PORTAGE ROAD TRAFFIC STUDY/ ROAD DIET FEASIBILITY STUDY

FINAL REPORT: DECEMBER 2015

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1. Introduction

The City of Portage retained CESO, Inc. to evaluate the feasibility of implementing a "Road Diet" along the Lake Center Core Node area (Portage Road between Lakeview and Forest Drives) in the City of Portage, Kalamazoo County, Michigan. Figure 1 illustrates the Lake Center Core Node area and Figure 2 illustrates an aerial view of the study area.

CESO reviewed two (2) separate roadway design alternatives as outlined by the City of Portage Engineering Department for the Lake Center Core Node area (Portage Road between Lakeview and Forest Drives) that include.

- **Alternative #1**: 3 lane section from Ames Drive south to Lakeview Drive with on-street parking and pedestrian/bikeway on the west side.
- **Alternative #2**: 3 lane section from Ames Drive south to Lakeview Drive with bike lane on east and west side and pedestrian walkway on the west side.

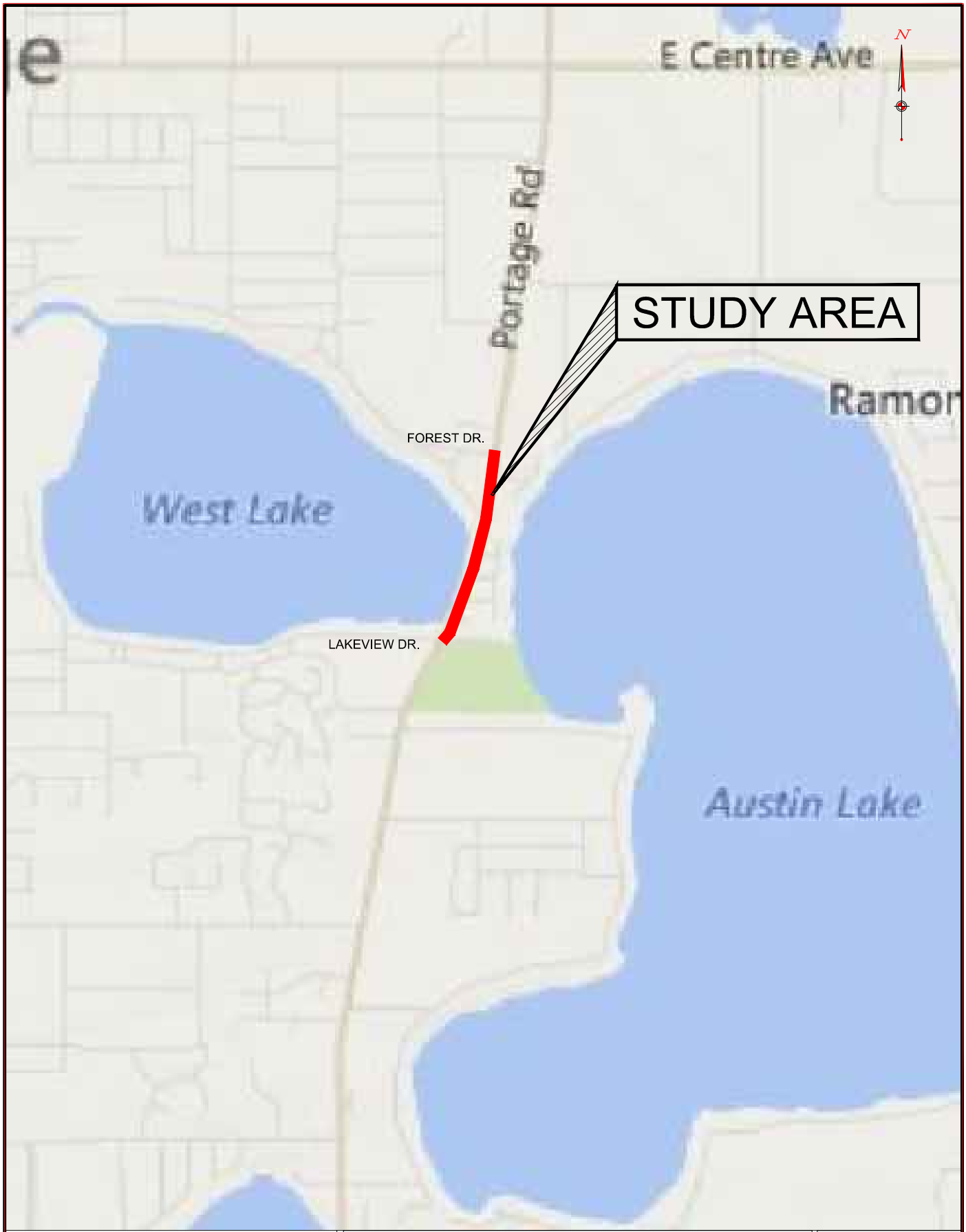
Figures 3 and 4 illustrate Alternative #1 and #2 and Figure 5 illustrates the typical section for both study alternatives.

The two (2) study alternatives are based on road diet concepts that involve *narrowing or eliminating travel lanes* on a roadway to make more room for pedestrians and bicyclists. According to the FHWA, "road diets typically consist of conversions of four-lane (or in this studies case - five-lane), undivided roads into three lanes – two through lanes plus a center left-turn lane. The fourth or fifth lane may be converted to a bicycle lane, sidewalk, and/or on-street parking."

Road diets can offer benefits to both drivers and pedestrians by creating fewer lanes of traffic to cross and by reducing vehicle speeds and vehicle interactions. According to the FHWA report on "Road Diet" measures on crashes, a 2001 study found a reduction in pedestrian crash risk when crossing two-and three-lane roads when compared to roads with four or more lanes. Other benefits of road diets include promoting better land use, promoting greater driving attentiveness, improving mobility and access, and improving livability and quality of life.

Standing on Portage Road at Forest Drive looking soutbound.

According to the City of Portage 2013 Major Thoroughfare Plan Status Report, Portage Road within the study area is currently classified as a Minor Arterial and is maintained by the City of Portage. Portage Road between Lakeview and Forest Drives currently exists as a five (5) lane cross section (two northbound and two southbound through lanes and a center left-turn lane).



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STUDY LOCATION MAP

PORTAGE ROAD TRAFFIC ANALYSIS
LAKEVIEW DRIVE TO FOREST DRIVE

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FIGURE	1
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STUDY AERIAL

PORTAGE ROAD TRAFFIC ANALYSIS
LAKEVIEW DRIVE TO FOREST DRIVE

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LAKE CENTER NODE CONCEPTUAL PLAN

DATE: 06/20/2014
REV. 07/18/2014

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ALTERNATE 1: LAKE CENTER NODE 3 LANE SECTION
CONCEPTUAL PLAN

PORTAGE ROAD TRAFFIC ANALYSIS
LAKEVIEW DRIVE TO FOREST DRIVE

CITY OF PORTAGE — KALAMAZOO COUNTY, MICHIGAN

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LAKE CENTER NODE CONCEPTUAL PLAN

DATE: 06/20/2014
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ALTERNATE 2: LAKE CENTER NODE 3 LANE SECTION
CONCEPTUAL PLAN

PORTAGE ROAD TRAFFIC ANALYSIS
LAKEVIEW DRIVE TO FOREST DRIVE

CITY OF PORTAGE — KALAMAZOO COUNTY, MICHIGAN

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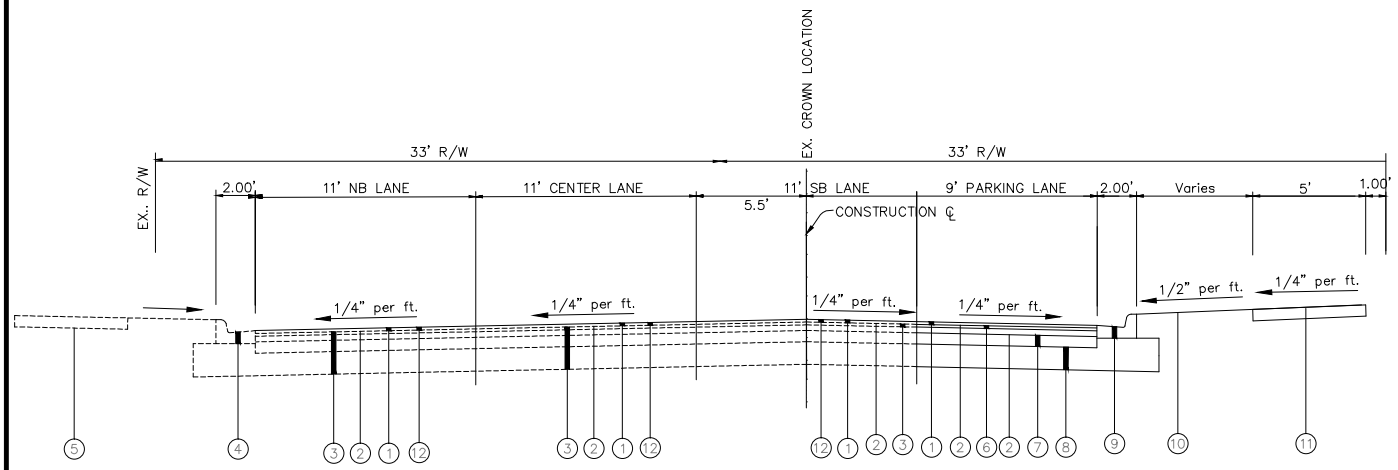
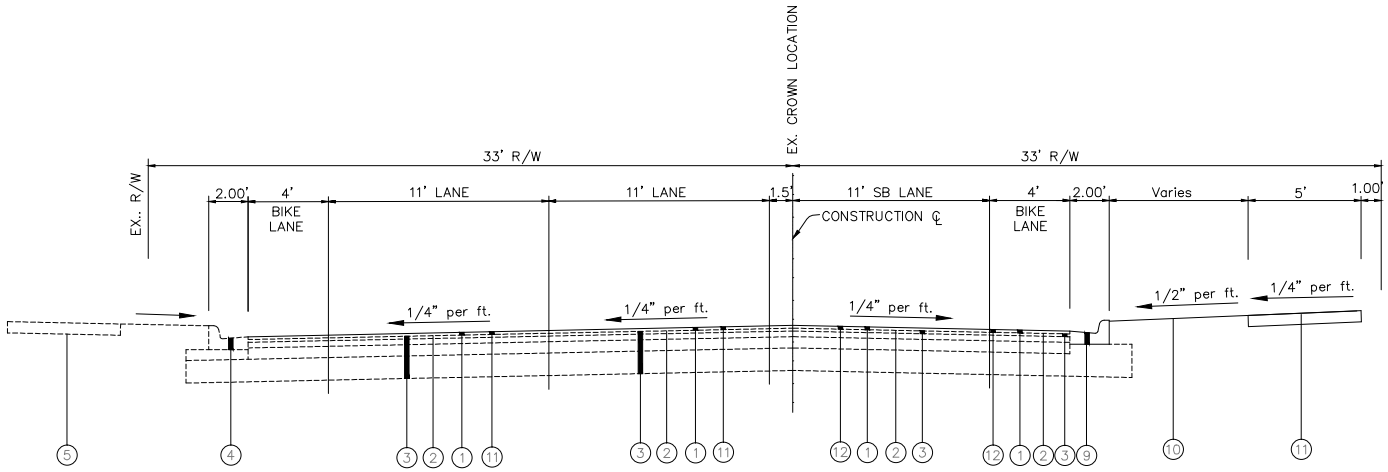


NO.	DESCRIPTION
1	1–1/2" Asphalt Concrete HMA Surface Course
2	Tack Coat
3	Existing Pavement and Base, Approximate Thickness 24" (incl sand subbase)
4	Existing Curb & Gutter
5	Existing Sidewalk
6	1–1/2" Asphalt Concrete HMA Leveling Course
7	3" Asphalt Concrete HMA Base Course
8	12" Sand Subbase
9	Curb & Gutter
10	Seeding & Mulching
11	4" Concrete Sidewalk, Slope 1/4" /ft
12	1–1/2" Pavement Planing, Asphalt Concrete

PORTAGE ROAD (FACING SOUTH)

ALTERNATIVE #1: 3 LANE SECTION FROM AMES DRIVE SOUTH TO LAKEVIEW DRIVE
WITH ON–STREET PARKING AND SIDEWALK ON WEST SIDE



NO.	DESCRIPTION
1	1–1/2" Asphalt Concrete HMA Surface Course
2	Tack Coat
3	Existing Pavement and Base, Approximate Thickness 24" (incl sand subbase)
4	Existing Curb & Gutter
5	Existing Sidewalk
6	1–1/2" Asphalt Concrete HMA Leveling Course
7	3" Asphalt Concrete HMA Base Course
8	12" Sand Subbase
9	Curb & Gutter
10	Seeding & Mulching
11	4" Concrete Sidewalk, Slope 1/4" /ft
12	1–1/2" Pavement Planing, Asphalt Concrete

PORTAGE ROAD (FACING SOUTH)

ALTERNATIVE #2: 3 LANE SECTION FROM AMES DRIVE SOUTH TO LAKEVIEW DRIVE
BIKE LANE ON EAST AND WEST SIDE AND PEDESTRIAN WALKWAY ON WEST SIDE

FIGURE 5
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TYPICAL SECTION FOR LAKE CENTER NODE
3 LANE SECTION

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LAKEVIEW DRIVE TO FOREST DRIVE

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Within the study corridor, there are a number of potential benefits associated with the potential implementation of a road diet. The following table identifies the benefits listed in the Guide for the Development of Bicycle Facilities 2012, fourth edition as published by AASHTO.

AASHTO Bicycle Facility Road Diet Benefits
The additional space gained by removing one lane can be used to provide bike lanes or shoulders on both sides of the road.
With one travel lane in each direction, top-end travel speeds are moderated by those who are following posted speed limits, which may reduce potential crash severities for all users.
It may be feasible to include a raised median or small refuge islands at some pedestrian crossing locations, making it easier for pedestrians to cross the street and reducing the likelihood of pedestrian crashes.
The reduction from two lanes to one in each direction virtually eliminates the likelihood of "multiple threat" crashes (where a driver in one lane stops to yield, but the driver in the adjacent lane continues at speed) for pedestrians and left-turning motorists and bicyclists.
Left-turn lanes provide a place for motorists and bicyclists to wait to make a left turn, reducing the incidence of left-turn and rear-end crashes.
Sideswipe crashes are reduced since motorists no longer need to change lanes to pass a vehicle waiting to turn left from the leftmost through lane.
Less traffic noise (due to reduced speeds) and greater separation from traffic for pedestrians, residents, and businesses.

The AASHTO guide does not list disadvantages, however there are several perceived concerns as listed below:

Road Diet Disadvantages
All through traffic in a single lane may increase vehicle delays.
All traffic shifted to a single lane results in more vehicles adjacent to on-road cyclists.
All through traffic in a single lane results in difficulty for vehicles turning to and from side streets and driveway in addition to reducing gaps.
All through traffic in a single lane may result in increased bus transit time, where bus service may be provided.
If on-street parking is permitted: through traffic in a single lane means that any vehicles maneuvering in/out of parking may block the single travel lane.

The previous discussion shows that there are a number of trade-offs associated with the implementation of a road diet. For example, placing all vehicle traffic in a single lane may provide a traffic calming effect but could increase delays for traffic turning onto Portage Road due to fewer gaps in the single stream of traffic. Section 3 of this analysis reviews the capacity of this section of Portage Road should a "road diet" be implemented.

City of Portage Lake Center Subarea Plan

According to the Lake Center Subarea plan, "the Lake Center business district runs along Portage Road from East Centre Avenue to Clarence Drive, with additional commercial nodes between Lakeview Park and Bacon Avenue and north of East Osterhout Road. Many businesses are locally-owned and have been in existence for more than 50 years. The area between East Centre Avenue and Lakeview Drive is the primary business district, identified as a commercial revitalization corridor in prior plans."

One of the goals of this plan is to create a vibrant commercial corridor with a unified attractive visual character that builds upon the history of the Lake Center District. Specifically, one of the objectives was to provide a balanced and safe means of travel for bicycles, pedestrians, and vehicles.

Based on the goals outlined in the City of Portage Lake Center Subarea plan, each study alternative was analyzed by capacity, projected safety and accident rate impacts, traffic and non-motorized mobility issues, federal highway funding, and construction cost. The following sections of this report summarize the analysis and results of each alternative.

1.1 Study Procedure

The following studies and analyses were undertaken:

1. Traffic counts (24 hour) were provided by the City of Portage at each of the key study intersections (Portage Road & Lakeview Drive, and Portage Road & Forest Drive) during a typical weekday.
2. Inventory the existing roadway system (existing traffic controls, signage, and lane geometry).
3. Capacity analysis to determine the capacity of the key study intersections under the Existing traffic scenario using Highway Capacity Software (HCS).
4. Synchro simulation analysis to review traffic flow along the Portage Road study corridor for both study alternatives.
5. Projected safety and crash rate impacts of on-street parking (crash frequency and severity). Crash data was obtained from the City of Portage for Portage Road from Lakeview to Forest for the past five (5) years.
6. Review of potential Federal Funding for study alternatives.
7. Review of functional classification of both study alternatives.
8. Construction cost estimate for both study alternatives.
9. Prepare a report summarizing all findings and recommendations.

1.2 References

This report utilizes information provided by the following sources:

1. Analysis of Capacity and Level of Service according to the procedures of the Highway Capacity Manual, Fifth Edition, Updated 2010, Transportation Research Board.
2. Lake Center Subarea Report provided by the City of Portage.
3. A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011, AASHTO.
4. The Manual of Uniform Traffic Control Devices (MUTCD).
5. Traffic Counts provided by the City of Portage for Portage Road & Lakeview and Forest Drives.

6. Accident data within the study area provided by the City of Portage.
7. City of Portage 2014 Major Thoroughfare Plan.
8. FHWA Evaluation of Lane Reduction “Road Diet” Measures on Crashes by Carol Tan, HSIS Program Manager, June 2012 (Publication Number FHWA-HRT-10-053).
9. FHWA Highway Functional Classification Concepts, Criteria and Procedures.
10. Road Diet Handbook; Setting Trends for Livable Streets.
11. Safety Effects of Marked versus Unmarked Crosswalks.
12. Guide for the Development for the Development of Bicycle Facilities 2012, fourth edition as published by AASHTO

2. Roadway and Traffic Conditions in the Vicinity of the Site

An inventory of existing transportation conditions in the vicinity of the study area was created to form a database for use in analyzing both study alternatives.

2.1 Study Location and Area Land Use

The study corridor location area along Portage Road is located between Forest and Lakeview drives in what is referred to as the Lake Center District Area. According to the Lake Center Subarea Plan, this isthmus area includes long-established stores that serve as important anchors for the district, including Hardware (Nelson Hardware) and Grocery stores (H&B Grocery), and available lakefront property for potential development.

2.2 Area Roadway Characteristics

Portage Road – Portage Road in the vicinity of the study area (Forest Drive to Lakeview Drive) is a five (5) lane curb and gutter minor arterial roadway, consisting of two (2) NB lanes, two (2) SB lanes, and a center left-turn lane that forms left-turn pocket lanes at Forest and Lakeview Drives. Portage Road has an existing sidewalk on the east side with lawn space that varies between back of curb and face of sidewalk. Marked crosswalks are generally present at each driveway approach on the east side of Portage Road. There are currently no bicycle accommodations on Portage Road. The current five (5) lane cross section requires that bicyclist either share the outermost travel lane or share the sidewalk. The posted speed limit on Portage Road in the vicinity of the study area is 45 mph.

Forest Drive – Forest Drive in the vicinity of the study area is a two (2) lane roadway with shoulders and a sidewalk on the north side that widens at Portage Road to provide an exclusive EB to NB left-turn lane and an exclusive EB to SB right-turn lane. Forest Drive forms a "T" type intersection with Portage Road and is stop sign controlled. The posted speed limit on Forest Drive in the vicinity of the study area is 25 mph.

Lakeview Drive – Lakeview Drive extends from Portage Road west to Organdy Street. Lakeview Drive is a narrow two (2) lane roadway that intersects Portage Road and forms a four (4) legged stop sign controlled intersection (City of Portage Lakeview Park on the east side). The posted speed limit on Forest Drive in the vicinity of the study area is 25 mph.

The existing transportation system is shown on Figure 6 of the report.

2.3 Existing Traffic Volumes

Traffic counts (twenty-four hour) collected on Tuesday, October 7, 2014 and were supplied by the City of Portage and included the Portage Road & Lakeview and Forest Drive intersections. Note: At the time of performing the traffic counts, this section of Portage Road was under construction, but all lanes of traffic were open and clear of lane restrictions. The results were compared with recent July 2015 speed and count data and found to be very similar. Based on the updated July 2015 speed and count data, the study speed and count data was not impacted by the construction. The following observations are evident:

- The weekday PM peak hour is the busiest time period.

- The heavy traffic flow is northbound in the weekday AM peak hour and southbound in the weekday PM peak hour.
- The EB to NB and EB to SB volumes on Forest Drive are minimal with the exception of the EB to SB right-turn volume during the weekday PM peak hour (67 vehicles).
- The EB to SB right-turn volumes on Lakeview Drive are minimal with the EB to NB left-turn volume being the higher volume movement.

The counts were conducted by an independent consultant from 12:00 am to 12:00 am.

The weekday peak hours were determined to occur between the hours of: 7:00 - 8:00 am, 11:45 am to 12:45 pm, and 4:45 - 5:45 pm. The ADT (average daily traffic volume) on Portage Road in the study area is approximately 17,626 vehicles per day.

The Existing Weekday Peak Hour traffic volumes and Existing Weekday Twenty-Four Hour traffic volumes are illustrated on Figure 7 and 8 and contained in Appendix A of the report.

2.4 Existing Speed Data

Speed data for both northbound and southbound Portage Road was provided by the City of Portage. This data was collected on October 7, 2014 at 12:00 am and concluded on October 8, 2014 on Portage Road at Forest Drive.

Northbound Portage Road:

According to the collected speed data, the average speed for all classified vehicles traveling northbound on Portage Road was 41 MPH. 0.48 percent of the total northbound vehicles were traveling in excess of 55 MPH. The 85th percentile speed for northbound traveling vehicles was 45.67 MPH.

Southbound Portage Road:

According to the collected speed data, the average speed for all classified vehicles traveling southbound on Portage Road was 43 MPH. 2.23 percent of the total southbound vehicles were traveling in excess of 55 MPH. The 85th percentile speed for southbound traveling vehicles was 49.76 MPH.

2.5 Vehicle Classification Data

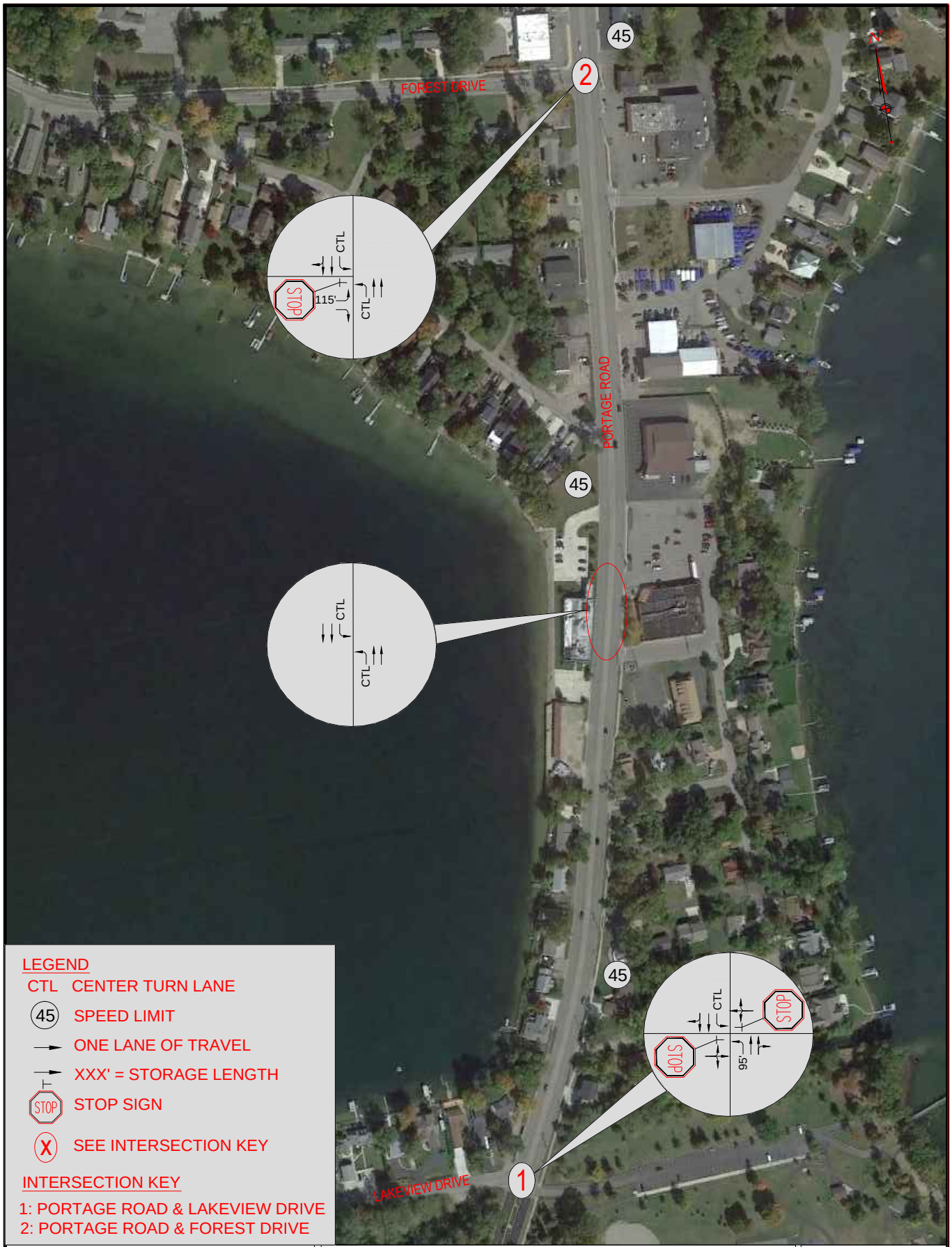
Northbound Portage Road:

According to the collected vehicle classification data, 70 percent of the total classified vehicles traveling northbound on Portage Road are passenger cars, 25% vans & pickups, 4% busses & trucks, and 1% tractor trailers.

Southbound Portage Road:

According to the collected vehicle classification data, 54% of the total classified vehicles traveling southbound on Portage Road are passenger cars, 34% vans & pickups, 9% busses & trucks, and 3% tractor trailers.

The speed and vehicle classification data are contained in Appendix A of the report.



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EXISTING TRANSPORTATION SYSTEM

PORTAGE ROAD TRAFFIC ANALYSIS
LAKEVIEW DRIVE TO FOREST DRIVE

CITY OF PORTAGE KALAMAZOO COUNTY, MICHIGAN

FIGURE	6
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LEGEND

(X) SEE INTERSECTION KEY

* DENOTES MINIMAL TRAFFIC VOLUME

AM PEAK HOUR
7:00 AM TO 8:00 AM
MID-DAY PEAK HOUR
11:45 AM TO 12:45 PM
PM PEAK HOUR
4:45 PM TO 5:45 PM

XXX/XXX/XXX

INTERSECTION KEY

1: PORTAGE ROAD & LAKEVIEW DRIVE
2: PORTAGE ROAD & FOREST DRIVE

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EXISTING WEEKDAY PEAK HOUR TRAFFIC VOLUMES

PORTAGE ROAD TRAFFIC ANALYSIS
LAKEVIEW DRIVE TO FOREST DRIVE

CITY OF PORTAGE — KALAMAZOO COUNTY, MICHIGAN

FIGURE 7
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LEGEND

(X) SEE INTERSECTION KEY

* DENOTES MINIMAL TRAFFIC VOLUME

INTERSECTION KEY

1: PORTAGE ROAD & LAKEVIEW DRIVE

2: PORTAGE ROAD & FOREST DRIVE

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EXISTING WEEKDAY 24 HOUR TRAFFIC VOLUMES

PORTAGE ROAD TRAFFIC ANALYSIS
LAKEVIEW DRIVE TO FOREST DRIVE

CITY OF PORTAGE KALAMAZOO COUNTY, MICHIGAN

FIGURE	8
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3. Capacity Analysis

3.1 Existing Capacity Analysis

Utilizing the Existing Weekday Peak Hour Traffic Volumes shown on Figure 7, capacity calculations were performed for the key study intersections using Highway Capacity Software (HCS) and Synchro version 8 software. The calculations employed procedures documented in the Highway Capacity Manual (Transportation Research Board, Special Report 209, most recent Edition). The analysis was also used to provide a base condition to compare the various alternatives.

The capacity of an intersection (stop sign controlled) can best be described by its corresponding Level of Service (LOS). The level of service of an intersection is a qualitative measure of the various attributes of an intersection. There are six levels of service ranging from "ideal" free flow conditions at LOS "A," to forced or "breakdown" conditions at LOS "F." The level of service for signalized intersections is based upon the average stopped delay per vehicle for various movements within the intersection. Although v/c affects delay, there are other parameters that more strongly affect it, such as the quality of progression, length of green phases, cycle lengths, and others. Thus for any given v/c ratio, a range of delay values may result, and vice versa.

The level of service for unsignalized intersections is based upon total delay. Total delay is defined in the HCM as the total elapsed time from when a vehicle stops at the end of the queue until the vehicle departs from the stop line; this time includes the time required for the vehicle to travel from the last-in-queue position to the first-in-queue position. Table 1 summarizes the LOS definitions for stop sign controlled locations.

Table 1
Level of Service Criteria (Stop Sign Controlled Intersections)

Level of Service	Delay per Vehicle (Sec.)	Description
A	≤ 10.0	Little or no delay
B	>10.0 and ≤ 15.0	Short traffic delays
C	>15.0 and ≤ 25.0	Average traffic delays
D	>25.0 and ≤ 35.0	Long traffic delays
E	>35.0 and ≤ 50.0	Very long traffic delays
F	≥ 50.0	Extreme traffic delays

Table 2 summarizes the capacity analysis (Highway Capacity Software) results for existing traffic conditions.

Table 2
Summary of Existing Capacity Analysis

Direction	Control	Approach / Movement	AM Peak Hour	MID-DAY Peak Hour	PM Peak Hour
Portage Road & Forest Drive					
Portage Road	Stop Sign	Left	A (8.3)	A (9.0)	B (11.6)
Northbound					
Forest Drive		Left	D (25.8)	C (23.4)	F (51.0)
Eastbound		Right	A (9.5)	B (10.3)	B (13.7)
Portage Road & Lakeview Drive					
Portage Road	Stop Sign				
Northbound		Left	B (8.1)	A (8.8)	B (11.2)
Southbound		Left	B (11.1)	A (8.6)	A (8.7)
Lakeview Park Drive		LR	D (28.4)	C (18.2)	D (30.2)
Westbound					

X – Level of Service (X.X) – Delay (seconds/vehicle)

The analysis shows that both key study intersections have movements that currently operate at levels of service "C" or better conditions with the exception of the eastbound left-turn movement on Forest Drive and the westbound left/right movement on Lakeview Park Drive.

The Existing Capacity Analysis Summary sheets are contained in Appendix B of the report.

3.2 Capacity Analysis with On-Street Parking (Alternative #1)

Using alternative #1 (3 lane section from Ames Drive south to Lakeview Drive with on-street parking and pedestrian/bikeway on the west side), the existing analysis in Table 2 was revised to include a three (3) lane section and on-street parking. In addition, the speed limit on Portage Road was reduced from 45 mph to 35 mph due to maneuvering conflicts. On-street parking provides a buffer to pedestrians from traffic and is found to decrease speeds.

On-street parking can limit street capacity in the following three (3) ways:

(1) It preempts lanes that otherwise would be used by moving traffic.

(2) AASHTO indicates that on-street parking can reduce capacity and interfere with the free flow of adjacent traffic. Parking and un-parking maneuvers frequently reduce the capacity of the adjacent lanes. A single vehicle can effectively stop the through lane to moving traffic when performing parking maneuvers. Studies have shown that even small numbers of parked vehicles can have an impact in reducing vehicle capacity.

(3) Pedestrian movements and door opening/closing can contribute to reduced capacity due to perceived safety risks.

The highway capacity manual recommends the application of the following equation to determine the proper adjustment factor for parking (Transportation Research Board, 2000):

$$f_p = \frac{N - 0.1 - N_M/200}{N}$$

Where:

f_p = Adjustment factor for parking
N = Number of lanes in group; and
N_M = Number of parking maneuvers per hour.

As far as capacity is concerned, on-street parking is typically accepted on arterials when the speed is low (< 35 mph) and the traffic demand is below capacity. At higher speeds and during periods of heavy traffic movement, on-street parking becomes more difficult and impacts the arterial street service.

Using alternative #1, capacity analyses (Highway Capacity Software), were performed and are summarized in Table 3.

Table 3
Summary of Three Lane Alternative #1 Capacity Analysis

Direction	Control	Approach / Movement	AM Peak Hour	MID-DAY Peak Hour	PM Peak Hour
Portage Road & Forest Drive					
Portage Road*	Stop Sign	Left	A (8.3)	A (9.0)	B (11.6)
Northbound					
Forest Drive*		Left	D (25.8)	C (23.4)	F (51.0)
Eastbound		Right	A (9.5)	B (10.3)	B (13.7)
Portage Road & Lakeview Drive					
Portage Road	Stop Sign	Left	A (8.1)	A (8.8)	B (11.2)
Northbound					
Portage Road		Left	B (11.1)	A (8.6)	A (8.7)
Southbound					
Lakeview Park Drive		L/T/R	D (32.3)	C (20.7)	E (38.3)
Westbound					

X – Level of Service (X.X) – Delay (seconds/vehicle) * Level of Service same as existing since Roadway Diet Alternatives begin south of Forest Drive.

Table 3 shows that reducing the number of through lanes on Portage Road from 2 to 1 with on-street parking increases the minor street delay at the Portage Road & Lakeview intersection. In order to achieve a level of service "C" or better condition at both study locations, CESO reviewed potential improvements outlined under section 3.3:

3.3 Capacity Analysis with Bike Lanes (Alternative #2)

Bicycle travel is an important element of multimodal, livable streets. Bike lanes are practical and often essential elements of road diet projects. They not only improve the bicycling environment, but also provide a buffer to pedestrians. In addition, bike lanes allow space for vehicles to temporarily store while emergency vehicles pass, they add to turning radii, and improve sight lines.

Using alternative #2, capacity analyses (Highway Capacity Software), were performed and are summarized in Table 4.

Table 4
Summary of Three Lane Alternative #2 Capacity Analysis

Direction	Control	Approach / Movement	AM Peak Hour	MID-DAY Peak Hour	PM Peak Hour
Portage Road & Forest Drive					
Portage Road*	Stop Sign	Left	A (8.3)	A (9.0)	B (11.6)
Northbound					
Forest Drive*		Left	D (25.8)	C (23.4)	F (51.0)
Eastbound		Right	A (9.5)	B (10.3)	B (13.7)
Portage Road & Lakeview Drive					
Portage Road	Stop Sign	Left	A (8.0)	A (8.7)	B (11.0)
Northbound					
Portage Road		Left	B (11.0)	A (8.4)	A (8.5)
Southbound					
Lakeview Park Drive		L/T/R	D (30.2)	C (20.4)	E (36.2)
Westbound					

X – Level of Service (X.X) – Delay (seconds/vehicle) * Level of Service same as existing since Roadway Diet Alternatives begin south of Forest Drive.

Table 4 shows that reducing the number of through lanes on Portage Road from 2 to 1 increases the minor street delay at the Portage Road & Lakeview intersection. In order to achieve a level of service "C" or better condition at both study locations, CESO reviewed the following potential improvements:

Short Term Improvements:

(1) Modify Lakeview Drive to one (1) direction only by restricting the outbound left/thru/right movements. The restricted Lakeview movements would be re-directed to the Portage Road/South Shore Drive intersection. *Note: Since the initial start of the study, this improvement has been implemented. The analysis shown in Tables 2, 3, and 4 include this improvement.*

Long Term Improvements:

(1) Potential Roundabout or intersection re-alignment at Lakeview Drive.
(2) Potential Traffic Signal at Forest Drive (note: Signal is not warranted at this time based on traffic volumes, and should a signal be installed, driveway consolidation and potential modification to Ames Drive will need to be accomplished by converting Ames Drive to a right-in/right-out only or complete closure/cul-de-sac at Portage Road).
(3) Potential re-alignment of Lakeview. Re-alignment would relocate Lakeview Drive further to the south to intersect Portage Road at a 90 degree angle.

Roundabouts/Traffic Signal

A Roundabout would improve safety as roundabouts reduce the frequency and severity of accidents while improving the capacity of the intersection by up to fifty (50) percent. A single roundabout will reduce the number of conflict points from 22 to 8 but does provide difficult pedestrian crossings. A traffic signal was also reviewed at the Portage Road & Forest Drive intersection. Warranted traffic signals can also improve safety and reduce the frequency and severity of accidents. The resulting levels or service are summarized in Table 5.

Table 5
Short and Long Term Improvements

Direction	Control	Approach / Movement	AM Peak Hour	MID-DAY Peak Hour	PM Peak Hour
Portage Road & Forest Drive (Traffic Signal option)					
Portage Road	Traffic Signal	Left	B (10.3)	B (12.8)	C (27.2)
Northbound		Thru/Right	C (21.1)	A (9.5)	A (6.6)
Forest Drive		EBL	C (27.7)	C (27.6)	C (33.1)
Eastbound		EBR	C (28.0)	C (28.2)	C (34.5)
Portage Road					
Southbound		SBTR	A (8.2)	A (9.5)	B (15.3)
OVERALL			**B (17.5)**	**B (10.5)**	**B (13.6)**
Portage Road & Lakeview Drive (Roundabout option)					
Portage Road	Roundabout				
Northbound		--	E (42.4)	B (10.3)	A (11.5)
Portage Road					
Southbound		--	A (8.3)	A (9.9)	C (19.9)
Lakeview Drive					
Eastbound		--	A (6.1)	A (6.4)	B (10.9)
Lakeview Park Drive					
Westbound		--	B (10.1)	C (21.2)	C (23.3)
OVERALL			**D (30.3)**	**A (9.9)**	**C (16.0)**

Based on Table 5, a roundabout at Lakeview Park Drive will slightly improve the level of service based on a “road diet” concept (3 lanes). Revising the Lakeview Park Drive approach to prohibit inbound vehicles improves the level of service (removes EB LTR level of service “E” movement). The Lakeview Park Drive modification to one (1) lane inbound has recently been implemented and is currently being analyzed to determine its effectiveness. A traffic signal at Portage Road & Forest Drive will improve the weekday AM and PM peak hour EB left turn movement from an “F” to a “C” level of service.

Table 6 compares the proposed Alternative #1 / #2 to the existing conditions for several measures of effectiveness (MOEs) including travel time, speed, and vehicle emissions.

Table 6
Measures of Effectiveness (MOE) Comparison

Measure of Effectiveness	Existing (5 lane section)			Alternative #1			Alternative #2		
	AM	MD	PM	AM	MD	PM	AM	MD	PM
Stops (#)	113	104	135	134	125	148	129	121	140
Total Delay (hrs)	1.5	1.0	1.5	3.5	2.1	4.2	3.1	1.8	3.9
Travel Time (min)	27.4	22.5	29.8	35.9	29.7	39.3	32.9	25.9	36.4
Fuel Consumed (gal)	27	22	29.8	34	26.7	36.2	31	24.8	33.8
CO Emissions (g)	14352	10221	14233	15410	12300	15605	15030	11810	15065
Average Speed	41/43*	41/43*	41/43*	30	31	29	32	33	31
Arterial LOS (sec/veh)									
Northbound	2.9	2.1	2.0	6.5	3.8	3.6	6.0	3.5	3.3
Southbound	1.5	1.8	2.3	3.1	4.7	8.6	2.8	4.4	8.2
Bike Benefit	NO	NO	NO	NO	NO	NO	YES	YES	YES
Accident Benefit	YES	YES	YES	NO	NO	NO	NO	NO	NO

*Avg. Speed taken from actual collected speed data. xx/xx – northbound/southbound

The analysis shows the following:

- Under existing conditions the corridor has an improved arterial level of service (sec/veh.) as opposed to Alternative #1/#2.
- Under existing conditions, the average speed is 41/43 (northbound/southbound) mph as opposed to 29 to 33 mph for Alternative #1/#2.
- CO emissions increase under Alternative #1/#2.
- Modifying Portage Road from five (5) lanes to three (3) lanes increases the total delay and travel time during the weekday pm peak hour.
- Both road diet alternatives will increase the potential for crashes (parked cars & bicycle accidents) ~ Refer to section 4.3 and 4.4 of the report.
- Alternative #2 results in improved bicycle accommodations.

The Three Lane Alternative Capacity Analysis Summary sheets are contained in Appendix C of the report.

4. Projected Safety and Accident Rate Impacts of On-Street Parking

This section of the report includes a crash analysis of the existing Portage Road segment between Lakeview Drive and Forest Drive and a discussion regarding the potential impacts associated with implementing on-street parking as shown in study Alternative #1.

4.1 Existing Crash Analysis

A crash analysis was completed utilizing crash data from January 1, 2009 to December 31, 2013 provided by the City of Portage traffic engineer on Portage Road between milepoint 7.042 (Lakeview Drive) and milepoint 7.534 (Forest Drive). Collisions were summarized in terms of reportable and non-reportable crashes. The analysis found 43 total accidents occurred on this segment between 2009 and 2013 with 9 reportable crashes and 34 non-reportable crashes. A reportable crash occurs if one of the vehicles involved in the crash cannot be driven away from the scene or if any type of injury or death is reported, otherwise the crash is considered non-reportable. Police departments are required to investigate reportable crashes but may at their discretion respond/investigate non-reportable crashes. Table 7 summarizes the results obtained from the crash analysis.

Table 7
Summary of Crash Data

Segment	Type of Crash	Reportable	Non-Reportable
Portage Road from Lakeview to Forest Drive	Rear End	1	2
	Angle	3	5
	Fixed Object	3	9
	Animal	0	8
	Side-swipe	1	8
	Other	0	2
	Head-On	1	0
Total		9	34
Total Crashes		43	

Crash rates for the Lake Center Core Node study corridor section are shown in Table 8. A crash rate greater than 10 indicates that crashes are a significant safety concern during the analysis period. Crash rates in Table 8 were calculated utilizing the ADT traffic count provided by the City of Portage. The ADT count for this segment is 17,626. Crash rate guidelines for roadway segments area based on national studies. Crash rates below 10 million vehicle miles (MVM) are not a major concern, crash rates between 10 and 20 per MVM should be monitored; and crash rates above 20 per MVM require attention. Based on Table 8, the average crash rate for the study corridor is significantly under the 20 per MVM threshold which requires attention.

Table 8
Crash Rate by Segment

Segment	Crash Frequency by Year																				ADT 2014	Length Mile	Avg. Crash Rate/Million Vehicle Miles (MVM)			
	2009			2010			2011			2012			2013			Average/Year										
	T	I	F	T	I	F	T	I	F	T	I	F	T	I	F	T	I	F	S			T	I	F	S
Portage Road from Lakeview to Forest Drive	5	1	0	10	3	0	5	0	0	14	1	0	9	3	0	8.6	1.6	0	13.4	17,626	0.492	2.72	0.51	0.0	4.25

T = Total, I = Injury, F = Fatal, S = Severity

The Crash Rate data is included in Appendix D of the report.

NOTE: "A fatal crash occurred on November 7, 2014 at approximately 6:00 pm. A southbound passenger vehicle was struck by a vehicle exiting Lakeview Drive as it attempted to make a left-turn onto Portage Road. The preliminary accident report indicates that the driver of the vehicle exiting Lakeview Drive did not see the southbound vehicle until the collision. A passenger in the southbound vehicle succumbed to the injuries of the crash." (City of Portage letter dated December 3, 2014).

The City of Portage Transportation & Utilities Department reviewed the same traffic data as summarized above and found that the crash history is not significant enough to be listed among the top 34 rated intersections in the 2014 Comprehensive Plan. The City staff reviewed a few options that included relocating Lakeview Avenue approximately 180 feet south of its current location thereby minimizing the intersection skew to no more than 10 degrees. Another option reviewed was to investigate a roundabout. CESO included this option in section 3 of the report. The roundabout would be oriented such that the entrance to Lakeview Park could be incorporated into the design. As noted in the City's letter, a roundabout at this location would be effective in reducing speeds on Portage Road as motorists approach and traverse the roundabout.

4.2 Crash Rate Impacts (On-Street Parking)-Alternate #1

The correlation between on-street parking and traffic safety is a common discussion. Many traffic engineers are concerned about the increase in the number of "dart out" accidents typically associated with on-street parking. On the other hand, proponents of neo-traditional design projects argue that a row of parked vehicles acts as a buffer between moving traffic and pedestrians, and that the overall street design slows moving traffic, resulting in safer conditions.

Primary focus on the impacts associated with the conversion of a travel lane into on-street parking reviewed the following:

- Capacity
- Safety
- Accessibility
- Traffic Calming

- Development and economic growth

Capacity: On-street parking limits street capacity in two ways. First, it preempts lanes that otherwise would be used by moving traffic. Second, parking and un-parking maneuvers frequently reduce the capacity of the adjacent lanes. Even a single vehicle parked within a curb lane can effectively close the lane to moving traffic. Studies have shown that small numbers of parked vehicles have relatively large effects in reducing capacity, and that the effect of a given increase in parking diminishes as the intensity increases. AASHTO also confirms that on-street parking reduces capacity and interferes with the free flow of adjacent traffic.

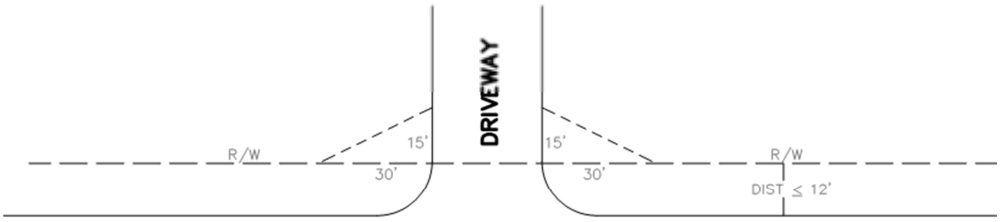
As far as capacity is concerned, on-street parking is typically accepted on arterials when the speed is low (< 35 mph) and the traffic demand is well below capacity. At higher speeds and during periods of heavy traffic movement, on-street parking is incompatible with arterial street service and is not advisable.

The levels of service found in Table 3 were analyzed with parking on the west side of Portage Road. As shown, the level of service for Portage Road decreases which correlates to the above. In addition, the level of service is impacted at intersections thereby making turning movements more difficult.

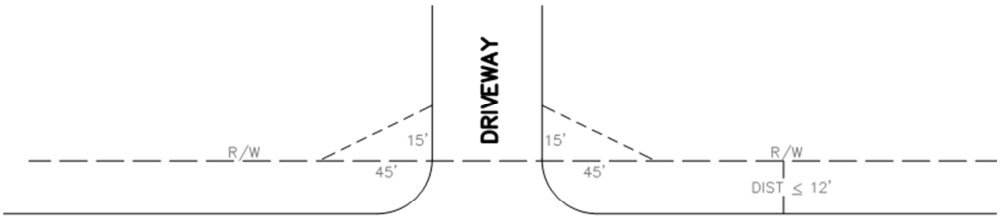
Safety:

On-street parking adversely affects the safety of the street system. Recent reports indicate that approximately 15% of all crashes are attributable to parked cars (Weant R.A. and Levinson H.S., 1990). It should be noted that several studies have compared the crash experience of angle and parallel parking and reported crash rates for parallel parking to be from 19 to 71% lower than those for angle parking (U.S. Department of Transportation, 1982).

Another concern with on-street parking relates to sight distance at driveway locations. A sight distance triangle must be maintained at all driveway approaches when on-street parking is present. The following illustration shows the sight distance triangle with on-street parking present.



PORTAGE ROAD SPEED LIMIT ≤ 35 MPH



PORTAGE ROAD SPEED LIMIT > 40 MPH

4.3 Crash Rate Impacts (Bike lane on both sides of Portage Road)-Alternate #2

Capacity:

Incorporating bicycle lanes on both sides of Portage Road will reduce capacity and increase delay by causing additional side friction between the bicycles and traveling vehicle. This increase in side friction is an awareness of the bicyclist that causes the motorist to slow down resulting in increased delay. Studies have shown that having bicycle lanes directly adjacent to a travel lane have relatively large effects in reducing capacity. Studies have shown that if there is a separation of the bicycle lane and motorist, capacity will not be impacted. The proposed Portage Road bicycle option does not have sufficient space to incorporate a buffer area to reduce the side friction effect.

The levels of service found in Table 3 were analyzed with bicycle lanes on both sides of Portage Road. As shown, the level of service for Portage Road decreases. In addition, the level of service is impacted at intersections thereby making turning movements more difficult.

Safety:

Studies have shown that creating a buffered dedicated bicycle lane can actually reduce accidents by as much as fifty (50) percent by moving the bicycle out of the vehicular travel lane. However, should a buffer between the bicyclist and motorist not be included, accidents can increase.

4.4 Other Corridor Impacts

The following is a summary of other corridor impacts associated with On-street parking proposed with Alternative #1.

Emergency Vehicle Access:

On-street parking constitutes an emergency hazard wherever cars block fire hydrants or obstruct fire apparatus. Parking restrictions in the vicinity of fire hydrants are essential public safety requirements. When the placement of on-street parking is necessary or desirable, available street space must meet requirements for emergency vehicle maneuvering and fire hose laying. Alternatively, on-street parking bays may be designated for use by ambulances or police, where proper road markings alongside the bay are used to indicate the type of vehicle allowed to use the bay (Chick C., 1996).

Economic Development:

There is a strong argument that convenient parking can foster economic growth and development. The placement of on-street parking near business and retail uses improves accessibility and convenience to customers and has been used as a strategy for revitalization of business districts in areas in which on-site parking is inadequate.

Traffic Calming:

For many years replacement of on-street parking by traffic lanes was a common practice as a countermeasure to increase road capacity. However, a 1990 ASCE report admits that “the tendency of many communities to equate wider streets with better streets and to design traffic and parking lanes as if the street were a microfreeway is a highly questionable practice (Residential Streets Task Force, 1990).

On-street parking is viewed as part of the strategy to reduce motorists speeding through increased side friction (perception of side activity). Replacement of traffic lanes by parking lanes, or reduction of traffic lane widths to allow for on-street parking show reduction in motorists speeds and better compliance with posted speed limits.

5. Traffic and Non-Motorized Mobility Issues

Traffic and non-motorized issues have been reviewed in prior sections of this report and will be further discussed in this section of the report.

Non-motorized traffic in this study consists of pedestrian and bicycle activities and how they are impacted by the quantity and quality of sidewalks, crosswalks, bike lanes and paths, system connectivity, and the security and attractiveness of bicycle and pedestrian facilities.

The Current Non-motorized transportation system and its use: Portage Road within the study area consists of a five (5) lane cross section with curb and gutter and a pedestrian walkway on the east side of the road. Currently, pedestrian/bicyclists who wish to access the west side of the road must cross at areas where no cross-walks exist. In addition, the west side of Portage Road does not have a pedestrian/bicycle path. As the population increases and additional development is added, pedestrian/bicycle trips will increase.

The ultimate goal of a good transportation system is accessibility. In many situations, the best way to improve transportation is to improve walking and bicycling access to transit as well as employment centers, schools, and other major destinations.

Transit Operational Issues: According to the Metro Transit Route Map (Revised 03/31/14), transit operations do not currently extend down through the Lake Center Core Node study corridor. The closest transit route is the Romence Road Parkway route that extends down Sprinkle Road then west along Centre and north along Westnedge Avenue. The City of Portage Council recently voted in October 2014 to “opt in” the entire city in the boundaries of the Central County Transportation Authority (CCTA) created by the Kalamazoo County Board of Commissioners in August 2014. The CCTA will replace the Kalamazoo County Transit Authority Board over the next few years. THE CCTA could potentially extend future transit service to the Lake Center Core Node area. The potential conversion (alternative 1 or 2) of Portage Road within the Lake Center Core Node area should not result in future transit causing undue additional delay if bus turnouts are constructed. The City of Portage should consider strategic bus turnouts (50 feet in length) for bus/transit operations should transit operations extend to the study area. If bus turnouts cannot be constructed, the City should work with the transit provider to look at bus stop spacing and location. Most transit operators prefer in-lane stops versus turn-outs due to the difficulty of through lane ingress from the turn-out.

Environmental Effects of Non-motorized Transportation: An increase in non-motorized transportation reduces energy consumption and pollution emissions; it also reduces the amount of land needed for roads and parking facilities preserving open space, wildlife habitat, and cultural resources (e.g. historic buildings).

Social Effects of Non-motorized Transportation: Walking and bicycling provide basic mobility and are particularly important for people who are transportation disadvantaged. Poor walking conditions or lack of can contribute to social exclusion – the physical, economic and social isolation of vulnerable population. Increases in walking and bicycling will result in improved public health from increased exercise and improved air quality. With more people out of their

cars and physically on the sidewalks and bike paths contributes to an increased neighborhood interaction and community cohesion.

Alternative #1 and #2 pedestrian walkway: Both alternative #1 and #2 proposes a bicycle/pedestrian walkway on the west side of Portage Road. Both alternatives also show two (2) crossing locations along the Portage Road study area. These crossing locations will connect the east side of Portage Road to the west side. These crossing locations should be signed accordingly based on the MMUTCD manual for pedestrian/bicycle crossings. The City may also wish to include pedestrian crossing indications as was recently completed in the study area near McClish Avenue to ensure safe crossings. In addition, the pedestrian/bicycle crossings are proposed to have a refuge area island for pedestrians.

6. Functional Classification

Portage Road in the vicinity of the study area (Forest Drive to Lakeview Drive) is a five (5) lane curb and gutter minor arterial roadway, consisting of two (2) NB lanes, two (2) SB lanes, and a center left-turn lane that forms left-turn pocket lanes at Forest and Lakeview Drives.

In reducing the number of lanes from five (5) to three (3), the functional classification on Portage Road between Forest and Lakeview Drive may be affected.

Several items go into determining which functional classification a roadway falls under. These items include:

- Number of Travel Lanes
- ADT Volumes
- Speed Limit
- Access Points
- Efficiency of Travel
- Distance Served (and Length of Route)

Functional Classification	Distance Served (and Length of Route)	Access Points	Speed Limit	Distance between Routes	Usage (AADT and DVMT)	Significance	Number of Travel Lanes
Arterial	Longest	Few	Highest	Lowest	Highest	Statewide	More
Collector	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Local	Shortest	Many	Lowest	Shortest	Lowest	Local	Fewer

According to the FHWA, "Minor Arterials provide service for trips of moderate length, serve geographic areas that are smaller than their higher Arterial counterparts and offer connectivity to the higher Arterial system. In addition, they provide intra-community continuity and may carry local bus routes."

Collectors serve a critical role in the roadway network by gathering traffic from Local Roads and funneling them to the Arterial network. Within the context of functional classification, collectors are broken down into two categories; Major Collectors and Minor Collectors. In the rural environment, collectors generally serve primarily intra-county travel and constitute those routes on which predominant travel distances are shorter than on Arterial routes. Consequently, more moderate speeds may be posted. Currently, the 85th percentile speed on Portage Road ranges from 45.67 mph to 49.76 mph.

One of the difficulties surrounding the relationship between highway functional classification and design guidelines is that the classification process is not an exact science. The predominant traffic service associated with a particular route cannot be definitely determined without exhaustive surveys of traffic origin destination patterns on each link of the road network. Engineering judgment based on

experience plays a role in making design decisions. As a result of variances with the highway functional classification system, design guidelines established in the Green Book have overlapping ranges of values.

Based on the above information, changing the number of lanes from five (5) to three (3), may potentially change the functional classification of Portage Road between Forest and Lakeview Drives from minor arterial to major collector since this section will reduce the number of lanes, and reduce the speed of vehicles traveling through this section.

7. Federal Highway Funding Ramifications

Federal Highway funding ramifications were reviewed to determine potential funding source that are available for implementing either Alternative 1 or 2.

The state of Michigan recently reviewed the conversion of a Roadway from "4 lanes to 3 lanes" in a letter addressed to Mr. John D. Niemela, Director, dated November 13, 2009. The following is a summary of that response:

The conversion of the Portage Road 5-lane undivided corridor to a 3-lane cross section with center lane reserved for left-turn **is** eligible for Federal-aid funding when documentation from the submitting jurisdiction shows positive resolution of the following issues.

1. Operational analysis shows that the 3-lane cross section will provide reasonable level of service for all traffic movements at major intersections through the design life. Reasonable level of service is generally considered to be LOS C; however, LOS D could be considered reasonable if part of a calculated trade-off to react to other community goals, such as traffic safety and traffic calming. Proposed projects with design year ADT projected to be 15,000 or less will not require operational analysis.

2. Projected ADT for the design life is consistent with the area Long Range Transportation Plan, for projects within an area covered by an MPO.

3. Project design life is determined to be:
    a. For safety project, supported by a time-of-return (TOR) analysis, project design life can be as chosen for the TOR analysis
    b. 3 years or longer – if the project consists mostly of signing, striping, and striping removal.
    c. 10-20 years – if the project consists of significant pavement or curb work.

4. Public involvement has demonstrated sufficient support for the project within the community OR formal agreement has been reached for a trial project that would allow at least one year of operation of the 3-lane section.

Reversal of cross-section: If Federal aid was used to convert a 4-lane section to 3-lane, FHWA will not participate in the reversal of that cross-section back to 4-lane, unless justified by crash analysis, level of service analysis or unanticipated operational issues.

Exception: if a 3-lane corridor was installed on a pilot project as discussed above, and the project is deemed to be unsuccessful according to the agreed-upon evaluation measures, FHWA will participate in the return to 4-lane cross-section.

FHWA Processing

Requests for 4-to-3 lane conversion projects that are to be accomplished with use of Federal-aid highway funds will be processed and approved in the same manner as typical highway projects.

- STIP –
  - Safety projects which are documented with a time-of-return analysis that meets the definition of state or local safety project could be covered under one of the local or trunkline safety General Program Accounts (GPA); however, a road agency can choose to list the project in the STIP individually if it so desires.
  - Rural Task Force projects may be lumped under one GPA
  - Projects which are not documented as safety projects or rural task force projects must be listed on the STIP individually

- Air Quality Analysis –
  - In EPA designated air quality nonattainment and maintenance areas, proposed 4-to-3 lane conversions should be reviewed through the interagency consultation process to determine if an air quality conformity analysis is needed.
  - For projects that are not located in an EPA non-attainment or maintenance area, no air quality analysis is needed.

- Environmental Clearance –
  - Projects can be processed as a categorical exclusion with FHWA approval per 23 CFR 771.117 (b) and (d) pending other proposed project elements and results of MDOT environmental classification process. Consultation with the public is required on all 4-to-3 lane conversions to ensure there is no substantial controversy on environmental grounds.

- Project Approval
  - FHWA Oversight projects - FHWA Area Engineer
  - FHWA non-oversight projects – FHWA fiscal clerk
  - On all projects (oversight and non-oversight), FHWA approval document should contain the following statement: "FHWA will not participate in the reversal of cross-section from 3-lane back to 4-lane, unless justified by crash analysis, level of service analysis or unanticipated operational issues, or if the 3-lane cross-section on a pilot project is deemed to be unsuccessful according to the agreed-upon evaluation measures".

8. Construction Cost Estimates

Construction cost estimates were prepared for both study alternatives based on the following assumptions:

- Alternative #1: 3 lane section from Ames Drive south to Lakeview Drive with on-street parking and pedestrian/bikeway on the west side.
  - Existing curb and gutter to remain on the east side of Portage Road.
  - Existing sidewalk on east side of Portage Road to remain.
  - Mill and overlay 33 feet of the existing 55 feet of Portage Road.
  - Remove 1,630 feet of existing curb and gutter on the west side.
  - Remove the last 23 feet of pavement on the west side of Portage Road.
  - New pavement for 9 foot parking lane.
  - 1,630 feet of new curb and gutter on the west side of Portage Road.
  - New lawn area on west side of Portage Road.
  - New Pedestrian walkway on west side of Portage Road.
  - Stripe in three (3) lane section with parallel parking on west side of Portage Road.
- Alternative #2: 3 lane section from Ames Drive south to Lakeview Drive with bike lane on east and west side and pedestrian walkway on the west side.
  - Existing curb and gutter to remain on the east side of Portage Road.
  - Existing sidewalk on east side of Portage Road to remain.
  - Mill and overlay 41 feet of the existing 55 feet of Portage Road.
  - Remove 1,630 feet of existing curb and gutter on the west side.
  - Remove the last 14 feet of pavement on the west side of Portage Road.
  - 1,630 feet of new curb and gutter on the west side of Portage Road.
  - New lawn area on west side of Portage Road.
  - New Pedestrian walkway on west side of Portage Road.
  - Stripe in three (3) lane section with bike lanes on both sides of Portage Road.

Detailed construction cost estimates and preliminary scope of work for both alternatives are contained in Appendix “E” of the report.

9. Summary of Findings

This report summarized the results of a road diet feasibility study on Portage Road from Ames Drive south to Lakeview Drive. A typical road diet involves the reallocation of four or five travel lanes (two in each direction with a center two-way left-turn lane) to one travel lane in each direction with a center two-way left-turn lane. The study compares the benefits and impacts associated with two (2) study alternatives:

- Alternative #1: 3 lane section from Ames Drive south to Lakeview Drive with on-street parking and pedestrian/sidewalk on the west side.

- Alternative #2: 3 lane section from Ames Drive south to Lakeview Drive with bike lane on east and west side and pedestrian walkway on the west side.

Based on the evaluation, overall corridor mobility could improve for all users through the implementation of a road diet by providing space for pedestrians/bicycles, and reducing pedestrian/vehicle conflicts. Analyses show that there is a decrease in the level of service along Portage Road and that mitigation measures would be needed at both Lakeview Drive and Forest Drive.

Based on "road diet" concepts, the current 85th percentile speed on Portage Road (45.67 mph NB, and 49.76 mph) will decrease by eliminating a northbound and southbound through lane.

In summary, it appears that a "Road Diet" is feasible for Portage Road from Ames Drive south to Lakeview Drive with the following potential trade-offs:

	Existing Condition	Alternative #1	Alternative #2
Vehicle Capacity	No Change	Reduction	Reduction
Level of Service (LOS) ~ Delay	No Change	Reduction	Reduction
Crash Reduction	No Change	Increase	
Bicycle Accommodation	No Change	No	Yes
Pedestrian Accommodation	No Change	Yes	Yes
Transit Accommodations	No Change	No	No
Land Use / Street Scaping	No Change	Yes	Yes
Cost	$0.00	$537,205.21	$428,997.51

Note: The City of Portage could implement a temporary "road diet" situation by placing barrels and temporary signage along Portage Road to simulate the impact of a "road diet".

APPENDIX A

EXISTING TRAFFIC COUNT DATA

Site ID: Portage and Forest City: Portage
Site Reference: Portage and Forest County: Kalamazoo
Location: Portage and Forest
Start Date: 10/7/2014 Start Time:
End Date: 10/7/2014 End Time:

		SOUTHBOUND					WESTBOUND				NORTHBOUIND					EASTBOUND					
Date	Time Ending	Right	SB curb lane	SB inside lane	Left	TOTAL	Right	Thru	Left	Total	Right	Nb inside lane	NB curb lane	Left	TOTAL	Right	Thru	Left	Total	TOTAL	
10/7/2014	12:15:00 AM	0	1	6	0	7	0	0	0	0	0	6	2	3	11	1	0	2	3	21	
10/7/2014	12:30:00 AM	0	3	14	0	17	0	0	0	0	0	1	0	1	2	0	0	0	0	19	
10/7/2014	12:45:00 AM	0	3	6	0	9	0	0	0	0	0	1	2	0	3	0	0	0	0	12	
10/7/2014	1:00:00 AM	0	1	2	0	3	0	0	0	0	0	1	1	0	2	1	0	0	1	6	58
10/7/2014	1:15:00 AM	0	4	6	0	10	0	0	0	0	0	1	2	0	3	0	0	0	0	13	50
10/7/2014	1:30:00 AM	0	2	4	0	6	0	0	0	0	0	3	2	0	5	0	0	0	0	11	42
10/7/2014	1:45:00 AM	0	0	6	0	6	0	0	0	0	0	5	5	0	10	1	0	0	1	17	47
10/7/2014	2:00:00 AM	0	0	3	0	3	0	0	0	0	0	2	1	0	3	1	0	0	1	7	48
10/7/2014	2:15:00 AM	0	3	3	0	6	0	0	0	0	0	0	1	0	1	0	0	0	0	7	42
10/7/2014	2:30:00 AM	0	0	2	0	2	0	0	0	0	0	2	2	0	4	0	0	0	0	6	37
10/7/2014	2:45:00 AM	0	2	1	0	3	0	0	0	0	0	1	2	0	3	0	0	0	0	6	26
10/7/2014	3:00:00 AM	0	2	3	0	5	0	0	0	0	0	2	1	0	3	0	0	0	0	8	27
10/7/2014	3:15:00 AM	0	4	4	0	8	0	0	0	0	0	3	2	0	5	0	0	1	1	14	34
10/7/2014	3:30:00 AM	0	1	3	0	4	0	0	0	0	0	2	0	1	3	0	0	0	0	7	35
10/7/2014	3:45:00 AM	0	0	4	0	4	0	0	0	0	0	5	2	1	8	0	0	1	1	13	42
10/7/2014	4:00:00 AM	0	0	3	0	3	0	0	0	0	0	6	7	0	13	0	0	1	1	17	51
10/7/2014	4:15:00 AM	0	1	3	0	4	0	0	0	0	0	9	2	0	11	0	0	0	0	15	52
10/7/2014	4:30:00 AM	0	2	7	0	9	0	0	0	0	0	5	1	1	7	0	0	1	1	17	62
10/7/2014	4:45:00 AM	0	2	3	0	5	0	0	0	0	0	16	21	0	37	1	0	0	1	43	92
10/7/2014	5:00:00 AM	0	1	6	0	7	0	0	0	0	0	15	18	1	34	0	0	0	0	41	116
10/7/2014	5:15:00 AM	0	0	8	0	8	0	0	0	0	0	24	8	1	33	0	0	0	0	41	142
10/7/2014	5:30:00 AM	0	3	4	0	7	0	0	0	0	0	35	28	0	63	0	0	0	0	70	195
10/7/2014	5:45:00 AM	0	6	11	0	17	0	0	0	0	0	27	29	0	56	0	0	1	1	74	226
10/7/2014	6:00:00 AM	0	6	9	0	15	0	0	0	0	0	45	30	1	76	0	0	1	1	92	277
10/7/2014	6:15:00 AM	0	12	28	0	40	0	0	0	0	0	56	36	0	92	0	0	1	1	133	369
10/7/2014	6:30:00 AM	0	22	40	0	62	0	0	0	0	0	58	61	3	122	4	0	2	6	190	489
10/7/2014	6:45:00 AM	0	26	38	0	64	0	0	0	0	0	96	94	2	192	1	0	3	4	260	675
10/7/2014	7:00:00 AM	0	28	30	0	58	0	0	0	0	0	73	90	8	171	4	0	2	6	235	818
10/7/2014	7:15:00 AM	0	22	30	0	52	0	0	0	0	0	131	96	10	237	2	0	6	8	297	982
10/7/2014	7:30:00 AM	0	44	49	0	93	0	0	0	0	0	161	129	16	306	5	0	5	10	409	1201
10/7/2014	7:45:00 AM	0	50	48	0	98	0	0	0	0	0	140	118	10	268	6	0	9	15	381	1322
10/7/2014	8:00:00 AM	0	36	53	0	89	0	0	0	0	0	118	111	9	238	9	0	1	10	337	1424
10/7/2014	8:15:00 AM	0	46	52	0	98	0	0	0	0	0	101	80	12	193	11	0	2	13	304	1431
10/7/2014	8:30:00 AM	0	22	51	0	73	0	0	0	0	0	118	91	6	215	4	0	6	10	298	1320
10/7/2014	8:45:00 AM	0	31	46	0	77	0	0	0	0	0	99	77	3	179	7	0	1	8	264	1203
10/7/2014	9:00:00 AM	0	41	47	0	88	0	0	0	0	0	96	51	8	155	3	0	2	5	248	1114
10/7/2014	9:15:00 AM	0	39	31	0	70	0	0	0	0	0	75	52	6	133	10	0	2	12	215	1025
10/7/2014	9:30:00 AM	0	25	42	0	67	0	0	0	0	0	79	41	6	126	6	0	7	13	206	933
10/7/2014	9:45:00 AM	0	28	56	0	84	0	0	0	0	0	89	43	3	135	8	0	1	9	228	897
10/7/2014	10:00:00 AM	0	35	44	0	79	0	0	0	0	0	69	48	4	121	12	0	5	17	217	866
10/7/2014	10:15:00 AM	0	39	46	0	85	0	0	0	0	0	64	45	5	114	3	0	4	7	206	857
10/7/2014	10:30:00 AM	0	34	56	0	90	0	0	0	0	0	70	50	10	130	4	0	5	9	229	880
10/7/2014	10:45:00 AM	0	32	47	0	79	0	0	0	0	0	50	49	5	104	8	0	2	10	193	845
10/7/2014	11:00:00 AM	0	35	62	0	97	0	0	0	0	0	53	45	10	108	6	0	2	8	213	841
10/7/2014	11:15:00 AM	0	46	58	0	104	0	0	0	0	0	65	43	4	112	15	0	4	19	235	870
10/7/2014	11:30:00 AM	0	48	81	0	129	0	0	0	0	0	64	43	11	118	9	0	3	12	259	900
10/7/2014	11:45:00 AM	0	50	56	0	106	0	0	0	0	0	80	45	8	133	8	0	8	16	255	962
10/7/2014	12:00:00 PM	0	53	76	0	129	0	0	0	0	0	71	47	12	130	8	0	5	13	272	1021
10/7/2014	12:15:00 PM	0	67	90	0	157	0	0	0	0	0	64	59	6	129	7	0	2	9	295	1081
10/7/2014	12:30:00 PM	0	43	64	0	107	0	0	0	0	0	73	57	18	148	13	0	2	15	270	1092
10/7/2014	12:45:00 PM	0	51	68	0	119	0	0	0	0	0	81	62	6	149	11	0	2	13	281	1118
10/7/2014	1:00:00 PM	0	42	77	0	119	0	0	0	0	0	68	51	7	126	6	0	2	8	253	1099
10/7/2014	1:15:00 PM	0	51	70	0	121	0	0	0	0	0	50	38	9	97	11	0	3	14	232	1036
10/7/2014	1:30:00 PM	0	42	59	0	101	0	0	0	0	0	69	46	9	124	13	0	5	18	243	1009
10/7/2014	1:45:00 PM	0	38	70	0	108	0	0	0	0	0	57	57	10	124	13	0	3	16	248	976
10/7/2014	2:00:00 PM	0	47	72	0	119	0	0	0	0	0	64	53	9	126	10	0	7	17	262	985
10/7/2014	2:15:00 PM	0	56	77	0	133	0	0	0	0	0	68	47	8	123	10	0	6	16	272	1025
10/7/2014	2:30:00 PM	0	56	95	0	151	0	0	0	0	0	59	51	3	113	9	0	2	11	275	1057
10/7/2014	2:45:00 PM	0	63	84	0	147	0	0	0	0	0	68	61	13	142	15	0	5	20	309	1118
10/7/2014	3:00:00 PM	0	61	88	0	149	0	0	0	0	0	84	48	11	143	8	0	4	12	304	1160
10/7/2014	3:15:00 PM	0	68	111	0	179	0	0	0	0	0	87	65	13	165	14	0	4	18	362	1250
10/7/2014	3:30:00 PM	0	76	114	0	190	0	0	0	0	0	95	51	6	152	12	0	5	17	359	1334

Site ID: Portage and Lakeview City Portage
Site Referer Portage and Lakeview County: Kalamazoo
Location: Portage and Lakeview
Start Date: 10/7/2014 Start Time: 12:00:00 AM
End Date: 10/8/2014 End Time: 12:00:00 AM

		SOUTHBOUND				WESTBOUND				NORTHBOUIND				EASTBOUND				Total	
Date	Time Ending	Right	thru	Left	Total	Right	thru	Left	Total	Right	thru	Left	Total	Right	Thru	Left	TOTAL		
10/7/2014	12:15:00 AM	0	6	2	8	0	0	0	0	0	8	0	8	0	0	1	1	17	
10/7/2014	12:30:00 AM	0	18	0	18	0	0	0	0	0	1	0	1	0	0	1	1	20	
10/7/2014	12:45:00 AM	0	6	0	6	0	0	0	0	0	3	0	3	0	0	0	0	9	
10/7/2014	1:00:00 AM	0	3	0	3	0	0	0	0	0	2	0	2	0	0	0	0	5	51
10/7/2014	1:15:00 AM	0	9	0	9	0	0	0	0	0	4	0	4	0	0	0	0	13	47
10/7/2014	1:30:00 AM	0	6	0	6	0	0	0	0	0	4	0	4	0	0	0	0	10	37
10/7/2014	1:45:00 AM	0	9	1	10	0	0	0	0	0	10	0	10	0	0	1	1	21	49
10/7/2014	2:00:00 AM	0	4	0	4	0	0	0	0	0	3	0	3	0	0	1	1	8	52
10/7/2014	2:15:00 AM	0	5	0	5	0	0	0	0	0	1	0	1	0	0	0	0	6	45
10/7/2014	2:30:00 AM	0	3	0	3	0	0	0	0	0	5	0	5	0	0	0	0	8	43
10/7/2014	2:45:00 AM	1	2	0	3	0	0	0	0	0	3	0	3	0	0	0	0	6	28
10/7/2014	3:00:00 AM	0	4	0	4	0	0	0	0	0	5	0	5	0	0	0	0	9	29
10/7/2014	3:15:00 AM	0	6	0	6	0	0	0	0	0	4	0	4	0	0	0	0	10	33
10/7/2014	3:30:00 AM	0	8	0	8	0	0	0	0	0	4	0	4	0	0	0	0	12	37
10/7/2014	3:45:00 AM	0	4	0	4	0	0	0	0	0	8	0	8	0	0	0	0	12	43
10/7/2014	4:00:00 AM	0	3	0	3	0	0	0	0	0	14	0	14	0	0	0	0	17	51
10/7/2014	4:15:00 AM	0	2	0	2	0	0	0	0	0	9	0	9	0	0	0	0	11	52
10/7/2014	4:30:00 AM	1	11	0	12	0	0	0	0	0	9	0	9	0	0	1	1	22	62
10/7/2014	4:45:00 AM	0	6	1	7	0	0	0	0	0	37	0	37	0	0	1	1	45	95
10/7/2014	5:00:00 AM	0	7	1	8	0	0	0	0	0	30	0	30	0	0	0	0	38	116
10/7/2014	5:15:00 AM	0	7	1	8	0	0	0	0	0	33	0	33	0	0	3	3	44	149
10/7/2014	5:30:00 AM	1	5	0	6	0	0	0	0	0	63	0	63	0	0	0	0	69	196
10/7/2014	5:45:00 AM	0	17	1	18	0	0	0	0	0	54	0	54	0	0	4	4	76	227
10/7/2014	6:00:00 AM	0	15	0	15	0	0	0	0	0	74	0	74	0	0	1	1	90	279
10/7/2014	6:15:00 AM	2	32	1	35	0	0	0	0	0	91	0	91	1	0	10	11	137	372
10/7/2014	6:30:00 AM	2	63	5	70	0	0	0	0	0	119	0	119	0	0	4	4	193	496
10/7/2014	6:45:00 AM	2	60	0	62	0	0	0	0	0	188	0	188	1	0	4	5	255	675
10/7/2014	7:00:00 AM	2	58	2	62	0	0	0	0	0	172	0	172	1	0	4	5	239	824
10/7/2014	7:15:00 AM	0	51	8	59	0	0	0	0	0	240	0	240	0	0	5	5	304	991
10/7/2014	7:30:00 AM	1	93	7	101	0	0	0	0	0	279	0	279	0	0	10	10	390	1188
10/7/2014	7:45:00 AM	3	97	6	106	0	0	0	0	0	258	0	258	0	0	7	7	371	1304
10/7/2014	8:00:00 AM	2	89	4	95	0	0	0	0	0	219	0	219	0	0	10	10	324	1389
10/7/2014	8:15:00 AM	3	98	4	105	0	0	0	0	0	184	0	184	0	0	3	3	292	1377
10/7/2014	8:30:00 AM	3	73	7	83	0	0	0	0	0	206	0	206	0	0	9	9	298	1285
10/7/2014	8:45:00 AM	5	77	4	86	0	0	0	0	0	177	0	177	2	0	10	12	275	1189
10/7/2014	9:00:00 AM	1	85	6	92	0	0	0	0	0	146	0	146	0	0	7	7	245	1110
10/7/2014	9:15:00 AM	5	68	7	80	0	0	0	0	0	112	1	113	0	0	11	11	204	1022
10/7/2014	9:30:00 AM	1	62	4	67	0	0	0	0	0	119	0	119	0	0	5	5	191	915
10/7/2014	9:45:00 AM	6	81	6	93	0	0	0	0	0	129	0	129	1	0	10	11	233	873
10/7/2014	10:00:00 AM	3	69	2	74	0	0	0	0	0	122	0	122	0	0	2	2	198	826
10/7/2014	10:15:00 AM	3	81	0	84	0	0	0	0	0	111	0	111	0	0	7	7	202	824
10/7/2014	10:30:00 AM	6	87	3	96	0	0	0	0	0	111	0	111	0	0	7	7	214	847
10/7/2014	10:45:00 AM	3	85	2	90	0	0	0	0	0	115	0	115	0	0	5	5	210	824
10/7/2014	11:00:00 AM	4	103	4	111	0	0	0	0	0	93	1	94	0	0	9	9	214	840

10/7/2014	11:15:00 AM	6	107	2	115	0	0	0	0	0	100	2	102	0	0	7	7	224	862
10/7/2014	11:30:00 AM	6	122	0	128	0	0	0	0	0	123	0	123	0	0	4	4	255	903
10/7/2014	11:45:00 AM	10	102	2	114	0	0	0	0	0	112	1	113	0	0	15	15	242	935
10/7/2014	12:00:00 PM	8	115	7	130	0	0	0	0	0	118	0	118	0	0	13	13	261	982
10/7/2014	12:15:00 PM	4	152	7	163	0	0	0	0	0	128	2	130	0	0	10	10	303	1061
10/7/2014	12:30:00 PM	3	109	5	117	0	0	0	0	0	138	0	138	0	0	7	7	262	1068
10/7/2014	12:45:00 PM	5	125	1	131	0	0	0	0	0	122	2	124	0	0	3	3	258	1084
10/7/2014	1:00:00 PM	2	110	5	117	0	0	0	0	0	113	0	113	0	0	7	7	237	1060
10/7/2014	1:15:00 PM	6	123	4	133	0	0	0	0	0	90	1	91	0	0	7	7	231	988
10/7/2014	1:30:00 PM	4	102	4	110	0	0	0	0	0	111	0	111	0	0	8	8	229	955
10/7/2014	1:45:00 PM	8	104	2	114	0	0	0	0	0	118	0	118	1	0	5	6	238	935
10/7/2014	2:00:00 PM	10	126	4	140	0	0	0	0	0	116	1	117	0	0	8	8	265	963
10/7/2014	2:15:00 PM	11	127	1	139	0	0	0	0	0	104	0	104	2	0	7	9	252	984
10/7/2014	2:30:00 PM	9	131	8	148	0	0	0	0	0	109	0	109	0	0	14	14	271	1026
10/7/2014	2:45:00 PM	14	144	4	162	0	0	0	0	0	131	0	131	0	0	13	13	306	1094
10/7/2014	3:00:00 PM	7	156	4	167	0	0	0	0	0	127	0	127	2	0	10	12	306	1135
10/7/2014	3:15:00 PM	9	181	3	193	0	0	0	0	0	157	0	157	2	0	5	7	357	1240
10/7/2014	3:30:00 PM	8	189	2	199	0	0	0	0	0	140	2	142	1	0	9	10	351	1320
10/7/2014	3:45:00 PM	11	226	4	241	0	0	0	0	0	153	1	154	3	0	4	7	402	1416
10/7/2014	4:00:00 PM	9	202	5	216	0	0	0	0	0	181	2	183	0	0	8	8	407	1517
10/7/2014	4:15:00 PM	10	210	1	221	0	0	0	0	0	144	1	145	2	0	11	13	379	1539
10/7/2014	4:30:00 PM	13	187	4	204	0	0	0	0	0	149	2	151	1	0	9	10	365	1553
10/7/2014	4:45:00 PM	10	210	6	226	0	0	0	0	0	123	0	123	0	0	8	8	357	1508
10/7/2014	5:00:00 PM	15	198	5	218	0	0	0	0	0	126	0	126	1	0	8	9	353	1454
10/7/2014	5:15:00 PM	12	277	4	293	0	0	0	0	0	149	0	149	1	0	7	8	450	1525
10/7/2014	5:30:00 PM	16	286	4	306	0	0	0	0	0	134	0	134	0	0	11	11	451	1611
10/7/2014	5:45:00 PM	12	243	2	257	0	0	0	0	0	132	2	134	1	0	6	7	398	1652
10/7/2014	6:00:00 PM	11	188	6	205	0	0	0	0	0	129	1	130	1	0	8	9	344	1643
10/7/2014	6:15:00 PM	5	179	4	188	0	0	0	0	0	122	1	123	0	0	8	8	319	1512
10/7/2014	6:30:00 PM	9	168	5	182	0	0	0	0	0	111	0	111	2	0	2	4	297	1358
10/7/2014	6:45:00 PM	11	150	0	161	0	0	0	0	0	96	0	96	1	0	6	7	264	1224
10/7/2014	7:00:00 PM	4	149	5	158	0	0	0	0	0	83	1	84	1	0	5	6	248	1128
10/7/2014	7:15:00 PM	12	141	7	160	0	0	0	0	0	82	1	83	2	0	12	14	257	1066
10/7/2014	7:30:00 PM	9	137	1	147	0	0	0	0	0	68	1	69	2	0	9	11	227	996
10/7/2014	7:45:00 PM	2	111	1	114	0	0	0	0	0	61	1	62	0	0	5	5	181	913
10/7/2014	8:00:00 PM	6	118	0	124	0	0	0	0	0	51	0	51	2	0	8	10	185	850
10/7/2014	8:15:00 PM	1	131	2	134	0	0	0	0	0	45	1	46	0	0	3	3	183	776
10/7/2014	8:30:00 PM	9	77	3	89	0	0	0	0	0	38	0	38	0	0	6	6	133	682
10/7/2014	8:45:00 PM	3	65	1	69	0	0	0	0	0	43	0	43	0	0	3	3	115	616
10/7/2014	9:00:00 PM	3	85	1	89	0	0	0	0	0	24	0	24	0	0	5	5	118	549
10/7/2014	9:15:00 PM	3	59	0	62	0	0	0	0	0	30	0	30	0	0	4	4	96	462
10/7/2014	9:30:00 PM	2	45	0	47	0	0	0	0	0	26	0	26	0	0	0	0	73	402
10/7/2014	9:45:00 PM	1	43	0	44	0	0	0	0	0	20	0	20	0	0	0	0	64	351
10/7/2014	10:00:00 PM	3	41	0	44	0	0	0	0	0	28	1	29	0	0	3	3	76	309
10/7/2014	10:15:00 PM	2	52	0	54	0	0	0	0	0	23	1	24	0	0	3	3	81	294
10/7/2014	10:30:00 PM	1	35	1	37	0	0	0	0	0	27	0	27	2	0	3	5	69	290
10/7/2014	10:45:00 PM	0	32	1	33	0	0	0	0	0	26	0	26	0	0	1	1	60	286
10/7/2014	11:00:00 PM	0	25	0	25	0	0	0	0	0	17	0	17	0	0	0	0	42	252
10/7/2014	11:15:00 PM	0	22	0	22	0	0	0	0	0	24	0	24	0	0	0	0	46	217
10/7/2014	11:30:00 PM	0	15	0	15	0	0	0	0	0	25	0	25	0	0	0	0	40	188
10/7/2014	11:45:00 PM	0	28	0	28	0	0	0	0	0	11	0	11	0	0	0	0	39	167
10/7/2014	12:00:00 AM	1	10	1	12	0	0	0	0	0	10	0	10	0	0	1	1	23	148
p		**396**	**8148**	**228**	**8772**	**0**	**0**	**0**	**0**	**0**	**8247**	**30**	**8277**	**36**	**0**	**472**	**508**	**17557**	

10/7/2014	3:45:00 PM	0	101	144	0	245	0	0	0	0	0	80	62	14	156	14	0	1	15	416	1441
10/7/2014	4:00:00 PM	0	72	124	0	196	0	0	0	0	0	97	77	15	189	20	0	6	26	411	1548
10/7/2014	4:15:00 PM	0	78	128	0	206	0	0	0	0	0	89	68	11	168	17	0	6	23	397	1583
10/7/2014	4:30:00 PM	0	71	115	0	186	0	0	0	0	0	69	74	8	151	11	0	5	16	353	1577
10/7/2014	4:45:00 PM	0	80	125	0	205	0	0	0	0	0	74	55	4	133	12	0	9	21	359	1520
10/7/2014	5:00:00 PM	0	86	132	0	218	0	0	0	0	0	72	66	9	147	14	0	1	15	380	1489
10/7/2014	5:15:00 PM	0	133	165	0	298	0	0	0	0	0	88	66	10	164	15	0	4	19	481	1573
10/7/2014	5:30:00 PM	0	122	161	0	283	0	0	0	0	0	73	71	10	154	23	0	3	26	463	1683
10/7/2014	5:45:00 PM	0	108	132	0	240	0	0	0	0	0	72	62	7	141	15	0	4	19	400	1724
10/7/2014	6:00:00 PM	0	79	111	0	190	0	0	0	0	0	67	63	11	141	17	0	2	19	350	1694
10/7/2014	6:15:00 PM	0	54	104	0	158	0	0	0	0	0	65	59	9	133	15	0	8	23	314	1527
10/7/2014	6:30:00 PM	0	79	100	0	179	0	0	0	0	0	60	41	4	105	13	0	3	16	300	1364
10/7/2014	6:45:00 PM	0	56	100	0	156	0	0	0	0	0	53	49	7	109	0	0	7	7	272	1236
10/7/2014	7:00:00 PM	0	60	79	0	139	0	0	0	0	0	46	32	2	80	6	0	12	18	237	1123
10/7/2014	7:15:00 PM	0	59	90	0	149	0	0	0	0	0	50	41	13	104	15	0	3	18	271	1080
10/7/2014	7:30:00 PM	0	53	68	0	121	0	0	0	0	0	35	36	7	78	14	0	0	14	213	993
10/7/2014	7:45:00 PM	0	50	59	0	109	0	0	0	0	0	37	30	5	72	11	0	1	12	193	914
10/7/2014	8:00:00 PM	0	58	69	0	127	0	0	0	0	0	26	20	3	49	9	0	1	10	186	863
10/7/2014	8:15:00 PM	0	45	72	0	117	0	0	0	0	0	31	27	6	64	6	0	1	7	188	780
10/7/2014	8:30:00 PM	0	30	51	0	81	0	0	0	0	0	27	17	2	46	2	0	5	7	134	701
10/7/2014	8:45:00 PM	0	23	37	0	60	0	0	0	0	0	23	16	0	39	3	0	0	3	102	610
10/7/2014	9:00:00 PM	0	30	63	0	93	0	0	0	0	0	10	12	0	22	0	0	2	2	117	541
10/7/2014	9:15:00 PM	0	33	26	0	59	0	0	0	0	0	22	14	0	36	4	0	5	9	104	457
10/7/2014	9:30:00 PM	0	15	24	0	39	0	0	0	0	0	15	10	0	25	5	0	1	6	70	393
10/7/2014	9:45:00 PM	0	17	26	0	43	0	0	0	0	0	14	8	0	22	3	0	0	3	68	359
10/7/2014	10:00:00 PM	0	17	29	0	46	0	0	0	0	0	14	13	0	27	1	0	2	3	76	318
10/7/2014	10:15:00 PM	0	17	30	0	47	0	0	0	0	0	16	6	0	22	2	0	0	2	71	285
10/7/2014	10:30:00 PM	0	8	28	0	36	0	0	0	0	0	16	13	0	29	1	0	0	1	66	281
10/7/2014	10:45:00 PM	0	15	18	0	33	0	0	0	0	0	10	19	0	29	1	0	0	1	63	276
10/7/2014	11:00:00 PM	0	8	17	0	25	0	0	0	0	0	9	8	0	17	0	0	0	0	42	242
10/7/2014	11:15:00 PM	0	8	13	0	21	0	0	0	0	0	12	9	0	21	2	0	0	2	44	215
10/7/2014	11:30:00 PM	0	1	14	0	15	0	0	0	0	0	19	7	0	26	1	0	1	2	43	192
10/7/2014	11:45:00 PM	0	7	19	0	26	0	0	0	0	0	6	4	0	10	0	0	1	1	37	166
10/7/2014	12:00:00 AM	0	4	7	0	11	0	0	0	0	0	9	1	0	10	0	0	1	1	22	146
TOTAL		0	3329	4907	0	8236	0	0	0	0	0	4686	3656	466	8808	582	0	243	825	17869	

Counter Turned off

Peak Hours

APPENDIX B

EXISTING CAPACITY ANALYSIS SUMMARY SHEETS

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 4/3/2015
Analysis Time Period: Weekday AM Peak Hour
Intersection: Portage Road & Forest Drive
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	47	958			378	1
Peak-Hour Factor, PHF	0.73	0.83			0.96	0.90
Hourly Flow Rate, HFR	64	1154			393	1
Percent Heavy Vehicles	1	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	2			2	0
Configuration	L	T			T	TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				17		31
Peak Hour Factor, PHF				0.70		0.70
Hourly Flow Rate, HFR				24		44
Percent Heavy Vehicles				1		1
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			/
Lanes				1		1
Configuration				L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L					L		R
v (vph)	64					24		44
C(m) (vph)	1168					197		846
v/c	0.05					0.12		0.05
95% queue length	0.17					0.41		0.16
Control Delay	8.3					25.8		9.5
LOS	A					D		A
Approach Delay							15.2	
Approach LOS							C	

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 4/3/2015
Analysis Time Period: Weekday AM Peak Hour
Intersection: Portage Road & Forest Drive
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	47	958			378	1
Peak-Hour Factor, PHF	0.73	0.83			0.96	0.90
Peak-15 Minute Volume	16	289			98	0
Hourly Flow Rate, HFR	64	1154			393	1
Percent Heavy Vehicles	1	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	2			2	0
Configuration	L	T			T	TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				17		31
Peak Hour Factor, PHF				0.70		0.70
Peak-15 Minute Volume				6		11
Hourly Flow Rate, HFR				24		44
Percent Heavy Vehicles				1		1
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		/
RT Channelized?						No
Lanes				1		1
Configuration				L		R

Pedestrian Volumes and Adjustments

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

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

Upstream Signal Data

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

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

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

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1					7.5		6.2
t(c,hv)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
P(hv)	1					1		1
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00					0.70		0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1					6.8		6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50		3.30
t(f,HV)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(HV)	1					1		1
t(f)	2.2					3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

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

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

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

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

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

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	394					1099		197
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						3000		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.					9		12	
Conflicting Flows							197	
Potential Capacity							846	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							846	
Probability of Queue free St.					1.00		0.95	
Step 2: LT from Major St.					4		1	
Conflicting Flows							394	
Potential Capacity							1168	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							1168	
Probability of Queue free St.					1.00		0.95	
Maj L-Shared Prob Q free St.								
Step 3: TH from Minor St.					8		11	
Conflicting Flows								
Potential Capacity								
Pedestrian Impedance Factor					1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt					0.95		0.95	
Movement Capacity								
Probability of Queue free St.					1.00		1.00	
Step 4: LT from Minor St.					7		10	
Conflicting Flows							1099	
Potential Capacity							208	
Pedestrian Impedance Factor					1.00		1.00	
Maj. L, Min T Impedance factor					0.95			
Maj. L, Min T Adj. Imp Factor.					0.96			
Cap. Adj. factor due to Impeding mvmnt					0.91		0.95	
Movement Capacity							197	

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

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

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1099
Potential Capacity		208
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.91	0.95
Movement Capacity		197
Results for Two-stage process:		
a		
y		
C t		197

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				24		44
Movement Capacity (vph)				197		846
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				197		846
Volume				24		44
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config	L					L		R
v (vph)	64					24		44
C(m) (vph)	1168					197		846
v/c	0.05					0.12		0.05
95% queue length	0.17					0.41		0.16
Control Delay	8.3					25.8		9.5
LOS	A					D		A
Approach Delay							15.2	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.95	1.00
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	8.3	
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 4/3/2015
Analysis Time Period: Weekday MD Peak Hour
Intersection: Portage Road & Forest Drive
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	42	514			512	1
Peak-Hour Factor, PHF	0.61	0.90			0.82	0.82
Hourly Flow Rate, HFR	68	571			624	1
Percent Heavy Vehicles	1	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	2			2	0
Configuration	L	T			T	TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				11		39
Peak Hour Factor, PHF				0.75		0.75
Hourly Flow Rate, HFR				14		52
Percent Heavy Vehicles				1		1
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			/
Lanes				1		1
Configuration				L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L					L		R
v (vph)	68					14		52
C(m) (vph)	959					210		730
v/c	0.07					0.07		0.07
95% queue length	0.23					0.21		0.23
Control Delay	9.0					23.4		10.3
LOS	A					C		B
Approach Delay							13.1	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 4/3/2015
Analysis Time Period: Weekday MD Peak Hour
Intersection: Portage Road & Forest Drive
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	42	514			512	1
Peak-Hour Factor, PHF	0.61	0.90			0.82	0.82
Peak-15 Minute Volume	17	143			156	0
Hourly Flow Rate, HFR	68	571			624	1
Percent Heavy Vehicles	1	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	2			2	0
Configuration	L	T			T	TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				11		39
Peak Hour Factor, PHF				0.75		0.75
Peak-15 Minute Volume				4		13
Hourly Flow Rate, HFR				14		52
Percent Heavy Vehicles				1		1
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		/
RT Channelized?						No
Lanes				1		1
Configuration				L		R

Pedestrian Volumes and Adjustments

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

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

Upstream Signal Data

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

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

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

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1					7.5		6.2
t(c,hv)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
P(hv)	1					1		1
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00					0.70		0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1					6.8		6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50		3.30
t(f,HV)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(HV)	1					1		1
t(f)	2.2					3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

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

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

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

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

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

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	625					1045		312
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						3000		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.					9		12	
Conflicting Flows							312	
Potential Capacity							730	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							730	
Probability of Queue free St.					1.00		0.93	
Step 2: LT from Major St.					4		1	
Conflicting Flows							625	
Potential Capacity							959	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							959	
Probability of Queue free St.					1.00		0.93	
Maj L-Shared Prob Q free St.								
Step 3: TH from Minor St.					8		11	
Conflicting Flows								
Potential Capacity								
Pedestrian Impedance Factor					1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt					0.93		0.93	
Movement Capacity								
Probability of Queue free St.					1.00		1.00	
Step 4: LT from Minor St.					7		10	
Conflicting Flows							1045	
Potential Capacity							226	
Pedestrian Impedance Factor					1.00		1.00	
Maj. L, Min T Impedance factor					0.93			
Maj. L, Min T Adj. Imp Factor.					0.95			
Cap. Adj. factor due to Impeding mvmnt					0.88		0.93	
Movement Capacity							210	

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

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

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		1045
Potential Capacity		226
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.93	
Maj. L, Min T Adj. Imp Factor.	0.95	
Cap. Adj. factor due to Impeding mvmnt	0.88	0.93
Movement Capacity		210
Results for Two-stage process:		
a		
y		
C t		210

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				14		52
Movement Capacity (vph)				210		730
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				210		730
Volume				14		52
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config	L					L		R
v (vph)	68					14		52
C(m) (vph)	959					210		730
v/c	0.07					0.07		0.07
95% queue length	0.23					0.21		0.23
Control Delay	9.0					23.4		10.3
LOS	A					C		B
Approach Delay							13.1	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.93	1.00
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	9.0	
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 4/3/2015
Analysis Time Period: Weekday PM Peak Hour
Intersection: Portage Road & Forest Drive
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	36	570			1039	1
Peak-Hour Factor, PHF	0.90	0.93			0.87	0.87
Hourly Flow Rate, HFR	40	612			1194	1
Percent Heavy Vehicles	1	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	2			2	0
Configuration	L	T			T	TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				12		67
Peak Hour Factor, PHF				0.73		0.73
Hourly Flow Rate, HFR				16		91
Percent Heavy Vehicles				1		1
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			/			/
Lanes				1		1
Configuration				L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L					L		R
v (vph)	40					16		91
C(m) (vph)	586					94		503
v/c	0.07					0.17		0.18
95% queue length	0.22					0.58		0.65
Control Delay	11.6					51.0		13.7
LOS	B					F		B
Approach Delay							19.3	
Approach LOS							C	

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 4/3/2015
Analysis Time Period: Weekday PM Peak Hour
Intersection: Portage Road & Forest Drive
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	36	570			1039	1
Peak-Hour Factor, PHF	0.90	0.93			0.87	0.87
Peak-15 Minute Volume	10	153			299	0
Hourly Flow Rate, HFR	40	612			1194	1
Percent Heavy Vehicles	1	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	2			2	0
Configuration	L	T			T	TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				12		67
Peak Hour Factor, PHF				0.73		0.73
Peak-15 Minute Volume				4		23
Hourly Flow Rate, HFR				16		91
Percent Heavy Vehicles				1		1
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage				/		/
RT Channelized?						No
Lanes				1		1
Configuration				L		R

Pedestrian Volumes and Adjustments

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

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

Upstream Signal Data

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

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

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

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1					7.5		6.2
t(c,hv)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
P(hv)	1					1		1
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00					0.70		0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1					6.8		6.2
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20					3.50		3.30
t(f,HV)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(HV)	1					1		1
t(f)	2.2					3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

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

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

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

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

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

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	1195					1580		598
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						3000		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.					9		12	
Conflicting Flows							598	
Potential Capacity							503	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							503	
Probability of Queue free St.					1.00		0.82	
Step 2: LT from Major St.					4		1	
Conflicting Flows							1195	
Potential Capacity							586	
Pedestrian Impedance Factor					1.00		1.00	
Movement Capacity							586	
Probability of Queue free St.					1.00		0.93	
Maj L-Shared Prob Q free St.								
Step 3: TH from Minor St.					8		11	
Conflicting Flows								
Potential Capacity								
Pedestrian Impedance Factor					1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt					0.93		0.93	
Movement Capacity								
Probability of Queue free St.					1.00		1.00	
Step 4: LT from Minor St.					7		10	
Conflicting Flows							1580	
Potential Capacity							101	
Pedestrian Impedance Factor					1.00		1.00	
Maj. L, Min T Impedance factor					0.93			
Maj. L, Min T Adj. Imp Factor.					0.95			
Cap. Adj. factor due to Impeding mvmnt					0.78		0.93	
Movement Capacity							94	

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

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

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor	1.00	1.00	
Cap. Adj. factor due to Impeding mvmnt	0.93	0.93	
Movement Capacity			
Result for 2 stage process:			
a			
y			
C t			
Probability of Queue free St.	1.00	1.00	
Step 4: LT from Minor St.	7	10	
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows		1580	
Potential Capacity		101	
Pedestrian Impedance Factor	1.00	1.00	
Maj. L, Min T Impedance factor	0.93		
Maj. L, Min T Adj. Imp Factor.	0.95		
Cap. Adj. factor due to Impeding mvmnt	0.78	0.93	
Movement Capacity		94	
Results for Two-stage process:			
a			
y			
C t		94	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				16		91
Movement Capacity (vph)				94		503
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				94		503
Volume				16		91
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config	L					L		R
v (vph)	40					16		91
C(m) (vph)	586					94		503
v/c	0.07					0.17		0.18
95% queue length	0.22					0.58		0.65
Control Delay	11.6					51.0		13.7
LOS	B					F		B
Approach Delay							19.3	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.93	1.00
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	11.6	
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday AM Peak Hour
Intersection: Portage Road & Lakeview Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	1	996	1	25	330	6
Peak-Hour Factor, PHF	0.89	0.89	0.89	0.78	0.85	0.85
Hourly Flow Rate, HFR	1	1119	1	32	388	7
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided /					
RT Channelized?						
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No /				/
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	1	32		3				
C(m) (vph)	1167	625		157				
v/c	0.00	0.05		0.02				
95% queue length	0.00	0.16		0.06				
Control Delay	8.1	11.1		28.4				
LOS	A	B		D				
Approach Delay				28.4				
Approach LOS				D				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday AM Peak Hour
Intersection: Portage Road & Lakeview Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	1	996	1	25	330	6
Peak-Hour Factor, PHF	0.89	0.89	0.89	0.78	0.85	0.85
Peak-15 Minute Volume	0	280	0	8	97	2
Hourly Flow Rate, HFR	1	1119	1	32	388	7
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided /					
RT Channelized?						
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Peak-15 Minute Volume	0	0	0			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No /			/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

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

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

Upstream Signal Data

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

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

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

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.5	6.5	6.2			
t(c,hv)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
P(hv)	1	1	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	6.8	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30			
t(f,HV)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(HV)	1	1	0	0	0			
t(f)	2.2	2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

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

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

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

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

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

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	395	1120	1380	1581	560			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		3000		3000				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.			9		12	
Conflicting Flows			560			
Potential Capacity			532			
Pedestrian Impedance Factor			1.00		1.00	
Movement Capacity			532			
Probability of Queue free St.			1.00		1.00	

Step 2: LT from Major St.			4		1	
Conflicting Flows			1120		395	
Potential Capacity			625		1167	
Pedestrian Impedance Factor			1.00		1.00	
Movement Capacity			625		1167	
Probability of Queue free St.			0.95		1.00	
Maj L-Shared Prob Q free St.						

Step 3: TH from Minor St.			8		11	
Conflicting Flows			1581			
Potential Capacity			110			
Pedestrian Impedance Factor			1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt			0.95		0.95	
Movement Capacity			104			
Probability of Queue free St.			0.99		1.00	

Step 4: LT from Minor St.			7		10	
Conflicting Flows			1380			
Potential Capacity			138			
Pedestrian Impedance Factor			1.00		1.00	
Maj. L, Min T Impedance factor					0.94	
Maj. L, Min T Adj. Imp Factor.					0.95	
Cap. Adj. factor due to Impeding mvmnt			0.95		0.95	
Movement Capacity			131			

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

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

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1581	
Potential Capacity	110	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity	104	
Result for 2 stage process:		
a		
y		
C t	104	
Probability of Queue free St.	0.99	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1380	
Potential Capacity	138	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.94
Maj. L, Min T Adj. Imp Factor.		0.95
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity	131	
Results for Two-stage process:		
a		
y		
C t	131	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	1	1			
Movement Capacity (vph)	131	104	532			
Shared Lane Capacity (vph)		157				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	131	104	532			
Volume	1	1	1			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		157				
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	1	32		3				
C(m) (vph)	1167	625		157				
v/c	0.00	0.05		0.02				
95% queue length	0.00	0.16		0.06				
Control Delay	8.1	11.1		28.4				
LOS	A	B		D				
Approach Delay				28.4				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.95
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	8.1	11.1
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday MD Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	1	506	1	20	501	20
Peak-Hour Factor, PHF	0.92	0.92	0.92	0.71	0.82	0.82
Hourly Flow Rate, HFR	1	549	1	28	610	24
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided /					
RT Channelized?						
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No /			/	
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	1	28		3				
C(m) (vph)	952	1023		276				
v/c	0.00	0.03		0.01				
95% queue length	0.00	0.08		0.03				
Control Delay	8.8	8.6		18.2				
LOS	A	A		C				
Approach Delay				18.2				
Approach LOS				C				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday MD Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	1	506	1	20	501	20
Peak-Hour Factor, PHF	0.92	0.92	0.92	0.71	0.82	0.82
Peak-15 Minute Volume	0	138	0	7	153	6
Hourly Flow Rate, HFR	1	549	1	28	610	24
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Peak-15 Minute Volume	0	0	0			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

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

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

Upstream Signal Data

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

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

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

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.5	6.5	6.2			
t(c,hv)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
P(hv)	1	1	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	6.8	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30			
t(f,HV)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(HV)	1	1	0	0	0			
t(f)	2.2	2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

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

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

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

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

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

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	634	550	913	1242	275			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		3000		3000				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.				9		12		
Conflicting Flows				275				
Potential Capacity				769				
Pedestrian Impedance Factor				1.00		1.00		
Movement Capacity				769				
Probability of Queue free St.				1.00		1.00		
Step 2: LT from Major St.				**4**		**1**		
Conflicting Flows				550		634		
Potential Capacity				1023		952		
Pedestrian Impedance Factor				1.00		1.00		
Movement Capacity				1023		952		
Probability of Queue free St.				0.97		1.00		
Maj L-Shared Prob Q free St.								
Step 3: TH from Minor St.				**8**		**11**		
Conflicting Flows				1242				
Potential Capacity				176				
Pedestrian Impedance Factor				1.00		1.00		
Cap. Adj. factor due to Impeding mvmnt				0.97		0.97		
Movement Capacity				171				
Probability of Queue free St.				0.99		1.00		
Step 4: LT from Minor St.				**7**		**10**		
Conflicting Flows				913				
Potential Capacity				277				
Pedestrian Impedance Factor				1.00		1.00		
Maj. L, Min T Impedance factor						0.97		
Maj. L, Min T Adj. Imp Factor.						0.97		
Cap. Adj. factor due to Impeding mvmnt				0.97		0.97		
Movement Capacity				269				

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

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

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	1242		
Potential Capacity	176		
Pedestrian Impedance Factor	1.00	1.00	
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97	
Movement Capacity	171		
Result for 2 stage process:			
a			
y			
C t	171		
Probability of Queue free St.	0.99	1.00	
Step 4: LT from Minor St.	7	10	
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	913		
Potential Capacity	277		
Pedestrian Impedance Factor	1.00	1.00	
Maj. L, Min T Impedance factor		0.97	
Maj. L, Min T Adj. Imp Factor.		0.97	
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97	
Movement Capacity	269		
Results for Two-stage process:			
a			
y			
C t	269		

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	1	1			
Movement Capacity (vph)	269	171	769			
Shared Lane Capacity (vph)		276				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	269	171	769			
Volume	1	1	1			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		276				
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	1	28		3				
C(m) (vph)	952	1023		276				
v/c	0.00	0.03		0.01				
95% queue length	0.00	0.08		0.03				
Control Delay	8.8	8.6		18.2				
LOS	A	A		C				
Approach Delay				18.2				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.97
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	8.8	8.6
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday PM Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	2	541	1	15	1004	55
Peak-Hour Factor, PHF	0.91	0.91	0.91	0.75	0.88	0.86
Hourly Flow Rate, HFR	2	594	1	20	1140	63
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided /					
RT Channelized?						
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No /			/	
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	2	20		3				
C(m) (vph)	581	984		146				
v/c	0.00	0.02		0.02				
95% queue length	0.01	0.06		0.06				
Control Delay	11.2	8.7		30.2				
LOS	B	A		D				
Approach Delay				30.2				
Approach LOS				D				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday PM Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Existing Traffic Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	2	541	1	15	1004	55
Peak-Hour Factor, PHF	0.91	0.91	0.91	0.75	0.88	0.86
Peak-15 Minute Volume	1	149	0	5	285	16
Hourly Flow Rate, HFR	2	594	1	20	1140	63
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	2	0	1	2	0
Configuration	L	T	TR	L	T	TR
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Peak-15 Minute Volume	0	0	0			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

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

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

Upstream Signal Data

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

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

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

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.5	6.5	6.2			
t(c,hv)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
P(hv)	1	1	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	6.8	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30			
t(f,HV)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(HV)	1	1	0	0	0			
t(f)	2.2	2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

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

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

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

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

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

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	1203	595	1208	1841	298			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		3000		3000				
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.			9			12	
Conflicting Flows			298				
Potential Capacity			746				
Pedestrian Impedance Factor			1.00			1.00	
Movement Capacity			746				
Probability of Queue free St.			1.00			1.00	

Step 2: LT from Major St.			4			1	
Conflicting Flows			595			1203	
Potential Capacity			984			581	
Pedestrian Impedance Factor			1.00			1.00	
Movement Capacity			984			581	
Probability of Queue free St.			0.98			1.00	
Maj L-Shared Prob Q free St.							

Step 3: TH from Minor St.			8			11	
Conflicting Flows			1841				
Potential Capacity			76				
Pedestrian Impedance Factor			1.00			1.00	
Cap. Adj. factor due to Impeding mvmnt			0.98			0.98	
Movement Capacity			74				
Probability of Queue free St.			0.99			1.00	

Step 4: LT from Minor St.			7			10	
Conflicting Flows			1208				
Potential Capacity			178				
Pedestrian Impedance Factor			1.00			1.00	
Maj. L, Min T Impedance factor						0.96	
Maj. L, Min T Adj. Imp Factor.						0.97	
Cap. Adj. factor due to Impeding mvmnt			0.98			0.97	
Movement Capacity			174				

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

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

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	1841		
Potential Capacity	76		
Pedestrian Impedance Factor	1.00	1.00	
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98	
Movement Capacity	74		
Result for 2 stage process:			
a			
y			
C t	74		
Probability of Queue free St.	0.99	1.00	
Step 4: LT from Minor St.	7	10	
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	1208		
Potential Capacity	178		
Pedestrian Impedance Factor	1.00	1.00	
Maj. L, Min T Impedance factor		0.96	
Maj. L, Min T Adj. Imp Factor.		0.97	
Cap. Adj. factor due to Impeding mvmnt	0.98	0.97	
Movement Capacity	174		
Results for Two-stage process:			
a			
y			
C t	174		

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	1	1			
Movement Capacity (vph)	174	74	746			
Shared Lane Capacity (vph)		146				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	174	74	746			
Volume	1	1	1			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		146				
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	2	20		3				
C(m) (vph)	581	984		146				
v/c	0.00	0.02		0.02				
95% queue length	0.01	0.06		0.06				
Control Delay	11.2	8.7		30.2				
LOS	B	A		D				
Approach Delay				30.2				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.98
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	11.2	8.7
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

APPENDIX C

THREE LANE ALTERNATIVE CAPACITY ANALYSIS SUMMARY SHEETS

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday AM Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Alternative 1/2 Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	1	996	1	25	330	6
Peak-Hour Factor, PHF	0.89	0.89	0.89	0.78	0.85	0.85
Hourly Flow Rate, HFR	1	1119	1	32	388	7
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided /					
RT Channelized?						
Lanes	1	1	0	1	1	0
Configuration	L	TR		L	TR	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No /			/	
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	1	32		3				
C(m) (vph)	1169	627		135				
v/c	0.00	0.05		0.02				
95% queue length	0.00	0.16		0.07				
Control Delay	8.1	11.1		32.3				
LOS	A	B		D				
Approach Delay				32.3				
Approach LOS				D				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday AM Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Alternative 1/2 Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	1	996	1	25	330	6
Peak-Hour Factor, PHF	0.89	0.89	0.89	0.78	0.85	0.85
Peak-15 Minute Volume	0	280	0	8	97	2
Hourly Flow Rate, HFR	1	1119	1	32	388	7
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	1	0	1	1	0
Configuration	L	TR		L	TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Peak-15 Minute Volume	0	0	0			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

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

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

Upstream Signal Data

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

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

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

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	1	1	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	6.4	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	1	1	0	0	0			
t(f)	2.2	2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

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

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

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

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

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

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	395	1120	1578	1581	1120			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

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

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.			9		12	
Conflicting Flows			1120			
Potential Capacity			254			
Pedestrian Impedance Factor			1.00		1.00	
Movement Capacity			254			
Probability of Queue free St.			1.00		1.00	
Step 2: LT from Major St.			**4**		**1**	
Conflicting Flows			1120		395	
Potential Capacity			627		1169	
Pedestrian Impedance Factor			1.00		1.00	
Movement Capacity			627		1169	
Probability of Queue free St.			0.95		1.00	
Maj L-Shared Prob Q free St.						
Step 3: TH from Minor St.			**8**		**11**	
Conflicting Flows			1581			
Potential Capacity			110			
Pedestrian Impedance Factor			1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt			0.95		0.95	
Movement Capacity			104			
Probability of Queue free St.			0.99		1.00	
Step 4: LT from Minor St.			**7**		**10**	
Conflicting Flows			1578			
Potential Capacity			122			
Pedestrian Impedance Factor			1.00		1.00	
Maj. L, Min T Impedance factor					0.94	
Maj. L, Min T Adj. Imp Factor.					0.95	
Cap. Adj. factor due to Impeding mvmnt			0.95		0.95	
Movement Capacity			116			

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

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

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	1581		
Potential Capacity	110		
Pedestrian Impedance Factor	1.00	1.00	
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95	
Movement Capacity	104		
Result for 2 stage process:			
a			
y			
C t	104		
Probability of Queue free St.	0.99	1.00	
Step 4: LT from Minor St.	7	10	
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	1578		
Potential Capacity	122		
Pedestrian Impedance Factor	1.00	1.00	
Maj. L, Min T Impedance factor		0.94	
Maj. L, Min T Adj. Imp Factor.		0.95	
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95	
Movement Capacity	116		
Results for Two-stage process:			
a			
y			
C t	116		

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	1	1			
Movement Capacity (vph)	116	104	254			
Shared Lane Capacity (vph)		135				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	116	104	254			
Volume	1	1	1			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		135				
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	1	32		3				
C(m) (vph)	1169	627		135				
v/c	0.00	0.05		0.02				
95% queue length	0.00	0.16		0.07				
Control Delay	8.1	11.1		32.3				
LOS	A	B		D				
Approach Delay				32.3				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.95
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	8.1	11.1
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday MD Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Alternative 1/2 Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	1	506	1	20	501	20
Peak-Hour Factor, PHF	0.92	0.92	0.92	0.71	0.82	0.82
Hourly Flow Rate, HFR	1	549	1	28	610	24
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided /					
RT Channelized?						
Lanes	1	1	0	1	1	0
Configuration	L	TR		L	TR	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No /			/	
Lanes	0	1	0			
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	1	28		3				
C(m) (vph)	954	1025		232				
v/c	0.00	0.03		0.01				
95% queue length	0.00	0.08		0.04				
Control Delay	8.8	8.6		20.7				
LOS	A	A		C				
Approach Delay				20.7				
Approach LOS				C				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday MD Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Alternative 1/2 Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	1	506	1	20	501	20
Peak-Hour Factor, PHF	0.92	0.92	0.92	0.71	0.82	0.82
Peak-15 Minute Volume	0	138	0	7	153	6
Hourly Flow Rate, HFR	1	549	1	28	610	24
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	1	0	1	1	0
Configuration	L	TR		L	TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Peak-15 Minute Volume	0	0	0			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No	/			/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

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

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

Upstream Signal Data

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

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

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

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	1	1	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	6.4	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	1	1	0	0	0			
t(f)	2.2	2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

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

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

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

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

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

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	634	550	1230	1242	550			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

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

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.			9		12	
Conflicting Flows			550			
Potential Capacity			539			
Pedestrian Impedance Factor			1.00		1.00	
Movement Capacity			539			
Probability of Queue free St.			1.00		1.00	

Step 2: LT from Major St.			4		1	
Conflicting Flows			550		634	
Potential Capacity			1025		954	
Pedestrian Impedance Factor			1.00		1.00	
Movement Capacity			1025		954	
Probability of Queue free St.			0.97		1.00	
Maj L-Shared Prob Q free St.						

Step 3: TH from Minor St.			8		11	
Conflicting Flows			1242			
Potential Capacity			176			
Pedestrian Impedance Factor			1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt			0.97		0.97	
Movement Capacity			171			
Probability of Queue free St.			0.99		1.00	

Step 4: LT from Minor St.			7		10	
Conflicting Flows			1230			
Potential Capacity			198			
Pedestrian Impedance Factor			1.00		1.00	
Maj. L, Min T Impedance factor					0.97	
Maj. L, Min T Adj. Imp Factor.					0.97	
Cap. Adj. factor due to Impeding mvmnt			0.97		0.97	
Movement Capacity			192			

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

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

Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	1242		
Potential Capacity	176		
Pedestrian Impedance Factor	1.00	1.00	
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97	
Movement Capacity	171		
Result for 2 stage process:			
a			
y			
C t	171		
Probability of Queue free St.	0.99	1.00	
Step 4: LT from Minor St.	7	10	
Part 1 - First Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 2 - Second Stage			
Conflicting Flows			
Potential Capacity			
Pedestrian Impedance Factor			
Cap. Adj. factor due to Impeding mvmnt			
Movement Capacity			
Part 3 - Single Stage			
Conflicting Flows	1230		
Potential Capacity	198		
Pedestrian Impedance Factor	1.00	1.00	
Maj. L, Min T Impedance factor		0.97	
Maj. L, Min T Adj. Imp Factor.		0.97	
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97	
Movement Capacity	192		
Results for Two-stage process:			
a			
y			
C t	192		

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	1	1			
Movement Capacity (vph)	192	171	539			
Shared Lane Capacity (vph)		232				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	192	171	539			
Volume	1	1	1			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		232				
SUM C sep						
n						
C act						

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

Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	1	28		3				
C(m) (vph)	954	1025		232				
v/c	0.00	0.03		0.01				
95% queue length	0.00	0.08		0.04				
Control Delay	8.8	8.6		20.7				
LOS	A	A		C				
Approach Delay				20.7				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.97
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	8.8	8.6
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday PM Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Alternative 1/2 Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	2	541	1	15	1004	55
Peak-Hour Factor, PHF	0.91	0.91	0.91	0.75	0.88	0.86
Hourly Flow Rate, HFR	2	594	1	20	1140	63
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided /					
RT Channelized?						
Lanes	1	1 0		1	1 0	
Configuration	L	TR		L	TR	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage		No /			/	
Lanes	0	1 0				
Configuration		LTR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	2	20		3				
C(m) (vph)	584	986		111				
v/c	0.00	0.02		0.03				
95% queue length	0.01	0.06		0.08				
Control Delay	11.2	8.7		38.3				
LOS	B	A		E				
Approach Delay				38.3				
Approach LOS				E				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: REM
Agency/Co.: CESO, INC.
Date Performed: 12/15/2015
Analysis Time Period: Weekday PM Peak Hour
Intersection: Portage Road & LakeForest Dr.
Jurisdiction: City of Portage, MI
Units: U. S. Customary
Analysis Year: Alternative 1/2 Scenario
Project ID: Traffic Study/Road Diet Feasibility Study - Portage Road
East/West Street: Lake Forest Drive
North/South Street: Portage Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	2	541	1	15	1004	55
Peak-Hour Factor, PHF	0.91	0.91	0.91	0.75	0.88	0.86
Peak-15 Minute Volume	1	149	0	5	285	16
Hourly Flow Rate, HFR	2	594	1	20	1140	63
Percent Heavy Vehicles	1	--	--	1	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	1	1	0	1	1	0
Configuration	L	TR		L	TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	1	1	1			
Peak Hour Factor, PHF	0.90	0.90	0.90			
Peak-15 Minute Volume	0	0	0			
Hourly Flow Rate, HFR	1	1	1			
Percent Heavy Vehicles	0	0	0			
Percent Grade (%)		0			0	
Flared Approach: Exists?/Storage			No	/		/
RT Channelized?						
Lanes	0	1	0			
Configuration		LTR				

Pedestrian Volumes and Adjustments

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

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

Upstream Signal Data

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

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

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

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1	4.1	7.1	6.5	6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	1	1	0	0	0			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	0.00	0.00	0.00
t(3,lt)	0.00	0.00	0.70	0.00	0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1	4.1	6.4	6.5	6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20	2.20	3.50	4.00	3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	1	1	0	0	0			
t(f)	2.2	2.2	3.5	4.0	3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

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

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

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

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

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

Computation 4 and 5 Single-Stage Process								
Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	1203	595	1810	1841	594			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process				
	7	8	10	11

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

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.			9		12	
Conflicting Flows			594			
Potential Capacity			509			
Pedestrian Impedance Factor			1.00		1.00	
Movement Capacity			509			
Probability of Queue free St.			1.00		1.00	

Step 2: LT from Major St.			4		1	
Conflicting Flows			595		1203	
Potential Capacity			986		584	
Pedestrian Impedance Factor			1.00		1.00	
Movement Capacity			986		584	
Probability of Queue free St.			0.98		1.00	
Maj L-Shared Prob Q free St.						

Step 3: TH from Minor St.			8		11	
Conflicting Flows			1841			
Potential Capacity			76			
Pedestrian Impedance Factor			1.00		1.00	
Cap. Adj. factor due to Impeding mvmnt			0.98		0.98	
Movement Capacity			74			
Probability of Queue free St.			0.99		1.00	

Step 4: LT from Minor St.			7		10	
Conflicting Flows			1810			
Potential Capacity			88			
Pedestrian Impedance Factor			1.00		1.00	
Maj. L, Min T Impedance factor					0.96	
Maj. L, Min T Adj. Imp Factor.					0.97	
Cap. Adj. factor due to Impeding mvmnt			0.98		0.97	
Movement Capacity			86			

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

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

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1841	
Potential Capacity	76	
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	74	
Result for 2 stage process:		
a		
y		
C t	74	
Probability of Queue free St.	0.99	1.00
Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1810	
Potential Capacity	88	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.96
Maj. L, Min T Adj. Imp Factor.		0.97
Cap. Adj. factor due to Impeding mvmnt	0.98	0.97
Movement Capacity	86	
Results for Two-stage process:		
a		
y		
C t	86	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	1	1	1			
Movement Capacity (vph)	86	74	509			
Shared Lane Capacity (vph)		111				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	86	74	509			
Volume	1	1	1			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh		111				
SUM C sep						
n						
C act						

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

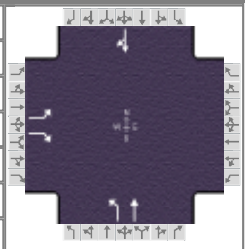
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L		LTR				
v (vph)	2	20		3				
C(m) (vph)	584	986		111				
v/c	0.00	0.02		0.03				
95% queue length	0.01	0.06		0.08				
Control Delay	11.2	8.7		38.3				
LOS	B	A		E				
Approach Delay				38.3				
Approach LOS				E				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.98
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	11.2	8.7
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

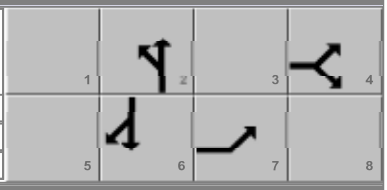
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	3/30/2016	Area Type	Other
Jurisdiction		Time Period		PHF	0.92
Intersection	Portate Road & Forest Driv	Analysis Year	2016	Analysis Period	1> 7:00
File Name	Streets1.xus				
Project Description	Weekday AM Peak Hour				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	17		31				47	958			378	1

Signal Information												
Cycle, s	100.0	Reference Phase	2									
Offset, s	0	Reference Point	End	Green	66.0	26.0	0.0	0.0	0.0	0.0		
Uncoordinated	No	Simult. Gap E/W	On	Yellow	4.0	4.0	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Red	0.0	0.0	0.0	0.0	0.0	0.0		



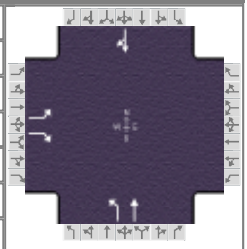
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2		6
Case Number		9.0				6.0		8.0
Phase Duration, s		30.0				70.0		70.0
Change Period, (*Y*+*Rc*), s		4.0				4.0		4.0
Max Allow Headway (*MAH*), s		3.3				0.0		0.0
Queue Clearance Time (g_s), s		3.6						
Green Extension Time (g_e), s		0.1				0.0		0.0
Phase Call Probability		1.00						
Max Out Probability		0.00						

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7		14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h	18		34				51	1041			412	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810		1610				989	1845			1862	
Queue Service Time (g_s), s	0.8		1.6				2.4	44.1			9.7	
Cycle Queue Clearance Time (g_c), s	0.8		1.6				12.0	44.1			9.7	
Green Ratio (*g*/*C*)	0.26		0.26				0.66	0.66			0.66	
Capacity (*c*), veh/h	470		419				629	1217			1229	
Volume-to-Capacity Ratio (*X*)	0.039		0.080				0.081	0.855			0.335	
Available Capacity (c_a), veh/h	470		419				629	1217			1229	
Back of Queue (*Q*), veh/ln (50th percentile)	0.3		0.6				0.5	17.8			3.6	
Queue Storage Ratio (*RQ*) (50th percentile)	0.07		0.00				0.09	0.00			0.00	
Uniform Delay (d_1), s/veh	27.7		28.0				10.1	13.3			7.4	
Incremental Delay (d_2), s/veh	0.0		0.0				0.3	7.8			0.7	
Initial Queue Delay (d_3), s/veh	0.0		0.0				0.0	0.0			0.0	
Control Delay (*d*), s/veh	27.7		28.0				10.3	21.1			8.2	
Level of Service (LOS)	C		C				B	C			A	
Approach Delay, s/veh / LOS	27.9		C	0.0			20.6		C	8.2		A
Intersection Delay, s/veh / LOS	17.5						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.3	B	2.1	B	0.7	A	2.2	B
Bicycle LOS Score / LOS		F			2.3	B	1.2	A

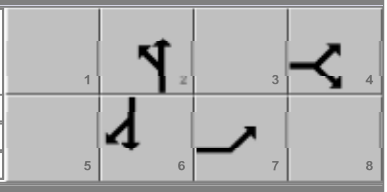
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	3/30/2016	Area Type	Other
Jurisdiction		Time Period		PHF	0.92
Intersection	Portate Road & Forest Driv	Analysis Year	2016	Analysis Period	1> 7:00
File Name	HCS AM.xus				
Project Description	Weekday MD Peak Hour				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	11		39				42	514			512	1

Signal Information											
Cycle, s	100.0	Reference Phase	2								
Offset, s	0	Reference Point	End								
Uncoordinated	No	Simult. Gap E/W	On								
Force Mode	Fixed	Simult. Gap N/S	On								
				Green	66.0	26.0	0.0	0.0	0.0	0.0	
				Yellow	4.0	4.0	0.0	0.0	0.0	0.0	
				Red	0.0	0.0	0.0	0.0	0.0	0.0	



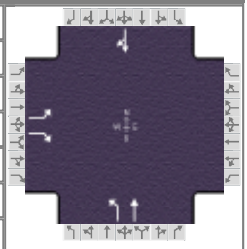
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2		6
Case Number		9.0				6.0		8.0
Phase Duration, s		30.0				70.0		70.0
Change Period, (*Y*+*Rc*), s		4.0				4.0		4.0
Max Allow Headway (*MAH*), s		3.3				0.0		0.0
Queue Clearance Time (g_s), s		4.0						
Green Extension Time (g_e), s		0.1				0.0		0.0
Phase Call Probability		1.00						
Max Out Probability		0.00						

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7		14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h	12		42				46	559			558	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810		1610				865	1845			1862	
Queue Service Time (g_s), s	0.5		2.0				2.7	14.8			14.5	
Cycle Queue Clearance Time (g_c), s	0.5		2.0				17.2	14.8			14.5	
Green Ratio (*g*/*C*)	0.26		0.26				0.66	0.66			0.66	
Capacity (*c*), veh/h	470		419				517	1217			1229	
Volume-to-Capacity Ratio (*X*)	0.025		0.101				0.088	0.459			0.454	
Available Capacity (c_a), veh/h	470		419				517	1217			1229	
Back of Queue (*Q*), veh/ln (50th percentile)	0.2		0.8				0.5	5.5			5.4	
Queue Storage Ratio (*RQ*) (50th percentile)	0.05		0.00				0.09	0.00			0.00	
Uniform Delay (d_1), s/veh	27.6		28.1				12.4	8.3			8.3	
Incremental Delay (d_2), s/veh	0.0		0.0				0.3	1.2			1.2	
Initial Queue Delay (d_3), s/veh	0.0		0.0				0.0	0.0			0.0	
Control Delay (*d*), s/veh	27.6		28.2				12.8	9.5			9.5	
Level of Service (LOS)	C		C				B	A			A	
Approach Delay, s/veh / LOS	28.0		C	0.0			9.8		A	9.5		A
Intersection Delay, s/veh / LOS	10.5						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.3	B	2.1	B	0.7	A	2.2	B
Bicycle LOS Score / LOS		F			1.5	A	1.4	A

HCS 2010 Signalized Intersection Results Summary

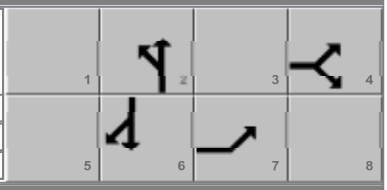
General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	3/30/2016	Area Type	Other
Jurisdiction		Time Period		PHF	0.92
Intersection	Portate Road & Forest Driv	Analysis Year	2016	Analysis Period	1> 7:00
File Name	HCS MD.xus				
Project Description	Weekday PM Peak Hour				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	12		67				36	570			1039	1

Signal Information			
Cycle, s	100.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	73.0	19.0	0.0	0.0	0.0	0.0	
Yellow	4.0	4.0	0.0	0.0	0.0	0.0	
Red	0.0	0.0	0.0	0.0	0.0	0.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2		6
Case Number		9.0				6.0		8.0
Phase Duration, s		23.0				77.0		77.0
Change Period, (*Y*+*Rc*), s		4.0				4.0		4.0
Max Allow Headway (*MAH*), s		3.3				0.0		0.0
Queue Clearance Time (g_s), s		5.8						
Green Extension Time (g_e), s		0.1				0.0		0.0
Phase Call Probability		1.00						
Max Out Probability		0.00						

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7		14				5	2			6	16
Adjusted Flow Rate (*v*), veh/h	13		73				39	620			1130	
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1810		1610				506	1845			1862	
Queue Service Time (g_s), s	0.6		3.8				5.8	13.7			41.7	
Cycle Queue Clearance Time (g_c), s	0.6		3.8				47.5	13.7			41.7	
Green Ratio (*g*/*C*)	0.19		0.19				0.73	0.73			0.73	
Capacity (*c*), veh/h	344		306				230	1347			1360	
Volume-to-Capacity Ratio (*X*)	0.038		0.238				0.170	0.460			0.831	
Available Capacity (c_a), veh/h	344		306				230	1347			1360	
Back of Queue (*Q*), veh/ln (50th percentile)	0.3		1.5				0.8	4.5			14.9	
Queue Storage Ratio (*RQ*) (50th percentile)	0.06		0.00				0.13	0.00			0.00	
Uniform Delay (d_1), s/veh	33.0		34.4				25.6	5.5			9.3	
Incremental Delay (d_2), s/veh	0.0		0.1				1.6	1.1			6.0	
Initial Queue Delay (d_3), s/veh	0.0		0.0				0.0	0.0			0.0	
Control Delay (*d*), s/veh	33.1		34.5				27.2	6.6			15.3	
Level of Service (LOS)	C		C				C	A			B	
Approach Delay, s/veh / LOS	34.3		C	0.0			7.8		A	15.3		B
Intersection Delay, s/veh / LOS	13.6						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.3	B	2.1	B	0.7	A	2.2	B
Bicycle LOS Score / LOS		F			1.6	A	2.4	B

Intersection	
Intersection Delay, s/veh	30.3
Intersection LOS	D

Approach	EB	WB	NB	SB
Entry Lanes	1	1	2	2
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	60	0	1092	447
Demand Flow Rate, veh/h	61	0	1135	465
Vehicles Circulating, veh/h	463	1156	21	52
Vehicles Exiting, veh/h	54	0	503	1104
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	6.1	0.0	40.6	8.3
Approach LOS	A	-	E	A

Lane	Left	Left	Left	Right	Left	Right
Designated Moves	LTR	LTR	L	TR	L	TR
Assumed Moves	LTR	LTR	L	TR	L	TR
RT Channelized						
Lane Util	1.000	1.000	0.046	0.954	0.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193	5.193	5.193
Entry Flow, veh/h	61	0	52	1083	0	465
Cap Entry Lane, veh/h	711	356	1106	1106	1073	1073
Entry HV Adj Factor	0.984	1.000	0.981	0.962	1.000	0.962
Flow Entry, veh/h	60	0	51	1041	0	447
Cap Entry, veh/h	700	356	1085	1064	1073	1032
V/C Ratio	0.086	0.000	0.047	0.979	0.000	0.433
Control Delay, s/veh	6.1	10.1	3.7	42.4	3.4	8.3
LOS	A	B	A	E	A	A
95th %tile Queue, veh	0	0	0	18	0	2

Intersection	
Intersection Delay, s/veh	9.9
Intersection LOS	A

Approach	EB	NB	SB
Entry Lanes	2	2	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	78	677	533
Demand Flow Rate, veh/h	79	703	554
Vehicles Circulating, veh/h	554	22	59
Vehicles Exiting, veh/h	59	611	666
Follow-Up Headway, s	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	6.4	10.3	9.9
Approach LOS	A	B	A

Lane	Left	Right	Left	Right	Left
Designated Moves	L	TR	L	TR	TR
Assumed Moves	L	TR	L	TR	TR
RT Channelized					
Lane Util	0.278	0.722	0.084	0.916	1.000
Critical Headway, s	5.193	5.193	5.193	5.193	5.193
Entry Flow, veh/h	22	57	59	644	554
Cap Entry Lane, veh/h	649	649	1105	1105	1065
Entry HV Adj Factor	1.000	0.982	0.983	0.962	0.962
Flow Entry, veh/h	22	56	58	619	533
Cap Entry, veh/h	649	638	1087	1063	1024
V/C Ratio	0.034	0.088	0.053	0.583	0.520
Control Delay, s/veh	5.9	6.6	3.8	10.9	9.9
LOS	A	A	A	B	A
95th %tile Queue, veh	0	0	0	4	3

Intersection	
Intersection Delay, s/veh	16.0
Intersection LOS	C

Approach	EB	NB	SB
Entry Lanes	2	1	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	108	652	883
Demand Flow Rate, veh/h	110	678	918
Vehicles Circulating, veh/h	918	16	0
Vehicles Exiting, veh/h	0	1012	694
Follow-Up Headway, s	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	10.9	11.5	19.9
Approach LOS	B	B	C

Lane	Left	Right	Left	Left
Designated Moves	L	TR	T	TR
Assumed Moves	L	TR	T	TR
RT Channelized				
Lane Util	0.145	0.855	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	16	94	678	918
Cap Entry Lane, veh/h	451	451	1112	1130
Entry HV Adj Factor	1.000	0.979	0.962	0.962
Flow Entry, veh/h	16	92	652	883
Cap Entry, veh/h	451	442	1069	1086
V/C Ratio	0.035	0.208	0.610	0.812
Control Delay, s/veh	8.4	11.3	11.5	19.9
LOS	A	B	B	C
95th %tile Queue, veh	0	1	4	9

3: PORTAGE RD. & FOREST DR. Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.1	0.0	0.0	0.6	0.0	0.8
Total Stops	11	36	15	0	0	62
Travel Dist (mi)	1.6	5.1	19.1	438.9	52.7	517.4
Travel Time (hr)	0.2	0.3	0.5	10.5	1.2	12.7
Avg Speed (mph)	10	20	37	42	44	41
Fuel Used (gal)	0.1	0.1	0.5	10.7	1.5	12.9
HC Emissions (g)	0	2	2	298	35	338
CO Emissions (g)	6	44	86	6256	924	7316
NOx Emissions (g)	1	7	16	1035	128	1187

7: PORTAGE RD. & LAKEVIEW DR. Performance by movement

Movement	EBL	NBT	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.2	0.1	0.0	0.1	0.0	0.5
Total Stops	32	0	19	0	0	51
Travel Dist (mi)	3.0	131.0	13.9	172.7	2.8	323.3
Travel Time (hr)	0.4	3.1	0.4	4.1	0.1	8.0
Avg Speed (mph)	8	43	37	42	42	41
Fuel Used (gal)	0.1	3.8	0.4	4.3	0.1	8.6
HC Emissions (g)	3	101	2	110	0	217
CO Emissions (g)	58	2601	89	2362	17	5127
NOx Emissions (g)	8	351	13	392	3	767

Total Network Performance

Denied Delay (hr)	0.1
Total Delay (hr)	1.5
Total Stops	113
Travel Dist (mi)	1035.7
Travel Time (hr)	27.4
Avg Speed (mph)	38
Fuel Used (gal)	27.0
HC Emissions (g)	658
CO Emissions (g)	14352
NOx Emissions (g)	2232

Arterial Level of Service: NB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	7	0.5	11.5	0.1	45
FOREST DR.	3	2.4	38.6	0.5	43
Total		2.9	50.1	0.6	44

Arterial Level of Service: SB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
FOREST DR.	3	0.3	10.9	0.1	46
LAKEVIEW DR.	7	1.3	35.7	0.5	47
Total		1.5	46.6	0.6	46

3: PORTAGE RD. & FOREST DR. Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.0	0.0	0.0	0.3	0.0	0.4
Total Stops	9	45	11	0	0	65
Travel Time (hr)	0.1	0.3	0.5	5.9	1.6	8.4
Avg Speed (mph)	15	20	38	42	44	41
Fuel Used (gal)	0.0	0.2	0.4	6.0	2.0	8.6
HC Emissions (g)	0	1	7	144	42	194
CO Emissions (g)	7	32	159	3048	1146	4392
NOx Emissions (g)	1	4	30	523	159	717

7: PORTAGE RD. & LAKEVIEW DR. Performance by movement

Movement	EBL	NBL	NBT	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.2	0.0	0.1	0.0	0.2	0.0	0.5
Total Stops	31	1	0	7	0	0	39
Travel Time (hr)	0.3	0.0	1.7	0.3	5.8	0.3	8.3
Avg Speed (mph)	10	34	43	37	42	40	41
Fuel Used (gal)	0.1	0.0	2.1	0.2	6.0	0.3	8.7
HC Emissions (g)	0	0	58	6	116	6	186
CO Emissions (g)	15	4	1441	109	2714	141	4424
NOx Emissions (g)	2	0	197	21	449	24	692

Total Network Performance

Denied Delay (hr)	0.1
Total Delay (hr)	1.0
Total Stops	104
Travel Time (hr)	22.5
Avg Speed (mph)	38
Fuel Used (gal)	22.0
HC Emissions (g)	453
CO Emissions (g)	10221
NOx Emissions (g)	1609

Arterial Level of Service: NB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	7	0.4	11.4	0.1	45
FOREST DR.	3	1.8	38.1	0.5	44
Total		2.1	49.6	0.6	44

Arterial Level of Service: SB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
FOREST DR.	3	0.2	10.9	0.1	46
LAKEVIEW DR.	7	1.6	36.8	0.5	45
Total		1.8	47.7	0.6	45

3: PORTAGE RD. & FOREST DR. Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.1	0.1
Total Delay (hr)	0.1	0.1	0.1	0.3	0.1	0.6
Total Stops	13	66	25	0	0	104
Travel Dist (mi)	1.8	9.3	16.6	257.0	134.8	419.5
Travel Time (hr)	0.1	0.5	0.5	6.0	3.2	10.4
Avg Speed (mph)	14	18	36	43	43	41
Fuel Used (gal)	0.1	0.3	0.4	6.2	4.0	10.9
HC Emissions (g)	0	2	1	152	90	245
CO Emissions (g)	9	46	43	3246	2517	5860
NOx Emissions (g)	1	6	14	549	326	896

7: PORTAGE RD. & LAKEVIEW DR. Performance by movement

Movement	EBL	EBR	NBT	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.1	0.0	0.0	0.0	0.5	0.0	0.7
Total Stops	21	7	0	3	0	0	31
Travel Dist (mi)	2.0	0.7	75.1	4.6	405.7	25.8	513.7
Travel Time (hr)	0.2	0.0	1.7	0.1	9.7	0.7	12.5
Avg Speed (mph)	10	17	44	37	42	39	41
Fuel Used (gal)	0.1	0.0	2.1	0.1	10.2	0.6	13.1
HC Emissions (g)	0	0	50	1	224	3	277
CO Emissions (g)	7	3	1281	33	5134	137	6595
NOx Emissions (g)	1	0	182	4	830	22	1040

Total Network Performance

Denied Delay (hr)	0.1
Total Delay (hr)	1.5
Total Stops	135
Travel Dist (mi)	1133.4
Travel Time (hr)	29.8
Avg Speed (mph)	38
Fuel Used (gal)	29.8
HC Emissions (g)	611
CO Emissions (g)	14233
NOx Emissions (g)	2191

Arterial Level of Service: NB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	7	0.3	11.3	0.1	46
FOREST DR.	3	1.7	37.9	0.5	44
Total		2.0	49.2	0.6	44

Arterial Level of Service: SB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
FOREST DR.	3	0.5	11.2	0.1	45
LAKEVIEW DR.	7	1.8	33.5	0.5	50
Total		2.3	44.7	0.6	48

3: PORTAGE RD. & FOREST DR. Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.1	0.0	0.1	0.4	0.1	0.7
Total Stops	14	38	21	0	0	73
Travel Dist (mi)	2.0	5.4	5.9	142.0	53.3	208.7
Travel Time (hr)	0.2	0.3	0.3	4.5	1.6	6.9
Avg Speed (mph)	9	19	23	31	34	30
Fuel Used (gal)	0.1	0.1	0.1	3.6	1.6	5.6
HC Emissions (g)	0	5	1	62	27	95
CO Emissions (g)	9	78	27	1039	622	1775
NOx Emissions (g)	1	12	5	180	83	281

7: PORTAGE RD. & LAKEVIEW DR. Performance by movement

Movement	EBL	NBT	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.3	0.0	0.0	0.0	0.3
Total Delay (hr)	0.3	0.3	0.1	0.2	0.0	0.9
Total Stops	38	0	18	0	0	56
Travel Dist (mi)	3.6	132.0	8.5	121.2	1.2	266.6
Travel Time (hr)	0.4	4.4	0.3	3.6	0.0	8.9
Avg Speed (mph)	8	32	25	33	29	31
Fuel Used (gal)	0.2	4.0	0.2	3.1	0.0	7.5
HC Emissions (g)	3	74	1	55	0	133
CO Emissions (g)	60	1529	16	899	2	2507
NOx Emissions (g)	7	221	4	169	0	401

Total Network Performance

Denied Delay (hr)	0.3
Total Delay (hr)	3.1
Total Stops	129
Travel Dist (mi)	1056.3
Travel Time (hr)	32.9
Avg Speed (mph)	32
Fuel Used (gal)	31.0
HC Emissions (g)	621
CO Emissions (g)	15030
NOx Emissions (g)	1896

Arterial Level of Service: NB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	7	1.2	16.3	0.1	33
	6	3.2	28.7	0.3	39
FOREST DR.	3	1.6	16.5	0.1	33
Total		6.0	61.5	0.6	36

Arterial Level of Service: SB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
FOREST DR.	3	0.5	14.3	0.1	35
	6	1.0	13.6	0.1	39
LAKEVIEW DR.	7	1.3	31.7	0.3	35
Total		2.8	59.7	0.6	36

3: PORTAGE RD. & FOREST DR. Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.1	0.1
Total Delay (hr)	0.0	0.1	0.1	0.1	0.1	0.4
Total Stops	7	47	24	0	0	78
Travel Dist (mi)	1.0	6.7	5.8	77.3	70.1	161.0
Travel Time (hr)	0.1	0.4	0.2	2.4	2.2	5.2
Avg Speed (mph)	18	18	24	33	33	31
Fuel Used (gal)	0.0	0.2	0.1	1.9	2.1	4.4
HC Emissions (g)	0	3	1	33	32	69
CO Emissions (g)	3	61	21	556	763	1405
NOx Emissions (g)	0	9	3	99	101	213

7: PORTAGE RD. & LAKEVIEW DR. Performance by movement

Movement	EBL	NBL	NBT	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Total Delay (hr)	0.1	0.0	0.1	0.0	0.4	0.0	0.7
Total Stops	32	4	0	7	0	0	43
Travel Dist (mi)	3.1	1.1	71.5	4.7	168.0	6.4	254.7
Travel Time (hr)	0.3	0.1	2.2	0.2	5.2	0.2	8.2
Avg Speed (mph)	11	23	33	28	32	30	31
Fuel Used (gal)	0.1	0.0	2.1	0.1	4.4	0.1	6.9
HC Emissions (g)	1	0	44	0	59	1	105
CO Emissions (g)	21	13	974	10	960	11	1989
NOx Emissions (g)	3	1	133	2	183	2	323

Total Network Performance

Denied Delay (hr)	0.2
Total Delay (hr)	1.8
Total Stops	121
Travel Dist (mi)	841.8
Travel Time (hr)	25.9
Avg Speed (mph)	33
Fuel Used (gal)	24.8
HC Emissions (g)	447
CO Emissions (g)	11810
NOx Emissions (g)	1378

Arterial Level of Service: NB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	7	0.6	15.1	0.1	35
	6	1.9	27.6	0.3	41
FOREST DR.	3	1.0	16.0	0.1	34
Total		3.5	58.8	0.6	37

Arterial Level of Service: SB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
FOREST DR.	3	0.6	14.6	0.1	35
	6	1.2	13.9	0.1	39
LAKEVIEW DR.	7	2.6	33.2	0.3	34
Total		4.4	61.7	0.6	35

3: PORTAGE RD. & FOREST DR. Performance by approach

Approach	EB	NB	SB	All
Denied Delay (hr)	0.0	0.0	0.3	0.3
Total Delay (hr)	0.3	0.3	0.4	1.0
Total Stops	72	17	0	89
Travel Dist (mi)	10.3	86.4	132.7	229.4
Travel Time (hr)	0.8	2.8	4.5	8.1
Avg Speed (mph)	13	31	32	30
Fuel Used (gal)	0.4	2.1	4.0	6.5
Fuel Eff. (mpg)	27.5	40.8	33.1	35.3
HC Emissions (g)	4	42	54	100
CO Emissions (g)	93	685	1248	2026
NOx Emissions (g)	11	125	171	308
Density (ft/veh)	1923	547	164	479

7: PORTAGE RD. & LAKEVIEW DR. Performance by approach

Approach	EB	NB	SB	All
Denied Delay (hr)	0.0	0.1	0.0	0.1
Total Delay (hr)	0.2	0.1	1.2	1.5
Total Stops	25	0	5	30
Travel Dist (mi)	2.4	74.9	289.3	366.6
Travel Time (hr)	0.3	2.3	9.6	12.2
Avg Speed (mph)	9	34	30	30
Fuel Used (gal)	0.1	2.2	8.1	10.3
Fuel Eff. (mpg)	24.6	34.4	35.9	35.4
HC Emissions (g)	2	49	96	146
CO Emissions (g)	28	1024	1866	2918
NOx Emissions (g)	3	151	312	467
Density (ft/veh)		630	335	449

Total Network Performance

Denied Delay (hr)	0.4
Total Delay (hr)	3.9
Total Stops	119
Travel Dist (mi)	1132.4
Travel Time (hr)	36.4
Avg Speed (mph)	31
Fuel Used (gal)	33.8
Fuel Eff. (mpg)	33.5
HC Emissions (g)	592
CO Emissions (g)	15065
NOx Emissions (g)	1844
Density (ft/veh)	322

Arterial Level of Service: NB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
	7	0.5	15.0	0.1	35
	6	1.7	27.0	0.3	41
FOREST DR.	3	1.1	15.9	0.1	34
Total		3.3	58.0	0.6	38

Arterial Level of Service: SB PORTAGE RD.

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
FOREST DR.	3	1.4	15.9	0.1	33
	6	2.7	15.4	0.1	35
LAKEVIEW DR.	7	4.2	31.5	0.3	36
Total		8.2	62.8	0.6	35

APPENDIX D

ACCIDENT & SPEED DATA SUMMARY SHEETS

Standard Crash Report - Milepoints

Portage

Report Module: Safety Management Analysis

Today's Date: Friday, October 17, 2014

Dates: 1/1/2009 to 12/31/2013

PR/RoadName: 24703 : Portage Rd

Milepoints: From 6.891 to 7.534

Sort Order: Road Name, Milepoint, Date of Crash

Milepoint	Intersection Name
5.373	Portage Rd & Mandigo Ave
5.538	Charles St & Portage Rd
6.152	Portage Rd & Lancelot Ct
6.381	Bacon Ave & Portage Rd
6.891	S Shore Dr & Portage Rd
7.184	Burt Dr & Portage Rd
7.382	Ames Dr & Portage Rd
7.589	Jacobs Ct & Portage Rd
8.225	Portage Rd & Prosperity Dr
8.959	South Dr & Portage Rd
9.349	N Concourse Dr & Portage Rd
9.746	Lansing Ave & Portage Rd
10.574	Yellow Brick Rd & Portage Rd
11.017	Winters Dr & Portage Rd
11.265	Fairfield Rd & Portage Rd

Milepoint	Intersection Name
5.387	Portage Rd & Metsa Ct
5.767	Vickery St & Portage Rd
6.186	Portage Rd & Wetherbee Ave
6.636	Portage Rd & Stanley Ave
7.080	Lakeview Dr & Portage Rd
7.232	Portage Rd & Clarence Dr
7.483	McClish Ct & Portage Rd
7.847	Portage Rd & Corstange Rd
8.325	Portage Rd & Pleasant Dr
9.135	Portage Rd & Industrial Dr
9.483	Portage Rd & Romence Pkwy
9.830	Portage Rd & Ramona Ave
10.866	Yellow Brick Rd & Portage Rd
11.077	Helen Ave & Portage Rd
11.351	Bender Rd & Kilgore Road Service Rd & Portage Rd

Milepoint	Intersection Name
5.457	Portage Rd & Weaver Dr
5.873	Portage Rd & E Osterhout Ave
6.252	Portage Rd & Auburn Woods Trl
6.848	Portage Rd & Woodbine Ave
7.137	Dixie Dr & Portage Rd
7.294	Portage Rd & Emily Dr
7.534	Forest Dr & Portage Rd
7.937	Zylman Ave & Portage Rd
8.443	Portage Rd & E Centre Ave
9.241	S Concourse Dr & Portage Rd
9.491	Portage Rd & Romence Pkwy
10.457	E Milham Ave & Portage Rd
10.954	Portage Rd & Lois Ln
11.178	Byrd Dr & Portage Rd
11.395	E I 94/ Portage RAMP & Portage Rd & Portage/ E I 94 RAMP

Report Filter

Field Name	Operator	Value(s)
Crash Type	=	Angle Drive or Angle Straight or Angle Turn or Animal or Backing or Bicycle or Dual Left-Turn or Dual Right-Turn or Fixed Object or Head-on or Head-On Left-Turn or Hit Parked Vehicle or Hit Train or Misc. Multiple Vehicle or Misc. Single Vehicle or Other Drive or Other Object or Overturn or Parking or Pedestrian or Rear End Left Turn or Rear End Right Turn or Rear-End Drive or Rear-End Straight or Side-Swipe Opposite or Side-Swipe Same or Miscellaneous

Standard Crash Report - Milepoints

MilePoint	UD10 #	UD10 City/Township	UD-10 Crash Location	UD-10 Crossroad Reference	Crash Type	Crash Severity	Date	Hour of Occurence	Number of: Veh.	Occup.	Inj.	Weekday	Environmental Condition: Weather	Lighting	Surface	Relationship On Road
PR Number: 24703			**Road Name: Portage Rd**													
6.891	8550790	Portage	45' W	SHORE	Fixed Object	PDO	1/31/2013	10AM-11AM	1	1	0	Thursday	Snow	Daylight	Icy	Out Shou/Curb
6.906	8764603	Portage	80' N	SHORE	Animal	PDO	10/17/2013	06AM-07AM	1	1	0	Thursday	Clear	Dawn	Wet	On Road
6.915	7698549	Portage	125' N	SHORE	Misc. Single Vehicle	Injury	9/14/2010	02PM-03PM	1	1	1	Tuesday	Clear	Daylight	Dry	On Road
6.929	8688308	Portage	200' N	SHORE	Side-Swipe Same	PDO	7/30/2013	02PM-03PM	2	4	0	Tuesday	Clear	Daylight	Dry	On Road
6.948	7808665	Portage	300' N	SHORE	Animal	PDO	11/27/2010	11PM-MDNT	1	1	0	Saturday	Cloudy	Dark	Dry	On Road
6.991	7632404	Portage	470' N	SHORE	Fixed Object	PDO	6/9/2010	04PM-05PM	1	1	0	Wednesday	Clear	Daylight	Dry	Out Shou/Curb
7.042	8265521	Portage	201' SW	LAKEVIEW	Fixed Object	PDO	2/4/2012	05AM-06AM	1	1	0	Saturday	Clear	Dark,Lighted	Dry	Out Shou/Curb
7.042	8393966	Portage	200' S	LAKEVIEW	Fixed Object	PDO	7/28/2012	11PM-MDNT	1	1	0	Saturday	Clear	Dark,Lighted	Dry	Out Shou/Curb
7.048	7675806	Portage	169' N	WOODBINE	Fixed Object	PDO	8/10/2010	08PM-09PM	1	1	0	Tuesday	Clear	Dusk	Dry	Unknown
7.052	8389151	Portage	150' S	LAKEVIEW	Animal	PDO	7/23/2012	08AM-09AM	1	2	0	Monday	Cloudy	Daylight	Dry	On Road
7.061	8411936	Portage	100' S	LAKEVIEW	Animal	PDO	8/24/2012	07AM-08AM	1	1	0	Friday	Clear	Dawn	Dry	On Road
7.066	7457313	Portage	75' S	LAKEVIEW	Animal	PDO	11/19/2009	10PM-11PM	1	1	0	Thursday	Clear	Daylight	Dry	On Road
7.071	8534155	Portage	50' S	LAKEVIEW	Animal	PDO	1/12/2013	07PM-08PM	1	2	0	Saturday	Cloudy	Dark	Dry	On Road
7.074	8813982	Portage	30' S	LAKEVIEW	Fixed Object	PDO	12/21/2013	04AM-05AM	1	1	0	Saturday	Fog	Dark,Lighted	Wet	Out Shou/Curb
7.077	8286140	Portage	15' S	LAKEVIEW	Fixed Object	PDO	2/25/2012	02AM-03AM	1	1	0	Saturday	Snow	Dark,Lighted	Snowy	On Shoulder
7.079	7815383	Portage	5' S	LAKEVIEW	Angle Straight	PDO	12/4/2010	07PM-08PM	2	3	0	Saturday	Cloudy	Dark	Dry	On Road
7.079	8458985	Portage	5' S	LAKEVIEW	Animal	PDO	10/25/2012	NOON-01PM	1	2	0	Thursday	Clear	Daylight	Dry	On Road
7.085	8545192	Portage	25' E	LAKEVIEW	Side-Swipe Same	PDO	1/25/2013	10AM-11AM	2	3	0	Friday	Snow	Daylight	Slushy	On Road
7.087	8617448	Portage	35' N	LAKEVIEW	Side-Swipe Same	PDO	1/10/2013	03PM-04PM	2	3	0	Thursday	Cloudy	Daylight	Dry	On Road
7.126	7949711	Portage	60' S	DIXIE	Fixed Object	PDO	2/24/2011	07AM-08AM	1	2	0	Thursday	Cloudy	Dawn	Slushy	Out Shou/Curb
7.128	8280300	Portage	50' S	DIXIE	Angle Drive	PDO	2/14/2012	03PM-04PM	2	3	0	Tuesday	Cloudy	Daylight	Wet	On Road
7.132	7639294	Portage	25' S	DIXIE	Rear-End Straight	Injury	6/15/2010	08AM-09AM	2	2	2	Tuesday	Cloudy	Daylight	Dry	On Road
7.143	8549889	Portage	30' N	DIXIE	Fixed Object	Injury	1/25/2013	MDNT-01AM	1	1	1	Friday	Cloudy	Dark,Lighted	Icy	Out Shou/Curb
7.165	7412991	Portage	100' S	BURT	Fixed Object	Injury	9/10/2009	11PM-MDNT	1	1	1	Thursday	Clear	Dark,Lighted	Dry	Out Shou/Curb
7.180	8249774	Portage	21' N	LAKEVIEW	Side-Swipe Same	PDO	1/16/2012	03AM-04AM	2	2	0	Monday	Clear	Dark,Lighted	Dry	Out Shou/Curb
7.182	7284258	Portage	10' S	BURT	Rear End Right Turn	PDO	3/30/2009	06PM-07PM	2	3	0	Monday	Clear	Daylight	Dry	On Road
7.218	8518562	Portage	75' S	CLARENCE	Fixed Object	PDO	12/30/2012	08AM-09AM	1	1	0	Sunday	Cloudy	Daylight	Snowy	Out Shou/Curb
7.224	7193247	Portage	40' SE	CLARENCE	Fixed Object	PDO	1/7/2009	06AM-07AM	1	1	0	Wednesday	Snow	Dark,Lighted	Snowy	On Shoulder
7.234	8283636	Portage	10' N	CLARENCE	Fixed Object	Injury	2/24/2012	08PM-09PM	1	2	1	Friday	Snow	Dark,Lighted	Snowy	Out Shou/Curb
7.251	7860561	Portage	100' NW	CLARENCE	Fixed Object	PDO	1/15/2011	10AM-11AM	1	2	0	Saturday	Snow	Daylight	Snowy	Unknown
7.282	8259440	Portage	63' S	AMES	Side-Swipe Opposite	PDO	1/29/2012	NOON-01PM	2	3	0	Sunday	Wind	Daylight	Snowy	On Road
7.303	7659555	Portage	50' N	EMILY	Side-Swipe Same	PDO	7/25/2010	02PM-03PM	2	2	0	Sunday	Clear	Daylight	Dry	On Road
7.313	7823131	Portage	100' N	EMILY	Side-Swipe Same	PDO	12/10/2010	08AM-09AM	2	2	0	Friday	Cloudy	Daylight	Slushy	On Road

Standard Crash Report - Milepoints

MilePoint	UD10 #	UD10 City/Township	UD-10 Crash Location	UD-10 Crossroad Reference	Crash Type	Crash Severity	Date	Hour of Occurence	Number of: Veh.	Occup.	Inj.	Weekday	Environmental Condition: Weather	Lighting	Surface	Relationship On Road
7.332	8638509	Portage	200' N	EMILY	Angle Drive	Injury	5/26/2013	05PM-06PM	2	4	1	Sunday	Clear	Daylight	Dry	On Road
7.344	8059875	Portage	200' S	AMES	Other Drive	PDO	7/2/2011	03PM-04PM	2	3	0	Saturday	Clear	Daylight	Dry	On Road
7.344	8566808	Portage	200' S	AMES	Angle Straight	Injury	1/25/2013	10AM-11AM	2	3	2	Friday	Snow	Daylight	Snowy	On Road
7.373	8202577	Portage	50' S	AMES	Side-Swipe Same	PDO	11/30/2011	04PM-05PM	2	2	0	Wednesday	Clear	Daylight	Wet	On Road
7.375	7668018	Portage	35' S	AMES	Animal	PDO	8/3/2010	05AM-06AM	1	1	0	Tuesday	Clear	Dark,Lighted	Dry	On Road
7.410	8469978	Portage	150' N	AMES	Animal	PDO	11/6/2012	07AM-08AM	1	1	0	Tuesday	Clear	Daylight	Dry	On Road
7.420	8619494	Portage	200' N	AMES	Rear-End Drive	PDO	4/28/2013	01PM-02PM	2	2	0	Sunday	Cloudy	Daylight	Wet	On Road
7.437	8283635	Portage	243' S	ZYLMAN	Misc. Multiple Vehicle	PDO	2/24/2012	10PM-11PM	2	2	0	Friday	Snow	Dark,Lighted	Icy	On Road
7.482	7586677	Portage	5' N	AMES	Angle Drive	Injury	4/7/2010	05PM-06PM	2	4	4	Wednesday	Rain	Daylight	Wet	On Road
7.496	7767653	Portage	69' S	FOREST	Side-Swipe Same	Injury	10/14/2010	NOON-01PM	2	2	1	Thursday	Clear	Daylight	Dry	On Road
7.502	8273105	Portage	100' N	MCCLISH	Animal	PDO	2/13/2012	05PM-06PM	1	1	0	Monday	Cloudy	Dusk	Dry	On Road
7.517	8101234	Portage	90' S	FOREST	Side-Swipe Same	PDO	9/2/2011	01PM-02PM	2	6	0	Friday	Clear	Daylight	Dry	On Road
7.520	7541008	Portage	75' S	FOREST	Angle Straight	PDO	2/12/2010	NOON-01PM	2	3	0	Friday	Cloudy	Daylight	Wet	On Road
7.525	7505687	Portage	45' S	FOREST	Angle Straight	PDO	1/9/2010	11AM-NOON	2	2	0	Saturday	Cloudy	Daylight	Wet	On Road
7.534	7457128	Portage	0' X	FOREST	Head-On Left-Turn	Injury	11/16/2009	02PM-03PM	3	4	2	Monday	Cloudy	Daylight	Dry	On Road
7.534	8808654	Portage	45' W	FOREST	Angle Turn	PDO	12/16/2013	08AM-09AM	2	2	0	Monday	Clear	Daylight	Snowy	On Road

Total crashes for PR 24703: 49 **Total Fatal Crashes: 0 Total Injury Crashes: 10 Total PDO Crashes: 39**

Standard Crash Report - Intersection

Portage

Report Module: Safety Management Analysis

Today's Date: Friday, October 17, 2014

Dates: 1/1/2009 to 12/31/2013

Intersection: Forest Dr & Portage Rd

Radius: 0.030 miles

Sort Order: PR No., Milepoint, Date of Crash

Physical Road(s) comprising intersection:

PR Number	Road Name	Milepoint
11201	Forest Dr	1.029
24703	Portage Rd	7.534

Report Filter

Field Name	Operator	Value(s)
Crash Type	=	Angle Drive or Angle Straight or Angle Turn or Animal or Backing or Bicycle or Dual Left-Turn or Dual Right-Turn or Fixed Object or Head-on or Head-On Left-Turn or Hit Parked Vehicle or Hit Train or Misc. Multiple Vehicle or Misc. Single Vehicle or Other Drive or Other Object or Overturn or Parking or Pedestrian or Rear End Left Turn or Rear End Right Turn or Rear-End Drive or Rear-End Straight or Side-Swipe Opposite or Side-Swipe Same or Miscellaneous

Standard Crash Report - Intersection

MilePoint	UD10 #	UD10 City/Township	UD-10 Crash Location	UD-10 Crossroad Reference	Crash Type	Crash Severity	Date	Hour of Occurence	Number of: Veh.	Occup.	Inj.	Weekday	Environmental Condition: Weather	Lighting	Surface	Relationship On Road
PR Number: 24703			**Road Name: Portage Rd**													
7.517	8101234	Portage	90' S	FOREST	Side-Swipe Same	PDO	9/2/2011	01PM-02PM	2	6	0	Friday	Clear	Daylight	Dry	On Road
7.520	7541008	Portage	75' S	FOREST	Angle Straight	PDO	2/12/2010	NOON-01PM	2	3	0	Friday	Cloudy	Daylight	Wet	On Road
7.525	7505687	Portage	45' S	FOREST	Angle Straight	PDO	1/9/2010	11AM-NOON	2	2	0	Saturday	Cloudy	Daylight	Wet	On Road
7.534	7457128	Portage	0' X	FOREST	Head-On Left-Turn	Injury	11/16/2009	02PM-03PM	3	4	2	Monday	Cloudy	Daylight	Dry	On Road
7.534	8808654	Portage	45' W	FOREST	Angle Turn	PDO	12/16/2013	08AM-09AM	2	2	0	Monday	Clear	Daylight	Snowy	On Road
7.536	7272356	Portage	10' NE	FOREST	Head-On Left-Turn	PDO	3/11/2009	MDNT-01AM	2	2	0	Wednesday	Rain	Dark,Lighted	Wet	On Shoulder
7.539	8599035	Portage	25' N	FOREST	Animal	PDO	3/26/2013	01AM-02AM	1	1	0	Tuesday	Cloudy	Dark,Lighted	Dry	On Road
7.553	8252995	Portage	100' N	FOREST	Misc. Multiple Vehicle	PDO	1/13/2012	06AM-07AM	2	2	0	Friday	Cloudy	Dark,Lighted	Icy	On Road
7.553	8400545	Portage	100' N	FOREST	Other Drive	PDO	8/8/2012	04PM-05PM	2	2	0	Wednesday	Cloudy	Daylight	Dry	On Road
7.562	8353621	Portage	143' N	FOREST	Animal	PDO	6/5/2012	09AM-10AM	1	1	0	Tuesday	Clear	Daylight	Dry	On Road
7.562	8383160	Portage	143' N	FOREST	Misc. Multiple Vehicle	PDO	7/13/2012	11AM-NOON	2	1	0	Friday	Clear	Daylight	Dry	Out Shou/Curb

Total crashes for PR 24703--Portage Rd: 11 **Total Fatal Crashes: 0 Total Injury Crashes: 1 Total PDO Crashes: 10**

Total crashes for Intersection: 11 **Total Fatal Crashes: 0 Total Injury Crashes: 1 Total PDO Crashes: 10**

Standard Crash Report - Intersection

Portage

Report Module: Safety Management Analysis

Today's Date: Friday, October 17, 2014

Dates: 1/1/2009 to 12/31/2013

Intersection: Lakeview Dr & Portage Rd

Radius: 0.030 miles

Sort Order: PR No., Milepoint, Date of Crash

Physical Road(s) comprising intersection:

PR Number	Road Name	Milepoint
10709	Lakeview Dr	0.900
24703	Portage Rd	7.080

Report Filter

Field Name	Operator	Value(s)
Crash Type	=	Angle Drive or Angle Straight or Angle Turn or Animal or Backing or Bicycle or Dual Left-Turn or Dual Right-Turn or Fixed Object or Head-on or Head-On Left-Turn or Hit Parked Vehicle or Hit Train or Misc. Multiple Vehicle or Misc. Single Vehicle or Other Drive or Other Object or Overturn or Parking or Pedestrian or Rear End Left Turn or Rear End Right Turn or Rear-End Drive or Rear-End Straight or Side-Swipe Opposite or Side-Swipe Same or Miscellaneous

Standard Crash Report - Intersection

MilePoint	UD10 #	UD10 City/Township	UD-10 Crash Location	UD-10 Crossroad Reference	Crash Type	Crash Severity	Date	Hour of Occurence	Number of: Veh.	Occup.	Inj.	Weekday	Environmental Condition: Weather	Lighting	Surface	Relationship On Road
PR Number: 24703			**Road Name: Portage Rd**													
7.052	8389151	Portage	150' S	LAKEVIEW	Animal	PDO	7/23/2012	08AM-09AM	1	2	0	Monday	Cloudy	Daylight	Dry	On Road
7.061	8411936	Portage	100' S	LAKEVIEW	Animal	PDO	8/24/2012	07AM-08AM	1	1	0	Friday	Clear	Dawn	Dry	On Road
7.066	7457313	Portage	75' S	LAKEVIEW	Animal	PDO	11/19/2009	10PM-11PM	1	1	0	Thursday	Clear	Daylight	Dry	On Road
7.071	8534155	Portage	50' S	LAKEVIEW	Animal	PDO	1/12/2013	07PM-08PM	1	2	0	Saturday	Cloudy	Dark	Dry	On Road
7.074	8813982	Portage	30' S	LAKEVIEW	Fixed Object	PDO	12/21/2013	04AM-05AM	1	1	0	Saturday	Fog	Dark,Lighted	Wet	Out Shou/Curb
7.077	8286140	Portage	15' S	LAKEVIEW	Fixed Object	PDO	2/25/2012	02AM-03AM	1	1	0	Saturday	Snow	Dark,Lighted	Snowy	On Shoulder
7.079	7815383	Portage	5' S	LAKEVIEW	Angle Straight	PDO	12/4/2010	07PM-08PM	2	3	0	Saturday	Cloudy	Dark	Dry	On Road
7.079	8458985	Portage	5' S	LAKEVIEW	Animal	PDO	10/25/2012	NOON-01PM	1	2	0	Thursday	Clear	Daylight	Dry	On Road
7.085	8545192	Portage	25' E	LAKEVIEW	Side-Swipe Same	PDO	1/25/2013	10AM-11AM	2	3	0	Friday	Snow	Daylight	Slushy	On Road
7.087	8617448	Portage	35' N	LAKEVIEW	Side-Swipe Same	PDO	1/10/2013	03PM-04PM	2	3	0	Thursday	Cloudy	Daylight	Dry	On Road

Total crashes for PR 24703--Portage Rd: 10 **Total Fatal Crashes: 0 Total Injury Crashes: 0 Total PDO Crashes: 10**

Total crashes for Intersection: 10 **Total Fatal Crashes: 0 Total Injury Crashes: 0 Total PDO Crashes: 10**

Standard Crash Report - Intersection

Portage

Report Module: Safety Management Analysis

Today's Date: Friday, October 17, 2014

Dates: 1/1/2009 to 12/31/2013

Intersection: S Shore Dr & Portage Rd

Radius: 0.030 miles

Sort Order: PR No., Milepoint, Date of Crash

Physical Road(s) comprising intersection:

PR Number	Road Name	Milepoint
24703	Portage Rd	6.891
3390067	S Shore Dr	0.890

Report Filter

Field Name	Operator	Value(s)
Crash Type	=	Angle Drive or Angle Straight or Angle Turn or Animal or Backing or Bicycle or Dual Left-Turn or Dual Right-Turn or Fixed Object or Head-on or Head-On Left-Turn or Hit Parked Vehicle or Hit Train or Misc. Multiple Vehicle or Misc. Single Vehicle or Other Drive or Other Object or Overturn or Parking or Pedestrian or Rear End Left Turn or Rear End Right Turn or Rear-End Drive or Rear-End Straight or Side-Swipe Opposite or Side-Swipe Same or Miscellaneous

Standard Crash Report - Intersection

MilePoint	UD10 #	UD10 City/Township	UD-10 Crash Location	UD-10 Crossroad Reference	Crash Type	Crash Severity	Date	Hour of Occurence	Number of: Veh.	Occup.	Inj.	Weekday	Environmental Condition: Weather	Lighting	Surface	Relationship On Road
PR Number: 24703			**Road Name: Portage Rd**													
6.863	8809780	Portage	150' S	SHORE	Fixed Object	PDO	12/17/2013	03PM-04PM	1	1	0	Tuesday	Cloudy	Daylight	Slushy	Out Shou/Curb
6.876	8633958	Portage	80' S	SHORE	Fixed Object	PDO	5/17/2013	08AM-09AM	1	1	0	Friday	Clear	Daylight	Dry	Out Shou/Curb
6.881	8516789	Portage	53' N	BACON	Animal	PDO	12/27/2012	10AM-11AM	1	1	0	Thursday	Cloudy	Daylight	Wet	On Road
6.882	7421842	Portage	48' S	AMES	Fixed Object	Injury	10/15/2009	02PM-03PM	1	1	1	Thursday	Cloudy	Daylight	Dry	On Road
6.886	8311134	Portage	25' S	SHORE	Fixed Object	PDO	3/30/2012	05PM-06PM	1	1	0	Friday	Cloudy	Daylight	Wet	On Shoulder
6.890	7463318	Portage	5' S	SHORE	Angle Turn	PDO	11/26/2009	06PM-07PM	2	2	0	Thursday	Rain	Dark,Lighted	Wet	On Road
6.891	8550790	Portage	45' W	SHORE	Fixed Object	PDO	1/31/2013	10AM-11AM	1	1	0	Thursday	Snow	Daylight	Icy	Out Shou/Curb
6.906	8764603	Portage	80' N	SHORE	Animal	PDO	10/17/2013	06AM-07AM	1	1	0	Thursday	Clear	Dawn	Wet	On Road
6.915	7698549	Portage	125' N	SHORE	Misc. Single Vehicle	Injury	9/14/2010	02PM-03PM	1	1	1	Tuesday	Clear	Daylight	Dry	On Road

Total crashes for PR 24703--Portage Rd: 9 **Total Fatal Crashes: 0 Total Injury Crashes: 2 Total PDO Crashes: 7**

Total crashes for Intersection: 9 **Total Fatal Crashes: 0 Total Injury Crashes: 2 Total PDO Crashes: 7**

Nu-Metrics Traffic Analyzer Study
Computer Generated Summary Report
City: Portage
Street: Portage AT Forest

A study of vehicle traffic was conducted with HI-STAR unit number 136089. The study was done in the NB TOTAL lane at Portage AT Forest in Portage, MI in Kalamazoo county. The study began on Oct/07/2014 at 12:00:00 AM and concluded on Oct/08/2014 at 12:00:00 AM, lasting a total of 24.00 hours. Traffic statistics were recorded in 15 minute time periods. The total recorded volume showed 8342 vehicles passed through the location with a peak volume of 290 on Oct/07/2014 at [07:15-07:30] and a minimum volume of 1 on Oct/07/2014 at [00:15-00:30]. The AADT count for this study was 8,342.

SPEED

Chart 1 lists the values of the speed bins and the total traffic volume for each bin. At least half the vehicles were traveling in the 40 - 45 MPH range or lower. The average speed for all classifed vehicles was 41 MPH with 16.92% vehicles exceeding the posted speed of 40 MPH. The HI-STAR found 0.48 percent of the total vehicles were traveling in excess of 55 MPH. The mode speed for this traffic study was 40MPH and the 85th percentile was 45.67 MPH.

< to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to >					
0	20	71	77	134	651	2561	3404	1195	154	20	10	7	7	16					

CHART 1

CLASSIFICATION

Chart 2 lists the values of the classification bins and the total traffic volume accumulated for each bin.

Most of the vehicles classified during the study were Passenger Vehicles. The number of Passenger Vehicles in the study was 5814 which represents 70 percent of the total classified vehicles. The number of Vans & Pickups in the study was 2072 which represents 25 percent of the total classified vehicles. The number of Busses & Trucks in the study was 320 which represents 4 percent of the total classified vehicles. The number of Tractor Tailers in the study was 121 which represents 1 percent of the total classified vehicles.

< to 17	18 to 23	24 to 27	28 to 31	32 to 37	38 to 43	44 to 61	62 to >												
5814	2072	194	126	66	36	13	6												

CHART 2

HEADWAY

During the peak traffic period, on Oct/07/2014 at [07:15-07:30] the average headway between vehicles was 3.093 seconds. During the slowest traffic period, on Oct/07/2014 at [00:15-00:30] the average headway between vehicles was 450 seconds.

WEATHER

The roadway surface temperature over the period of the study varied between 47.00 and 79.00 degrees F.

Nu-Metrics Traffic Analyzer Study
Computer Generated Summary Report
City: Portage
Street: Portage AT Forest

A study of vehicle traffic was conducted with HI-STAR unit number 136078. The study was done in the SB TOTAL lane at Portage AT Forest in Portage, MI in Kalamazoo county. The study began on Oct/07/2014 at 12:00:00 AM and concluded on Oct/08/2014 at 12:00:00 AM, lasting a total of 24.00 hours. Traffic statistics were recorded in 15 minute time periods. The total recorded volume showed 8236 vehicles passed through the location with a peak volume of 298 on Oct/07/2014 at [17:00-17:15] and a minimum volume of 2 on Oct/07/2014 at [02:15-02:30]. The AADT count for this study was 8,236.

SPEED

Chart 1 lists the values of the speed bins and the total traffic volume for each bin. At least half the vehicles were traveling in the 40 - 45 MPH range or lower. The average speed for all classifed vehicles was 43 MPH with 35.89% vehicles exceeding the posted speed of 40 MPH. The HI-STAR found 2.23 percent of the total vehicles were traveling in excess of 55 MPH. The mode speed for this traffic study was 40MPH and the 85th percentile was 49.76 MPH.

< to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	60 to 64	65 to 69	70 to 74	75 to >					
1	14	68	260	237	531	1574	2578	1801	720	242	69	34	30	50					

CHART 1

CLASSIFICATION

Chart 2 lists the values of the classification bins and the total traffic volume accumulated for each bin.

Most of the vehicles classified during the study were Passenger Vehicles. The number of Passenger Vehicles in the study was 4467 which represents 54 percent of the total classified vehicles. The number of Vans & Pickups in the study was 2800 which represents 34 percent of the total classified vehicles. The number of Busses & Trucks in the study was 714 which represents 9 percent of the total classified vehicles. The number of Tractor Tailers in the study was 228 which represents 3 percent of the total classified vehicles.

< to 17	18 to 23	24 to 27	28 to 31	32 to 37	38 to 43	44 to 61	62 to >												
4467	2800	484	230	125	52	37	14												

CHART 2

HEADWAY

During the peak traffic period, on Oct/07/2014 at [17:00-17:15] the average headway between vehicles was 3.01 seconds. During the slowest traffic period, on Oct/07/2014 at [02:15-02:30] the average headway between vehicles was 300 seconds.

WEATHER

The roadway surface temperature over the period of the study varied between 47.00 and 81.00 degrees F.

Date/Time/Volume/Average Speed/Temperature Report

HI-Star ID: 136082	Begin: Oct/07/2014 12:00:00 AM	End: Oct/08/2014 12:00:00 AM
Street: Forest at Portage	Lane: wb	Hours: 24.00
State: MI	Oper: BB	Period: 15
City: Portage	Posted: 40	Raw Count: 400
County: Kalamazoo	AADT Factor: 1	AADT Count: 400

Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry
Tue,Oct/07/2014				
[00:00-00:15]	1	12 MPH	50 F	---
[00:15-00:30]	1	12 MPH	50 F	---
[00:30-00:45]	2	28 MPH	50 F	---
[00:45-01:00]	0	0 MPH	50 F	---
[01:00-01:15]	0	0 MPH	49 F	---
[01:15-01:30]	0	0 MPH	49 F	---
[01:30-01:45]	0	0 MPH	49 F	---
[01:45-02:00]	0	0 MPH	49 F	---
[02:00-02:15]	0	0 MPH	49 F	---
[02:15-02:30]	0	0 MPH	49 F	---
[02:30-02:45]	0	0 MPH	49 F	---
[02:45-03:00]	0	0 MPH	49 F	---
[03:00-03:15]	0	0 MPH	49 F	---
[03:15-03:30]	1	22 MPH	49 F	---
[03:30-03:45]	0	0 MPH	49 F	---
[03:45-04:00]	0	0 MPH	49 F	---
[04:00-04:15]	0	0 MPH	49 F	---
[04:15-04:30]	0	0 MPH	49 F	---
[04:30-04:45]	0	0 MPH	49 F	---
[04:45-05:00]	0	0 MPH	49 F	---
[05:00-05:15]	1	18 MPH	49 F	---
[05:15-05:30]	0	0 MPH	49 F	---
[05:30-05:45]	1	22 MPH	49 F	---
[05:45-06:00]	0	0 MPH	49 F	---
[06:00-06:15]	0	0 MPH	49 F	---
[06:15-06:30]	3	19 MPH	47 F	---
[06:30-06:45]	2	13 MPH	47 F	---
[06:45-07:00]	6	23 MPH	47 F	---
[07:00-07:15]	6	21 MPH	47 F	---
[07:15-07:30]	12	19 MPH	47 F	---
[07:30-07:45]	9	26 MPH	47 F	---
[07:45-08:00]	8	21 MPH	47 F	---
[08:00-08:15]	9	20 MPH	47 F	---
[08:15-08:30]	4	33 MPH	49 F	---
[08:30-08:45]	4	25 MPH	49 F	---
[08:45-09:00]	4	35 MPH	50 F	---

Date/Time/Volume/Average Speed/Temperature Report

HI-Star ID: 136082	Begin: Oct/07/2014 12:00:00 AM	End: Oct/08/2014 12:00:00 AM
Street: Forest at Portage	Lane: wb	Hours: 24.00
State: MI	Oper: BB	Period: 15
City: Portage	Posted: 40	Raw Count: 400
County: Kalamazoo	AADT Factor: 1	AADT Count: 400

Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry
Tue,Oct/07/2014				
[09:00-09:15]	6	19 MPH	52 F	---
[09:15-09:30]	8	18 MPH	56 F	---
[09:30-09:45]	2	20 MPH	54 F	---
[09:45-10:00]	5	18 MPH	56 F	---
[10:00-10:15]	4	21 MPH	56 F	---
[10:15-10:30]	6	17 MPH	58 F	---
[10:30-10:45]	2	20 MPH	61 F	---
[10:45-11:00]	7	17 MPH	61 F	---
[11:00-11:15]	1	4 MPH	61 F	---
[11:15-11:30]	8	14 MPH	63 F	---
[11:30-11:45]	5	16 MPH	65 F	---
[11:45-12:00]	9	22 MPH	67 F	---
[12:00-12:15]	3	23 MPH	72 F	---
[12:15-12:30]	13	20 MPH	76 F	---
[12:30-12:45]	7	19 MPH	74 F	---
[12:45-13:00]	11	19 MPH	74 F	---
[13:00-13:15]	8	20 MPH	74 F	---
[13:15-13:30]	9	21 MPH	79 F	---
[13:30-13:45]	6	21 MPH	79 F	---
[13:45-14:00]	5	16 MPH	81 F	---
[14:00-14:15]	10	22 MPH	79 F	---
[14:15-14:30]	2	18 MPH	81 F	---
[14:30-14:45]	7	20 MPH	81 F	---
[14:45-15:00]	7	21 MPH	79 F	---
[15:00-15:15]	10	21 MPH	81 F	---
[15:15-15:30]	5	19 MPH	83 F	---
[15:30-15:45]	13	17 MPH	81 F	---
[15:45-16:00]	8	19 MPH	79 F	---
[16:00-16:15]	5	19 MPH	79 F	---
[16:15-16:30]	7	24 MPH	79 F	---
[16:30-16:45]	13	15 MPH	76 F	---
[16:45-17:00]	11	20 MPH	74 F	---
[17:00-17:15]	13	18 MPH	72 F	---
[17:15-17:30]	9	21 MPH	70 F	---
[17:30-17:45]	9	19 MPH	68 F	---
[17:45-18:00]	9	25 MPH	68 F	---

Date/Time/Volume/Average Speed/Temperature Report

HI-Star ID: 136082	Begin: Oct/07/2014 12:00:00 AM	End: Oct/08/2014 12:00:00 AM
Street: Forest at Portage	Lane: wb	Hours: 24.00
State: MI	Oper: BB	Period: 15
City: Portage	Posted: 40	Raw Count: 400
County: Kalamazoo	AADT Factor: 1	AADT Count: 400

Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry
Tue,Oct/07/2014				
[18:00-18:15]	6	21 MPH	67 F	---
[18:15-18:30]	16	19 MPH	65 F	---
[18:30-18:45]	7	15 MPH	65 F	---
[18:45-19:00]	5	18 MPH	65 F	---
[19:00-19:15]	4	23 MPH	63 F	---
[19:15-19:30]	5	19 MPH	63 F	---
[19:30-19:45]	4	20 MPH	61 F	---
[19:45-20:00]	2	20 MPH	61 F	---
[20:00-20:15]	4	22 MPH	61 F	---
[20:15-20:30]	1	18 MPH	61 F	---
[20:30-20:45]	3	17 MPH	61 F	---
[20:45-21:00]	3	23 MPH	61 F	---
[21:00-21:15]	1	12 MPH	61 F	---
[21:15-21:30]	0	0 MPH	61 F	---
[21:30-21:45]	0	0 MPH	58 F	---
[21:45-22:00]	0	0 MPH	58 F	---
[22:00-22:15]	0	0 MPH	58 F	---
[22:15-22:30]	0	0 MPH	56 F	---
[22:30-22:45]	1	22 MPH	56 F	---
[22:45-23:00]	0	0 MPH	56 F	---
[23:00-23:15]	0	0 MPH	56 F	---
[23:15-23:30]	0	0 MPH	56 F	---
[23:30-23:45]	0	0 MPH	56 F	---
[23:45-00:00]	1	18 MPH	54 F	---
Oct/07/2014 12:00:00 AM Oct/08/2014 12:00:00 AM	400	18 MPH	60 F	

APPENDIX E

ALTERNATIVE 1 AND ALTERNATIVE 2
COST ESTIMATE

ENGINEER'S OPININON
OF CONSTRUCTION COSTS
(03-15-15)

8164 Executive Court, Suite B
Lansing, Michigan 48917-7719
(517) 622-3000
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LAKE CENTER NODE OPTION #1

ROADWAY

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
1	LUMP	CLEARING AND GRUBBING	$ 10,000.00	$10,000.00
3,984	SQ YD	PAVEMENT REMOVED	$ 8.14	$32,429.76
1,650	FT	CURB AND GUTTER REMOVED	$ 6.40	$10,560.00
150	FT	PIPE REMOVED, 24" AND UNDER	$ 8.23	$1,234.50
10	EACH	CATCH BASIN OR INLET REMOVED	$ 392.80	$3,928.00
250	CU YD	EXCAVATION	$ 6.95	$1,737.50
150	CU YD	EMBANKMENT	$ 8.81	$1,321.50
1,630	SQ YD	SUBGRADE COMPACTION	$ 2.58	$4,205.40
6	HOUR	PROOF ROLLING	$ 250.00	$1,500.00
8,145	SQ FT	4" CONCRETE WALK	$ 5.01	$40,806.45
8	EACH	CURB RAMP	$ 655.32	$5,242.56
1,628	FT	CONCRETE CURB & GUTTER	$ 17.37	$28,278.36
			SUBTOTAL=	**$141,244.03**

EROSION CONTROL

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
10	CU YD	TREE ROOT AERATION	$35.00	$350.00
400	CU YD	TOPSOIL	$20.00	$8,000.00
650	SQ YD	SEEDING AND MULCHING	$2.00	$1,300.00
50	SQ YD	REPAIR SEEDING AND MULCHING	$0.41	$20.50
100	SQ YD	INTER-SEEDING	$0.22	$22.00
.5	TON	COMMERCIAL FERTILIZER	$458.59	$229.30
.75	ACRE	LIME	$64.35	$48.26
15	M. GAL	WATER	$4.16	$62.40
1,650	FT	SNOW FENCE - DELINEATION OF CONSTRUCTION LIMITS	$1.25	$2,062.50
150	FT	SNOW FENCE - TREE PROTECTION	$1.25	$187.50
1	EACH	STORM WATER POLLUTION PREVENTION PLAN	$3,500.00	$3,500.00
1	LUMP	EROSION CONTROL	$10,000.00	$10,000.00
			SUBTOTAL=	**$25,782.46**

DRAINAGE

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
100	FT	12" RCP	$50.00	$5,000.00
75	FT	15" RCP	$60.00	$4,500.00
50	FT	18" RCP	$65.00	$3,250.00
10	EACH	CATCH BASIN	$2,185.00	$21,850.00
2	EACH	CONNECT TO EX. CATCH BASIN	$550.00	$1,100.00
			SUBTOTAL=	**$35,700.00**

PAVEMENT

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
5,977	SQ YD	PAVEMENT MILLING	$3.50	$20,919.50
250	TONS	1.5" ASPHALT CONCRETE SURFACE COURSE OVERLAY	$185.00	$46,250.00
136	TONS	3" ASPHALT CONCRETE BASE	$135.06	$18,368.16
272	CU YD	6" AGGREGATE BASE	$60.25	$16,388.00
543	CU YD	12" SAND SUBBASE	$35.00	$19,005.00

ENGINEER'S OPININON
OF CONSTRUCTION COSTS
(03-15-15)

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350	GALLON	TACK COAT	$1.57	$549.50
68	TONS	1.5" ASPHALT CONCRETE SURFACE COURSE	$185.00	$12,580.00
68	TONS	1.5" ASPHALT CONCRETE LEVELING COURSE	$145.92	$9,922.56
100	SQ YD	CONCRETE FOR DRIVEWAY APPROACH (8 DRIVEWAY APPROACHES) - 6" CONCRETE	$105.00	$10,500.00
			SUBTOTAL=	**$154,482.72**

MAINTENANCE OF TRAFFIC

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
1	LUMP	MAINTAINING TRAFFIC	$20,000.00	$20,000.00
4	MONTH	FIELD OFFICE	$967.14	$3,868.56
1	LUMP	CONSTRUCTION LAYOUT STAKES	$9,500.00	$9,500.00
1	LUMP	MOBILIZATION	$25,000.00	$25,000.00
			SUBTOTAL=	**$58,368.56**

TRAFFIC CONTROL

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
80	FT	GROUND MOUNTED SUPPORT	$7.55	$604.00
75	SQ FT	SIGN, FLAT SHEET	$20.00	$1,500.00
11	EACH	REMOVAL OF GROUND MOUNTED SIGN AND DISPOSAL	$9.73	$107.03
5	EACH	REMOVAL OF GROUND MOUNTED POST SUPPORT AND REERECTION	$59.67	$298.35
.8	MILE	CENTER LEFT-TURN	$4,000.00	$3,200.00
.8	MILE	EDGE LINE	$2,500.00	$2,000.00
110	FT	CROSSWALK LINE	$2.10	$231.00
100	FT	CHANNELIZING LINE	$1.50	$150.00
10	EACH	LANE ARROW	$100.00	$1,000.00
			SUBTOTAL=	**$9,090.38**

TOTALS

ROADWAY SUBTOTAL	**$141,244.03**
EROSION CONTROL SUBTOTAL	**$25,782.46**
DRAINAGE SUBTOTAL	**$35,700.00**
PAVEMENT SUBTOTAL	**$154,482.72**
MAINTENANCE OF TRAFFIC SUBTOTAL	**$58,368.56**
TRAFFIC CONTROL SUBTOTAL	**$9,090.38**
10% CONTINGENCY	**$42,466.81**
15% ENGINEERING	**$70,070.24**
LAKE CENTER NODE OPTION #1 TOTAL PROJECT COST	**$537,205.21**

ENGINEER'S OPININON
OF CONSTRUCTION COSTS
(3-31-15)

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LAKE CENTER NODE OPTION #2

ROADWAY

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
1	LUMP	CLEARING AND GRUBBING	$ 10,000.00	$10,000.00
2,535	SQ YD	PAVEMENT REMOVED	$ 8.14	$20,634.90
1,650	FT	CURB AND GUTTER REMOVED	$ 6.40	$10,560.00
150	FT	PIPE REMOVED, 24" AND UNDER	$ 8.23	$1,234.50
6	EACH	CATCH BASIN OR INLET REMOVED	$ 392.80	$2,356.80
250	CU YD	EXCAVATION	$ 6.95	$1,737.50
150	CU YD	EMBANKMENT	$ 8.81	$1,321.50
8,145	SQ FT	4" CONCRETE WALK	$ 4.01	$32,661.45
8	EACH	CURB RAMP	$ 655.32	$5,242.56
1,628	FT	CONCRETE CURB & GUTTER	$ 17.37	$28,278.36
			SUBTOTAL=	**$114,027.57**

EROSION CONTROL

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
10	CU YD	TREE ROOT AERATION	$35.00	$350.00
400	CU YD	TOPSOIL	$20.00	$8,000.00
650	SQ YD	SEEDING AND MULCHING	$2.00	$1,300.00
50	SQ YD	REPAIR SEEDING AND MULCHING	$0.41	$20.50
100	SQ YD	INTER-SEEDING	$0.22	$22.00
.5	TON	COMMERCIAL FERTILIZER	$458.59	$229.30
.75	ACRE	LIME	$64.35	$48.26
15	M. GAL	WATER	$4.16	$62.40
1,650	FT	SNOW FENCE - DELINEATION OF CONSTRUCTION LIMITS	$1.25	$2,062.50
150	FT	SNOW FENCE - TREE PROTECTION	$1.25	$187.50
1	EACH	STORM WATER POLLUTION PREVENTION PLAN	$3,500.00	$3,500.00
1	LUMP	EROSION CONTROL	$10,000.00	$10,000.00
			SUBTOTAL=	**$25,782.46**

DRAINAGE

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
100	FT	12" RCP	$50.00	$5,000.00
75	FT	15" RCP	$60.00	$4,500.00
50	FT	18" RCP	$65.00	$3,250.00
8	EACH	CATCH BASIN	$2,185.00	$17,480.00
2	EACH	CONNECT TO EX. CATCH BASIN	$550.00	$1,100.00
			SUBTOTAL=	**$31,330.00**

PAVEMENT

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
7,425	SQ YD	PAVEMENT MILLING	$3.50	$25,987.50

ENGINEER'S OPININON
OF CONSTRUCTION COSTS
(3-31-15)

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LAKE CENTER NODE OPTION #2

309	TON	1.5" ASPHALT CONCRETE SURFACE COURSE OVERLAY	$185.00	$57,165.00
500	GALLON	TACK COAT	$1.57	$785.00
100	TON	1.5" ASPHALT CONCRETE LEVELING COURSE	$145.92	$14,592.00
			SUBTOTAL=	**$98,529.50**

MAINTENANCE OF TRAFFIC

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
1	LUMP	MAINTAINING TRAFFIC	$20,000.00	$20,000.00
4	MONTH	FIELD OFFICE	$967.14	$3,868.56
1	LUMP	CONSTRUCTION LAYOUT STAKES	$9,500.00	$9,500.00
1	LUMP	MOBILIZATION	$25,000.00	$25,000.00
			SUBTOTAL=	**$58,368.56**

TRAFFIC CONTROL

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	COST
80	FT	GROUND MOUNTED SUPPORT	$7.55	$604.00
75	SQ FT	SIGN, FLAT SHEET	$20.00	$1,500.00
11	EACH	REMOVAL OF GROUND MOUNTED SIGN AND DISPOSAL	$9.73	$107.03
5	EACH	REMOVAL OF GROUND MOUNTED POST SUPPORT AND REERECTION	$59.67	$298.35
.8	MILE	CENTER LEFT-TURN	$4,000.00	$3,200.00
1.6	MILE	EDGE LINE	$2,500.00	$4,000.00
110	FT	CROSSWALK LINE	$2.10	$231.00
100	FT	CHANNELIZING LINE	$1.50	$150.00
10	EACH	LANE ARROW	$100.00	$1,000.00
			SUBTOTAL=	**$11,090.38**

TOTALS

ROADWAY SUBTOTAL	**$114,027.57**
EROSION CONTROL SUBTOTAL	**$25,782.46**
DRAINAGE SUBTOTAL	**$31,330.00**
PAVEMENT SUBTOTAL	**$98,529.50**
MAINTENANCE OF TRAFFIC SUBTOTAL	**$58,368.56**
TRAFFIC CONTROL SUBTOTAL	**$11,090.38**
10% CONTINGENCY	**$33,912.85**
15% ENGINEERING	**$55,956.20**
LAKE CENTER NODE OPTION #2 TOTAL PROJECT COST	**$428,997.51**