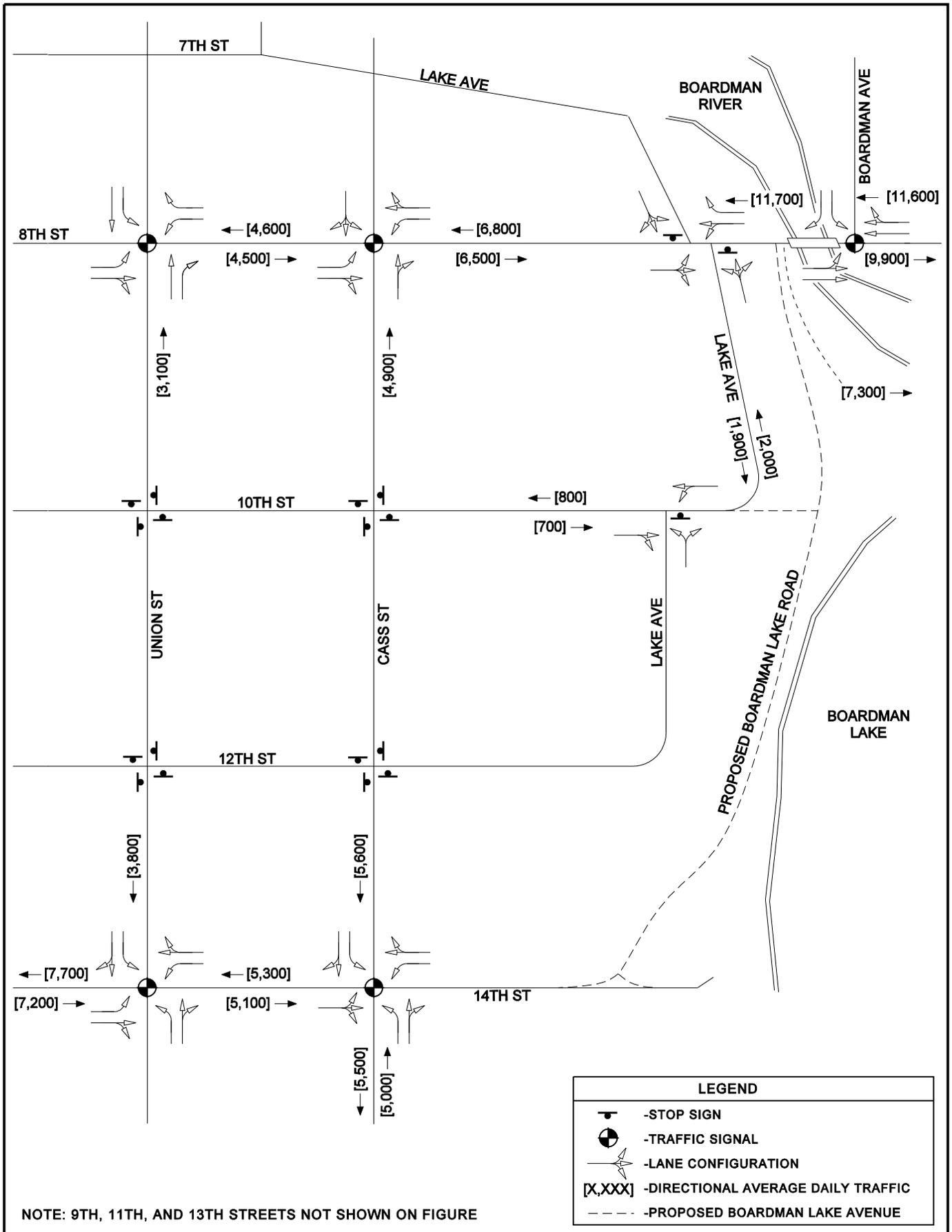
1. The construction of Boardman Lake Avenue is anticipated to improve traffic operations at study area intersections as traffic is diverted from these intersections to the proposed Boardman Lake Avenue.
2. The traffic volume on Boardman Lake Avenue is projected to approach or exceed 500 vehicles in the peak hour, and 6,000 vehicles per day.
3. Daily traffic volumes on Cass Street and Union Street will be reduced by more than 30% between 8<sup>th</sup> Street and 14<sup>th</sup> Street. Daily traffic volume between on 8<sup>th</sup> Street between Cass Street and the proposed Boardman Lake Avenue will be reduced by more than 35%.



LEGEND	
	-STUDY AREA
	-PROPOSED BOARDMAN LAKE AVENUE

BOARDMAN LAKE AVENUE ORIGIN/DESTINATION STUDY

	 	<p>EXISTING STUDY AREA AND PROPOSED BOARDMAN LAKE AVENUE</p>	<p>FIGURE 1</p>
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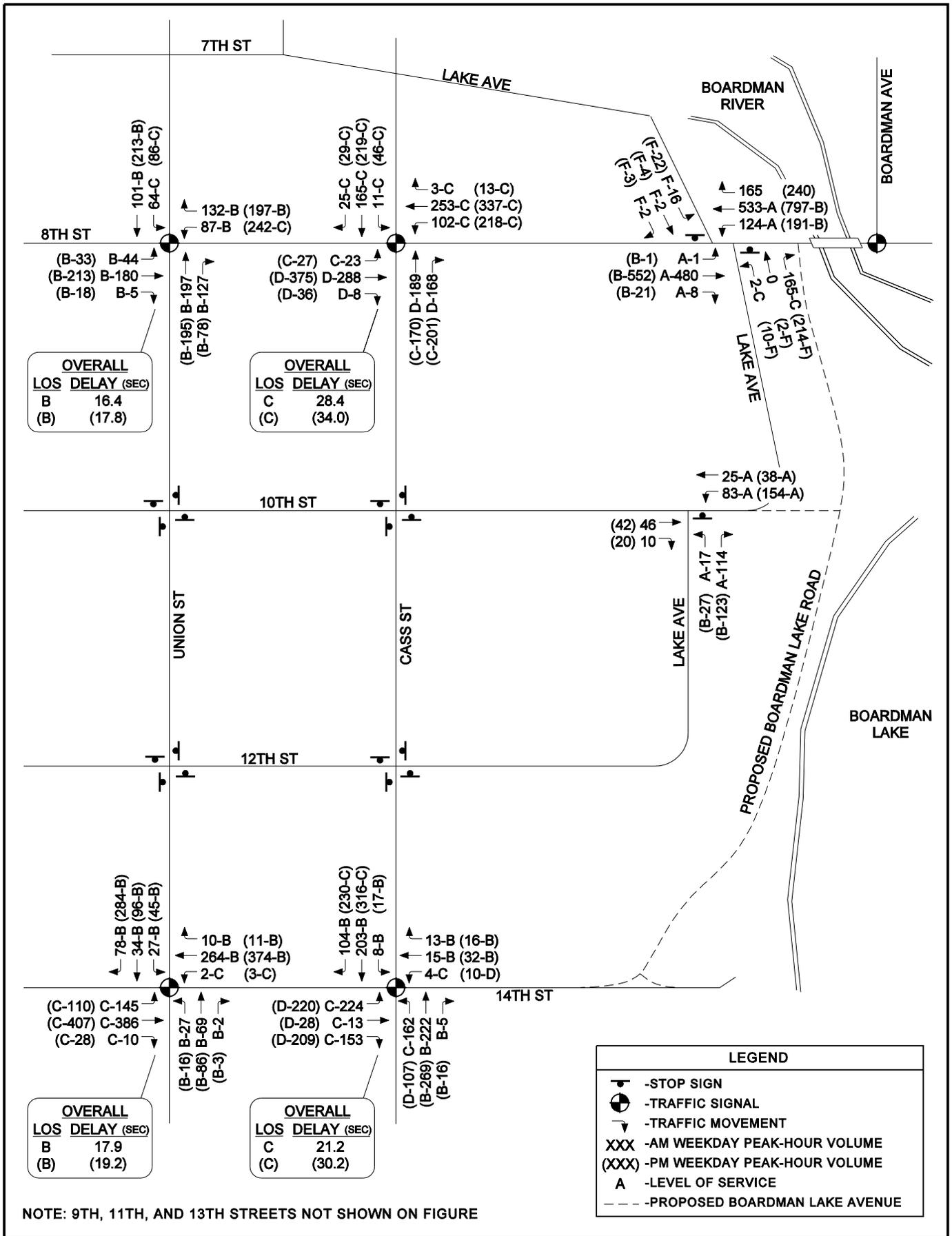


NOTE: 9TH, 11TH, AND 13TH STREETS NOT SHOWN ON FIGURE

LEGEND	
	-STOP SIGN
	-TRAFFIC SIGNAL
	-LANE CONFIGURATION
[X,XXX]	-DIRECTIONAL AVERAGE DAILY TRAFFIC
	-PROPOSED BOARDMAN LAKE AVENUE

BOARDMAN LAKE AVENUE ORIGIN/DESTINATION STUDY

			EXISTING TRAFFIC OPERATIONS	FIGURE 2
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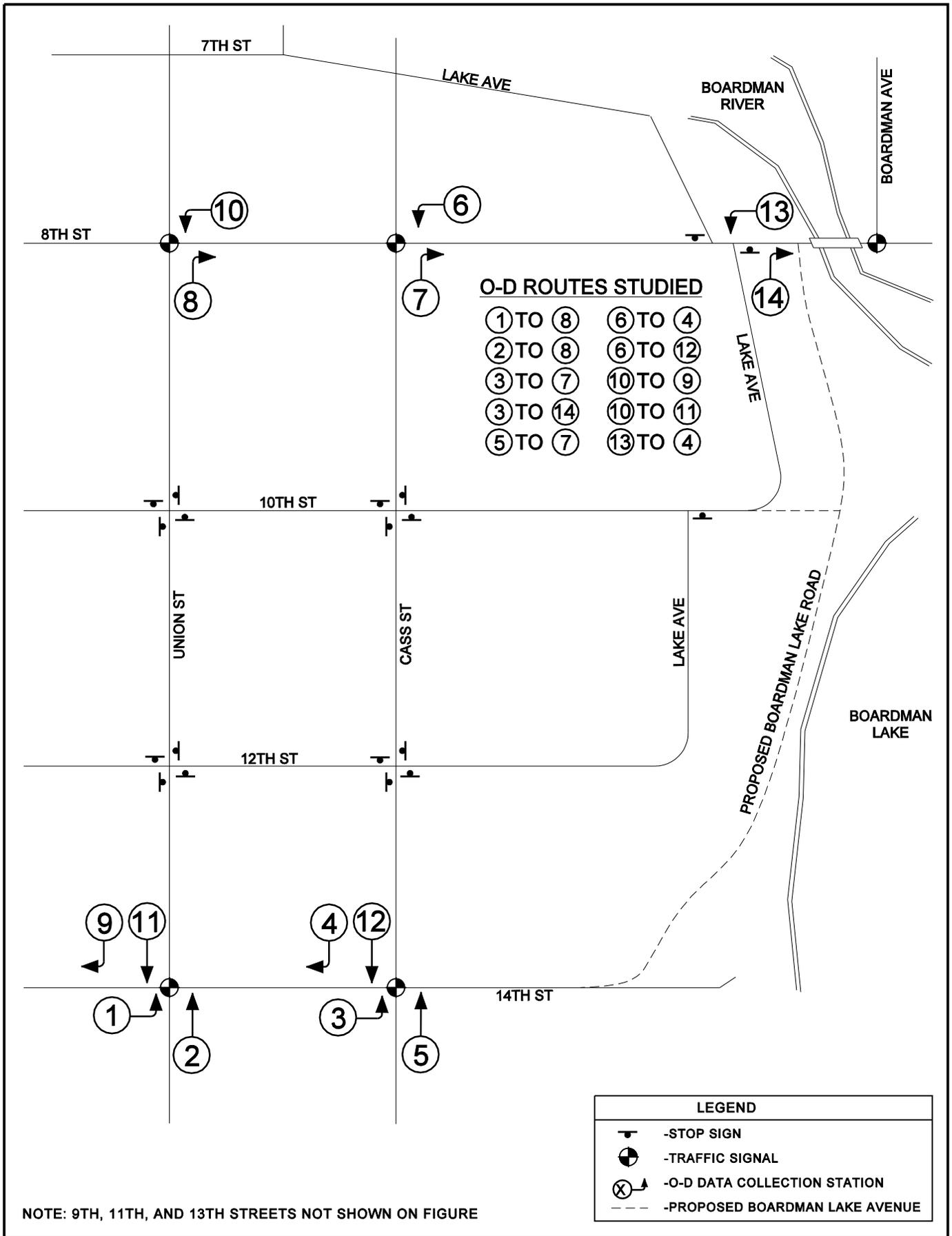


BOARDMAN LAKE AVENUE ORIGIN/DESTINATION STUDY



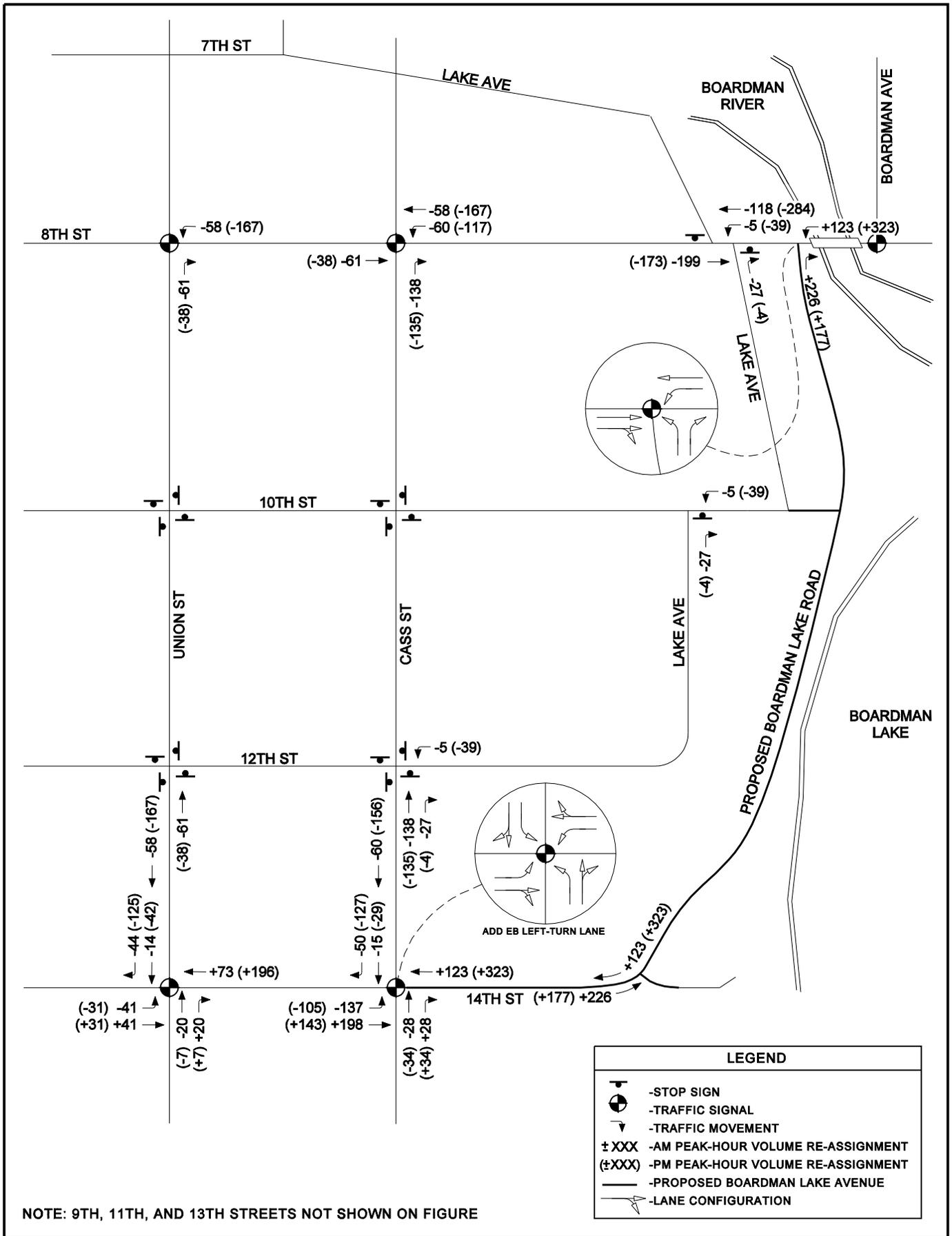
EXISTING (2011) PEAK-HOUR VOLUMES AND LEVEL-OF-SERVICE

FIGURE 3



BOARDMAN LAKE AVENUE ORIGIN/DESTINATION STUDY

			<p>ORIGIN-DESTINATION STUDY DATA COLLECTION LOCATIONS</p>	<p>FIGURE 4</p>
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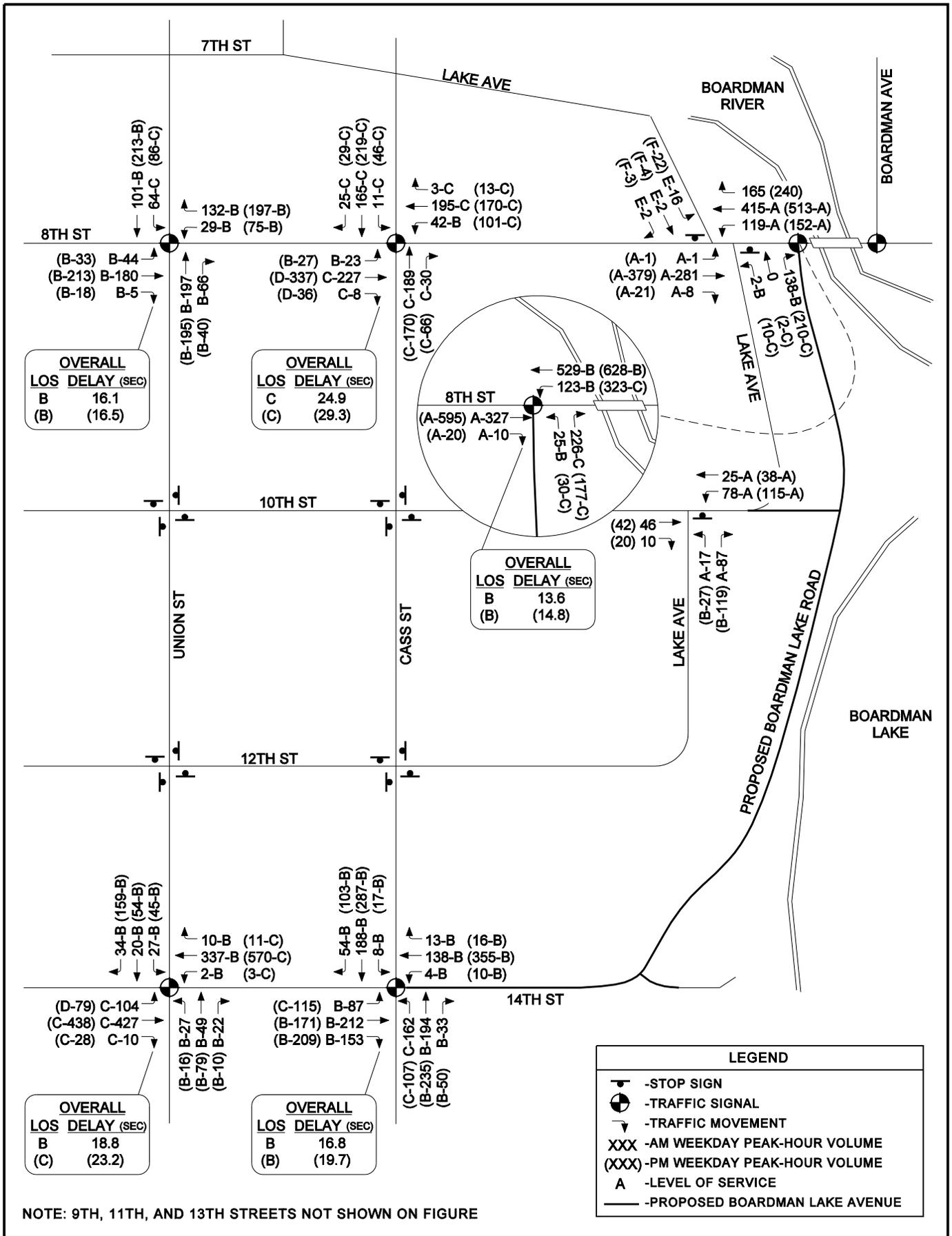


BOARDMAN LAKE AVENUE ORIGIN/DESTINATION STUDY



EXISTING (2011) PEAK-HOUR VOLUME RE-ASSIGNMENT WITH PROPOSED BOARDMAN LAKE AVENUE

FIGURE 5

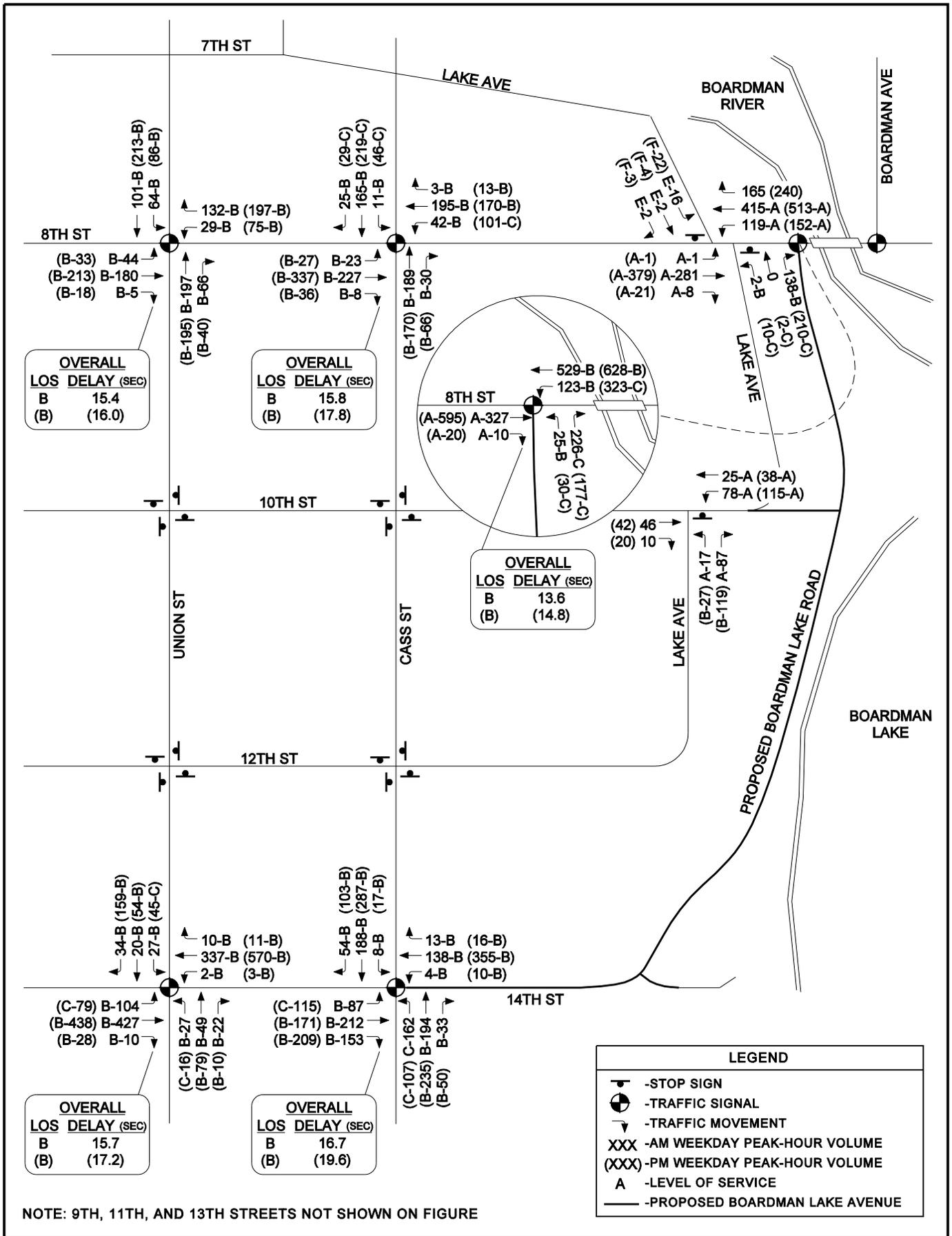


BOARDMAN LAKE AVENUE ORIGIN/DESTINATION STUDY



EXISTING (2011) PEAK HOUR VOLUMES AND LEVELS-OF-SERVICE WITH PROPOSED BOARDMAN LAKE AVENUE

FIGURE 6



BOARDMAN LAKE AVENUE ORIGIN/DESTINATION STUDY



EXISTING (2011) PEAK HOUR VOLUMES AND LEVELS-OF-SERVICE WITH PROPOSED BOARDMAN LAKE AVENUE AND SIGNAL RE-TIMINGS

FIGURE 7