

Exhibit E

TRANSPORTATION IMPACT STUDY

FOR

SANDY WOODS PHASE 2

**SOUTH OF KELSO ROAD AND WEST OF JEWELBERRY
AVENUE**

CITY OF SANDY, OREGON



PREPARED BY

KELLY ENGINEERING

March 2021

TRANSPORTATION IMPACT STUDY

Sandy Woods Phase 2

City of Sandy, Oregon

March 3, 2021

Prepared for:

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TRANSPORTATION IMPACT STUDY

Sandy Woods Phase 2

March 3, 2021

INTRODUCTION

A transportation impact study (TIS) for the Sandy Woods Phase 2 development was conducted to determine the potential traffic related impacts of the development to the surrounding roadway system. The site is located on the south side of SE Kelso Road and west of SE Jewelberry Avenue in the City of Sandy. Phase 1 of the development is located to the south. A tract of land and the Bonneville Power Administration (BPA) power lines separates the two phases. There will be no roadway connection between the two phases.

The development will consist of 43 single-family detached homes. The Sandy Crest Phase 2 development was based on discussions with staff from the City of Sandy and Clackamas County. SE Kelso Road is within the jurisdiction of Clackamas County.

Land uses in the vicinity of the site consist of single family homes and undeveloped land. A vicinity map, aerial photograph and site plan are shown in Figures 1a, 1b and 1c.

Roadway Characteristics

The site will have access onto SE Kelso Road. SE Kelso Road is a two lane paved roadway with a posted speed limit of 45 mph. The roadway is classified as a Minor Arterial.

The Bluff Road/SE Kelso Road intersection is controlled by stop signs on the SE Kelso Road approaches. The SE Orient Drive/SE Kelso Road intersection was recently converted to all way stop sign control. The lane configurations for the intersections are shown in Figure 2.

Traffic Volumes

The traffic counts in this report were obtained from the Sandy Bluff Annex 6 Subdivision & Future Development Transportation Impact Study. The study was prepared by Lancaster Engineering in 2017 and included an analysis of several intersections in the area. The Sandy Bluff development is located south of the Sandy Woods Phase 2 development.

The traffic counts in the Sandy Bluff Annex 6 Subdivision & Future Development transportation impact study were conducted from 7:00 to 9:00 am and 4:00 to 6:00 pm during October 2017. The AM peak hour occurred between approximately 7:00 to 8:00 am and the PM peak hour occurred between approximately 4:00 to 5:00 pm at the SE Orient Drive/SE Kelso Road intersection and 4:45 to 5:45 pm at the Bluff Road/SE Kelso Road intersection. The peak hour at the intersections is the one hour time period when traffic on the adjacent streets are the highest and congestion is most likely to occur. The existing traffic volumes for 2017 are shown in Figure 3. The raw traffic count data is shown in Appendix A.

As a result of the current service oriented facility and other required closures there has been a noticeable decline in traffic volumes on the roadway systems. Therefore, the traffic counts used in this report for 2017 were assumed to have an adjustment factor of 2.5% per year to current year. The adjustment factor was based on historical traffic counts obtained from Clackamas County. The historical traffic counts at two locations on SE Kelso Road are included in Appendix B. Data from the permanent count stations on SE Kelso Road were used to evaluate the decline in traffic volumes due to the “Stay Home, Stay Safe” orders associated with the COVID-19 pandemic. The adjusted traffic volumes are shown in Figure 4.

Trip Generation/Distribution

The Sandy Woods Phase 2 development could generate approximately 406 trips per day, ITE Trip Generation Manual, 10th edition. A trip is a one directional vehicle movement. 32 trips could occur during the AM peak hour and 43 trips could occur during the PM peak hour. The trip generation rates are shown in Table 1.

**Table 1
Site Traffic Generation
Sandy Woods Phase 2**

Land Use	ITE code	Dwell units	Daily Trips	AM Peak Hour Trips	PM Peak Hour Trips
<i>Proposed Single Family Homes</i>	210	43	406	32 (in-8, out-24)	43 (in-27, out-16)

The directional distribution of traffic generated by the development was assigned to the study area intersections. Based on the existing traffic volumes and a survey conducted along the site frontage it was assumed that 55% of the site trips will travel to and from the west on SE Kelso Road and 45% will travel to and from the east towards Bluff Road. At the SE Kelso Road/SE Orient Drive intersection 20% will travel to and from the north on SE Orient Drive and 5% will travel to and from the south. 30% will continue towards the west on SE Kelso Road towards US-26. The site traffic distribution and assignment diagram is shown in Figure 6.

Year 2023 Traffic Volumes

The assumption was made in this report that build out of the Sandy Woods Phase 2 development will occur within two years. A 2.5 percent per year compounded growth rate was used at the study area intersections for the year 2023 planning horizon.

In addition to the traffic growth rate in-process traffic from the Jewelberry Meadows Subdivision was included. In-process traffic is traffic from developments that have been approved, but are not generating full build out traffic volumes. The Jewelberry Meadows Subdivision is a 20 lot subdivision located east of SE Jewelberry Avenue and north of the Penny Street intersection. The in-process traffic was obtained from the City of Sandy's Development Activity Map and correspondence with staff from the City of Sandy.

Peak Hour Traffic Operations

The scope of the transportation impact study was based on discussions with staff from the City of Sandy and Clackamas County. Based on the discussions an analysis was conducted at the following intersections during the weekday AM and PM peak hours:

- (1) SE Kelso Road & SE Orient Drive
- (2) SE Kelso Road. & Bluff Road
- (3) SE Kelso Road & site access

The study area intersections and were analyzed to determine existing, year 2023 without project and year 2023 with project conditions. The year 2023 traffic volumes without and with the project are shown in Figures 5 and 7.

The intersection operational analysis was conducted using the procedures in the 2010 Highway Capacity Manual. These procedures describe the operation of an intersection in terms of its level of service (LOS). The LOS criteria ranges from "A", which indicates little, if any, delay to "F", which indicates that vehicles experience very long delays. The LOS criteria with the corresponding delay in seconds per vehicle is shown in Table 2. The capacity analysis summary is shown in Table 3.

Table 2
Level of Service Criteria

Level of Service (LOS)	A	B	C	D	E	F
<i>Unsignalized intersections</i>						
Average Delay (seconds per vehicle)	≤10	>10 - 15	>15 - 25	>25 - 35	>35 - 50	>50

Table 3
Capacity Analysis Summary

	AM Peak Hour		PM Peak Hour	
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
<i>SE Orient Drive & SE Kelso Road</i>				
Existing	B	11.0	B	10.8
Year 2022 w/o Project	B	11.5	B	11.4
Year 2022 with Project	B	11.8	B	11.7
<i>Bluff Road & SE Kelso Road</i>				
Existing	B	13.5	B	12.6
Year 2023 w/o Project	B	14.0	B	12.9
Year 2023 with Project	B	14.3	B	13.3
<i>SE Kelso Road & site access</i>				
Existing	n/a			
Year 2022 w/o Project	n/a			
Year 2022 with Project	B	11.2	B	11.3

Based on the findings of this TIS the study area intersections will operate at acceptable levels with build out of the Sandy Woods Phase 2 development. The LOS computer printouts are included in Appendix E.

Pedestrian/Bicycle/Transit Considerations

No pedestrian or bicycle activities were observed within the vicinity of the site along SE Kelso Road during field observations. The site is not served by public transit service.

Sight Distance

Sight distance was measured at the proposed site access onto SE Kelso Road. The measured corner sight distance was over 500 feet when looking towards the east and west. Based on the posted speed limit of 45 mph on SE Kelso Road and the criteria in AASHTO, A Policy on Geometric Design of Highways and Streets, 2011 the sight distance requirement is met.

Turn Lanes

A left turn lane improves safety and increases the capacity of the roadway by reducing the speed differential between the through and left turn vehicles. The requirement for a left turn lane was evaluated at the study area intersections as based on ODOT guidelines (ODOT Highway Design Manual, 2012). Based on the findings a southbound left turn at the SE Orient Drive/SE Kelso Road intersection is justified as based on volumes during the PM peak hour under existing conditions. The left turn lane criterion for southbound traffic at the intersection is shown in Appendix D. However, the SE Orient Drive/SE Kelso Road intersection was recently converted to all way stop sign control and a left turn lane is no longer necessary. This issue was also addressed in the Sandy Bluff Annex 6 Subdivision & Future Development Transportation Impact Study prepared by Lancaster Engineering.

Traffic Signal Warrant Analysis

The need for a traffic signal was examined at the study area intersections. Due to the low volume of traffic on the minor and major street approaches traffic signals are not justified.

Transportation Improvements

The City of Sandy and the Oregon State Department of Transportation are currently updating the Transportation System Plan (TSP). The TSP will review community, business, visitor and stakeholder input to identify and prioritize future transportation projects and investments. The current TSP was last completed in 2011. The 2011 TSP and Transportation Capital Project List identifies no motor vehicle system projects within the vicinity of the Sandy Woods Phase 2 development.

Collision Data

Collision data was obtained from ODOT for the most recent five years of available data. The collision data is shown in Table 4 and Appendix C.

Table 4
Collision Data

Intersection	Number of Collisions	Collision Type					Rate MEV*
		Angle	Backing	Rear End	Turning Movements	Fixed Object	
SE Orient Drive/ SE Kelso Road	25	14	1	4	6		1.8
Bluff Road/ SE Kelso Road	3			1	1	1	0.4

Based on the available data 25 accidents have been reported to ODOT at the SE Orient Drive/SE Kelso Road intersection during the previous five years. The 25 accidents equate to an accident rate of 1.8 accidents per million entering vehicles (MEV). This is above the threshold of 1.0 accidents per MEV that usually identifies an intersection with a high accident rate. The majority of accidents at the intersection were angle type collisions. Angle type collisions can be caused by restricted sight distance, a large total intersection volume or a high approach speed. The sight distance at the intersection is adequate and the total entering volumes is also not excessive given the acceptable level of service. The appropriate countermeasure would be to install all way stop sign control at the intersection and this was recently done. Therefore, the accident rate should be significantly reduced.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this transportation impact study the surrounding roadway system can adequately accommodate traffic from the Sandy Woods Phase 2 development. No off site transportation improvements or traffic control devices were identified to accommodate the development.

Adequate sight distance should be maintained at the site access onto SE Kelso Road. Obstructions by landscaping, signs or other objects should not be allowed.



FIGURE 1a



FIGURE 1b



SISUL ENGINEERING
 375 PORTLAND AVENUE
 GLADSTONE OREGON 97027
 (503) 857-0188
 Drawn: Sandy Woods 2 - Subdivision DP - current.dwg

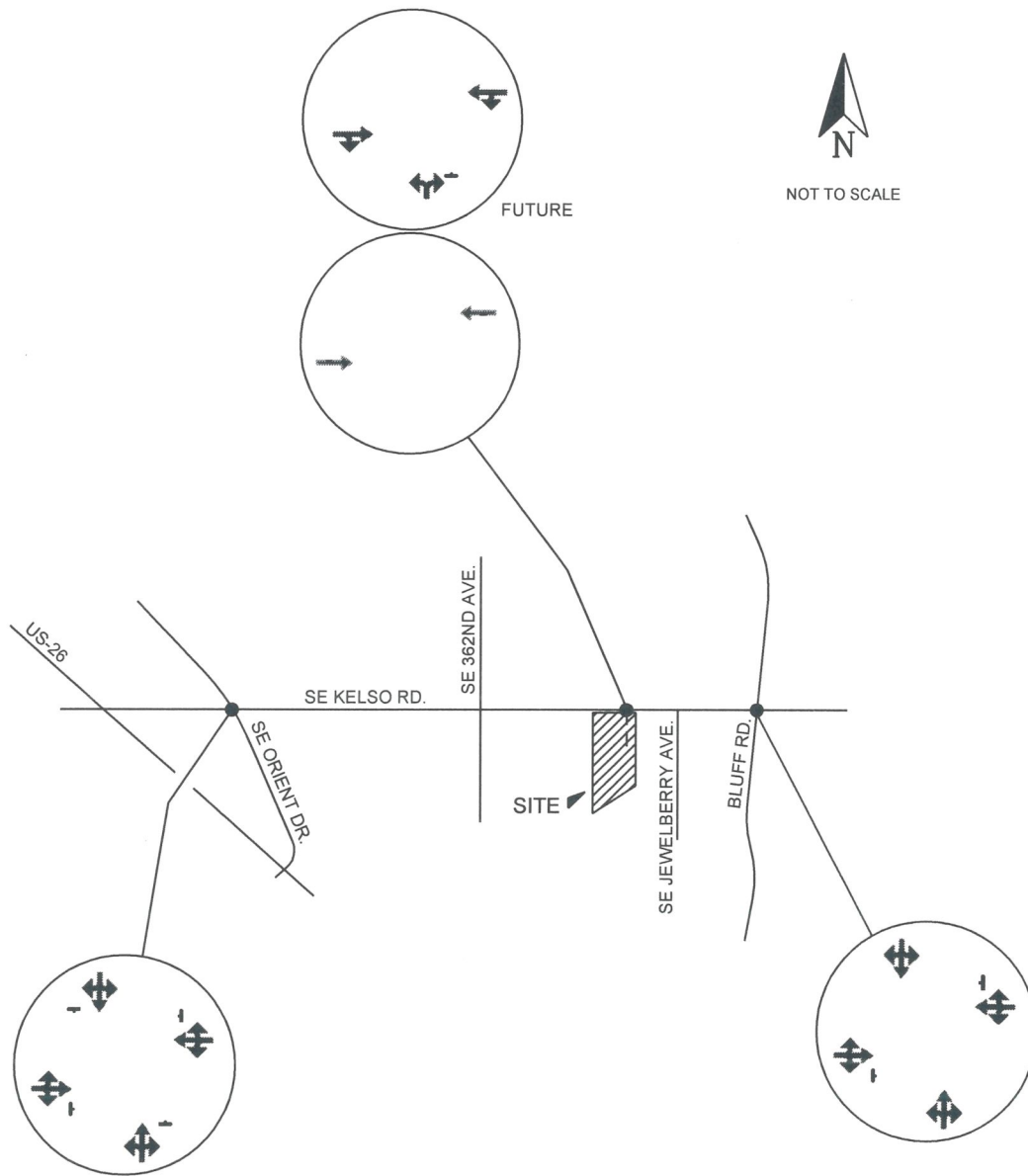
DATE: FEB. 2021
 SCALE: 1" = 50'
 SHEET: 05-11-01-3
 OF 11 SHEETS

Site Plan

Sandy Woods 2
 Rosemont Development

REVISIONS	BY

FIGURE 1c



LEGEND

STOP SIGN 1

EXISTING CONDITIONS UNLESS NOTED

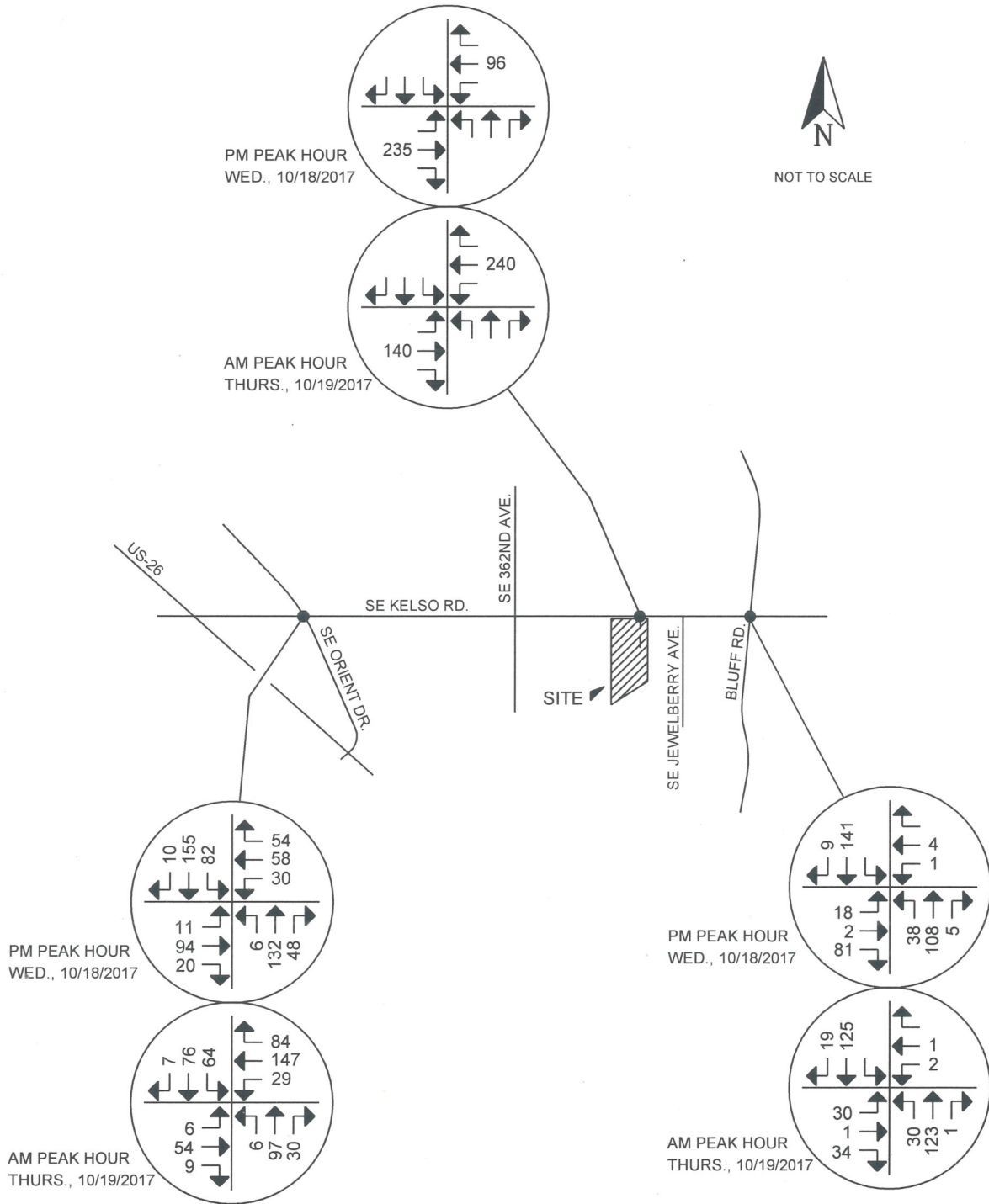
SANDY WOODS PHASE 2

**FIGURE 2
LANE CONFIGURATIONS**

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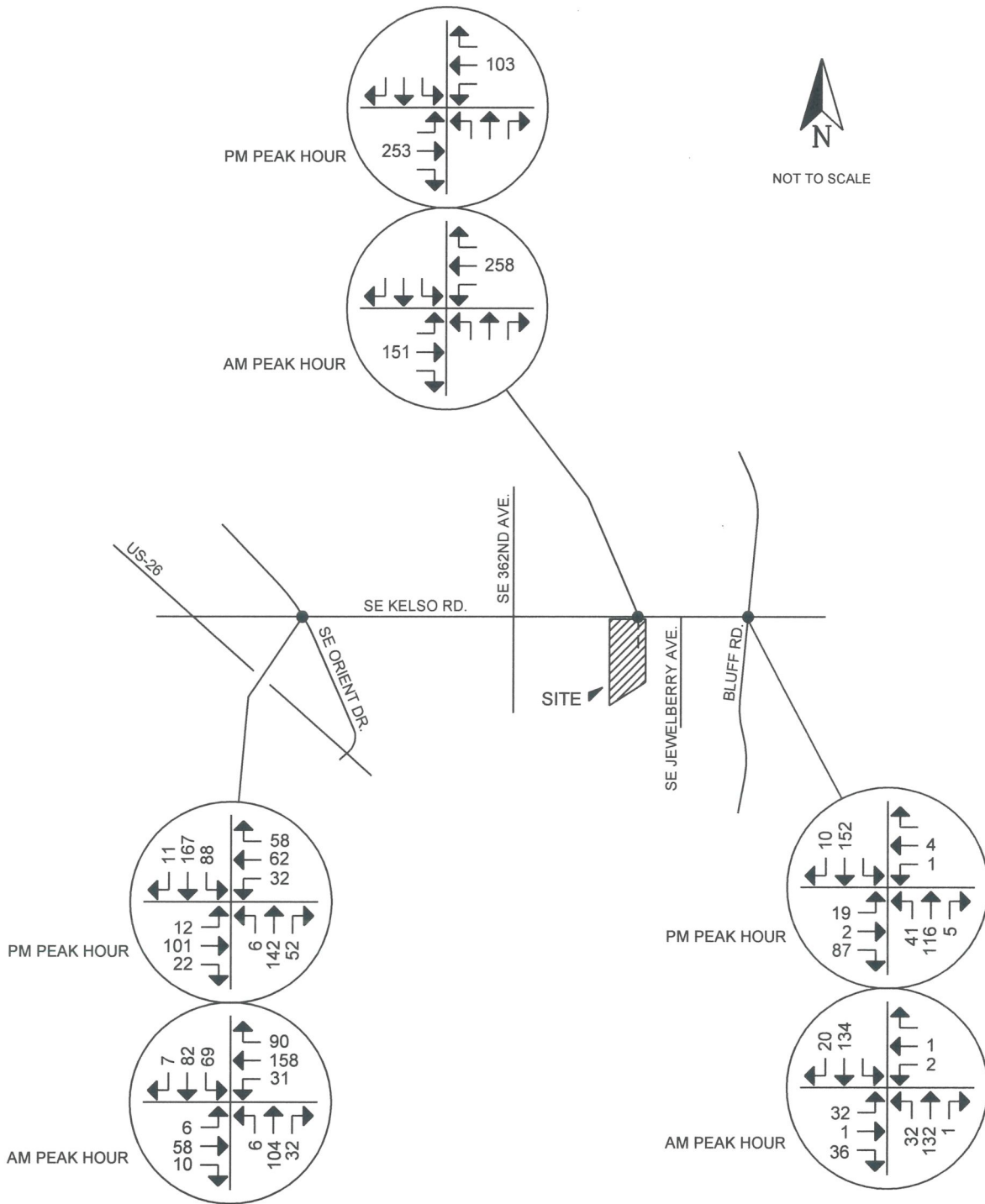
SANDY WOODS PHASE 2

FIGURE 3
EXISTING TRAFFIC VOLUMES
YEAR 2017

KELLY ENGINEERING

1805 NE 94th St., No. 19, Vancouver, WA 98665

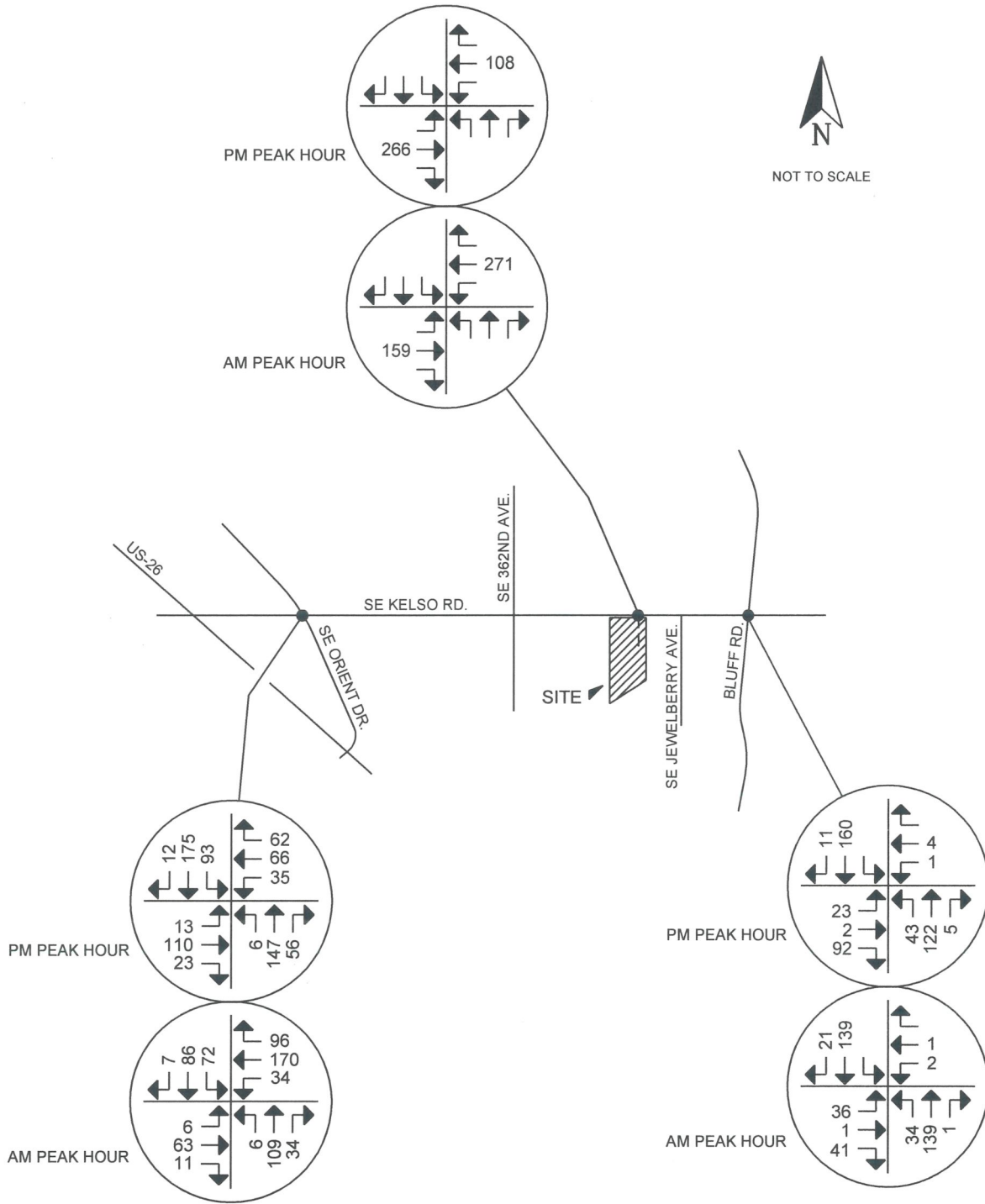
Phone: 360-433-7530



SANDY WOODS PHASE 2

FIGURE 4
ADJUSTED TRAFFIC VOLUMES
YEAR 2021

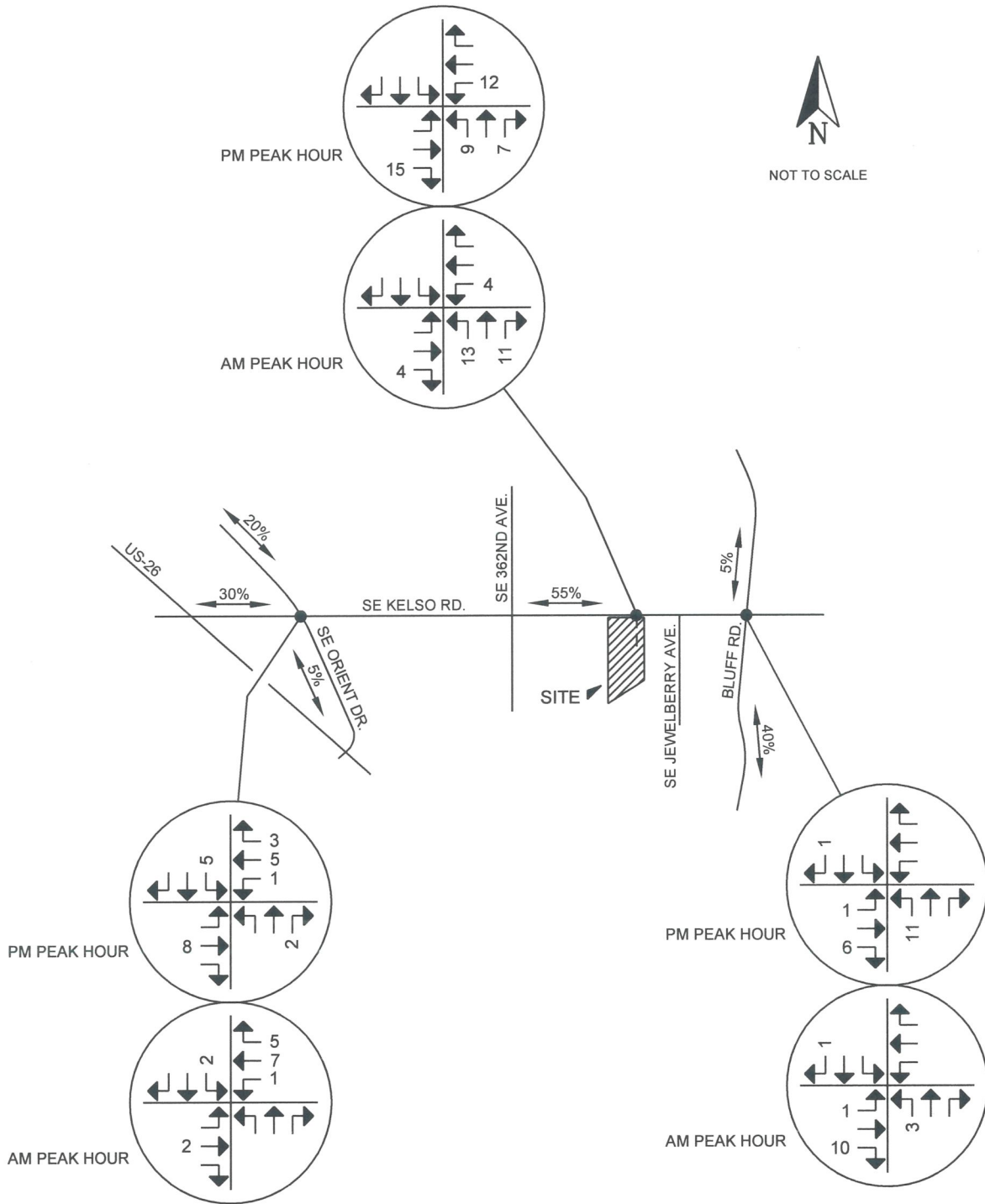
KELLY ENGINEERING
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SANDY WOODS PHASE 2

FIGURE 5
YEAR 2023 TRAFFIC VOLUMES
W/O PROJECT

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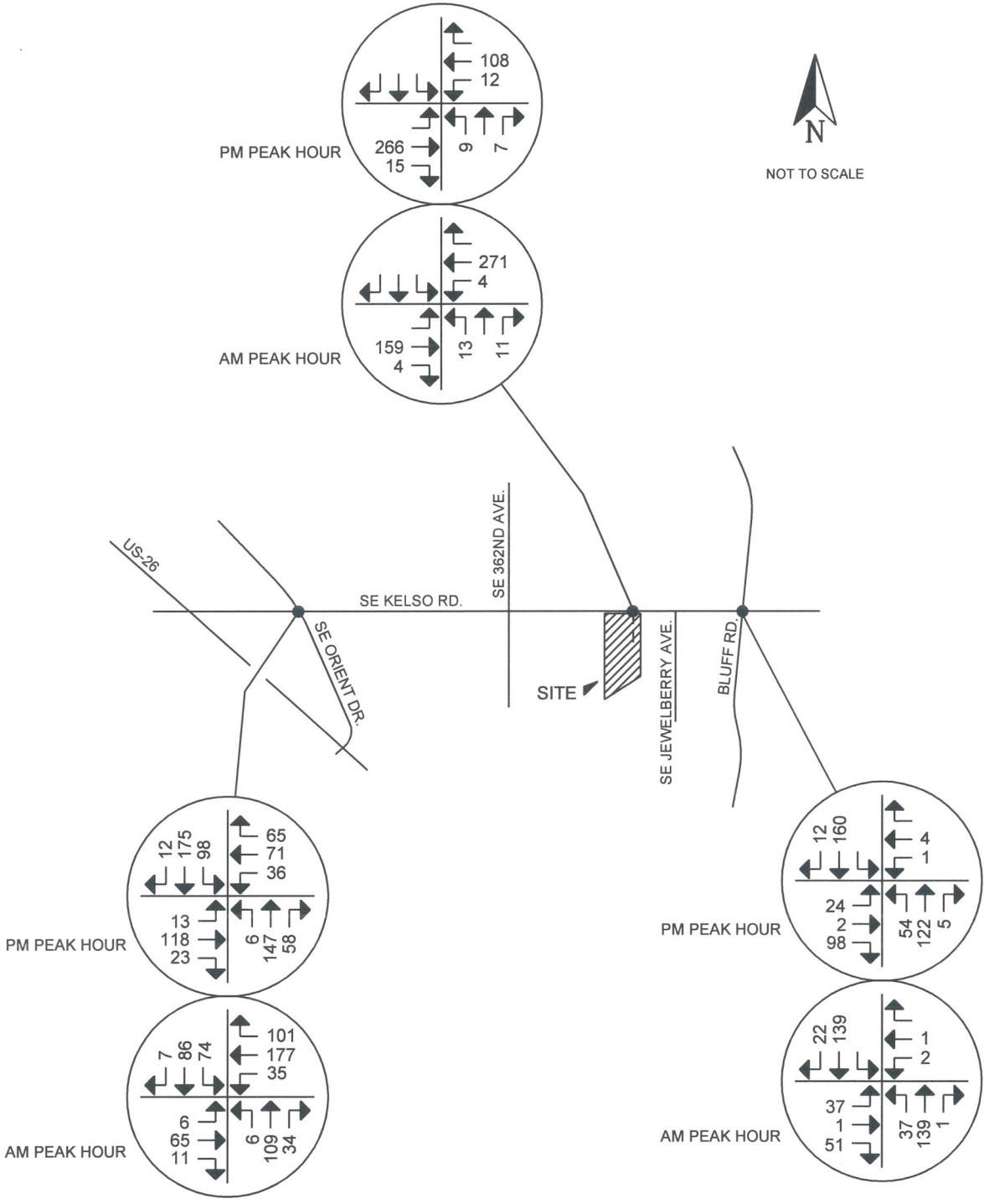
SITE TRIPS

PM PEAK HOUR: IN-27, OUT-16
 AM PEAK HOUR: IN-8, OUT-24

SANDY WOODS PHASE 2

FIGURE 6
**SITE TRAFFIC DISTRIBUTION/
 ASSIGNMENT**

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N
NOT TO SCALE

**FIGURE 7
YEAR 2023 TRAFFIC VOLUMES
WITH PROJECT**

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SANDY WOODS PHASE 2

APPENDIX A
RAW TRAFFIC COUNT DATA

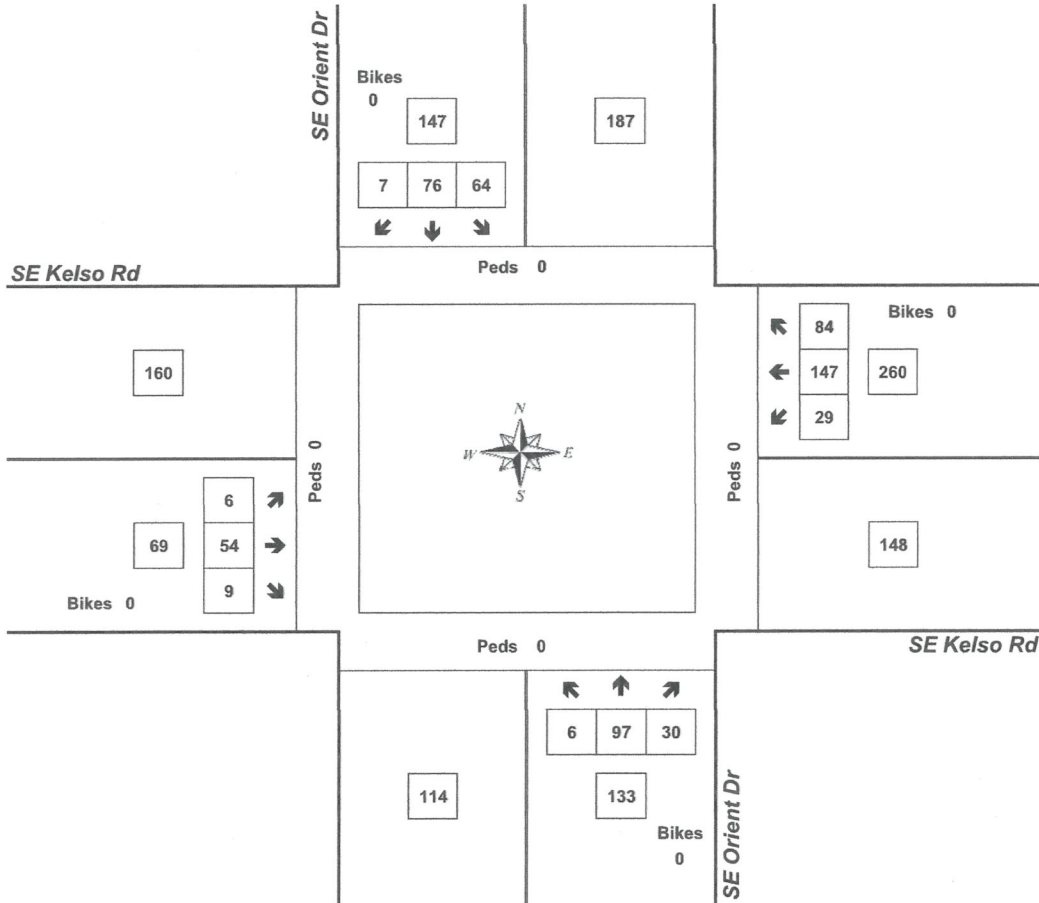
Peak Hour Summary



Clay Carney
(503) 833-2740

SE Orient Dr & SE Kelso Rd

7:00 AM to 8:00 AM
Thursday, October 19, 2017



Approach	PHF	HV%	Volume
EB	0.75	1.4%	69
WB	0.80	1.5%	260
NB	0.79	3.0%	133
SB	0.77	4.1%	147
Intersection	0.90	2.5%	609

Count Period: 7:00 AM to 9:00 AM

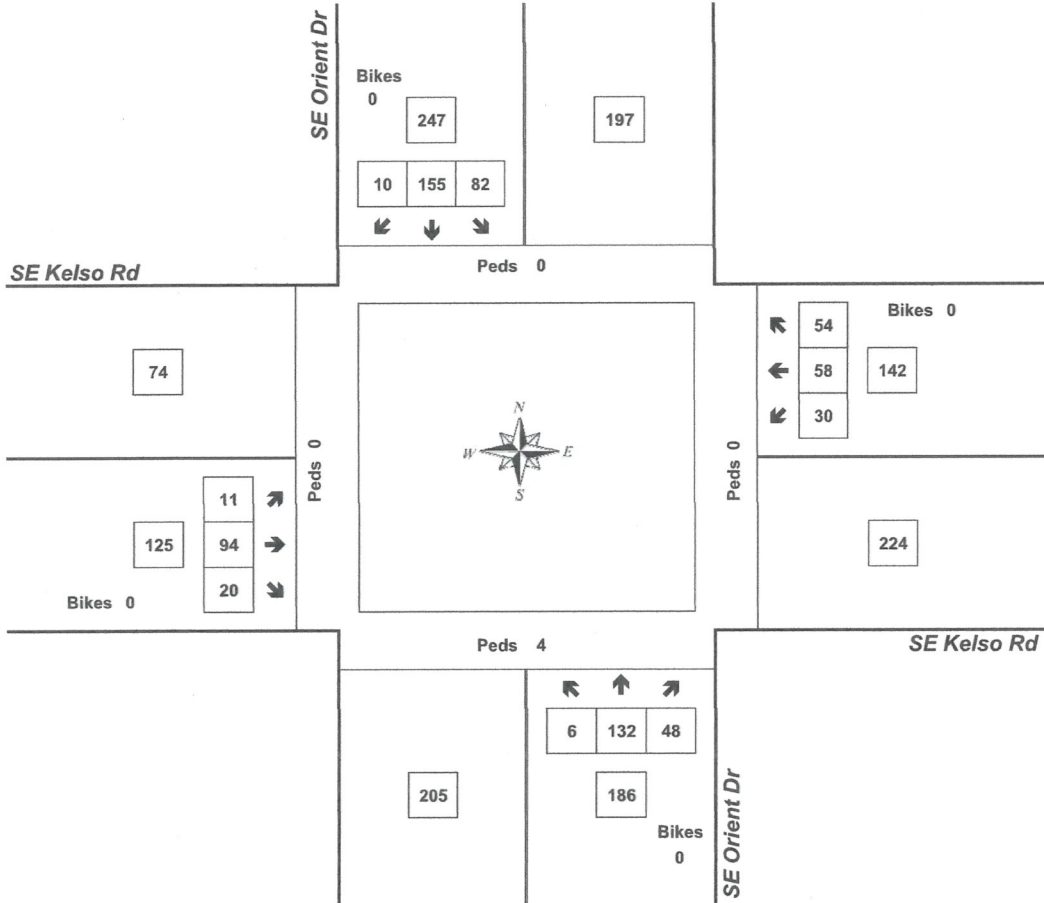
Peak Hour Summary



Clay Carney
(503) 833-2740

SE Orient Dr & SE Kelso Rd

4:00 PM to 5:00 PM
Wednesday, October 18, 2017



Approach	PHF	HV%	Volume
EB	0.76	1.6%	125
WB	0.65	3.5%	142
NB	0.91	1.1%	186
SB	0.83	1.2%	247
Intersection	0.91	1.7%	700

Count Period: 4:00 PM to 6:00 PM

Peak Hour Summary



Clay Carney
(503) 833-2740

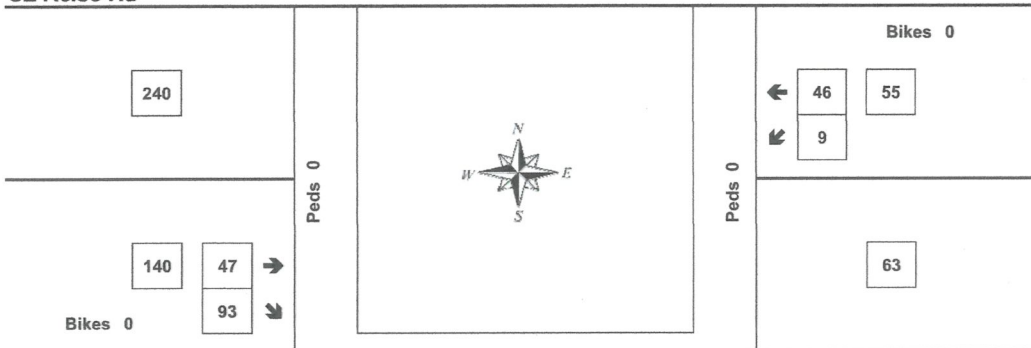
SE Jewelberry Ave & SE Kelso Rd

7:00 AM to 8:00 AM
Thursday, October 19, 2017

Bikes
0

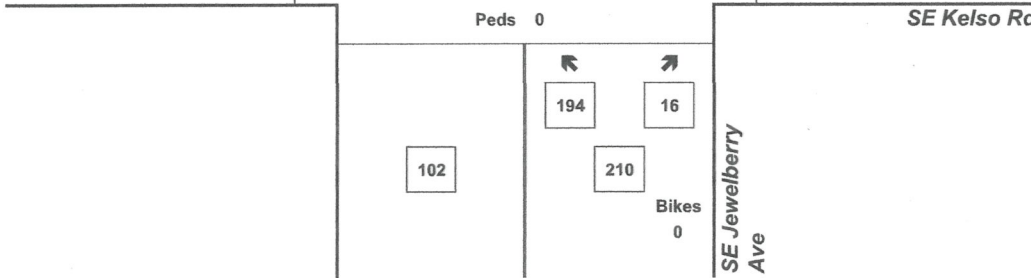
SE Kelso Rd

Peds 0



Peds 0

SE Kelso Rd



Approach	PHF	HV%	Volume
EB	0.63	2.1%	140
WB	0.65	3.6%	55
NB	0.77	1.9%	210
SB	0.00	0.0%	0
Intersection	0.74	2.2%	405

Count Period: 7:00 AM to 9:00 AM

Peak Hour Summary

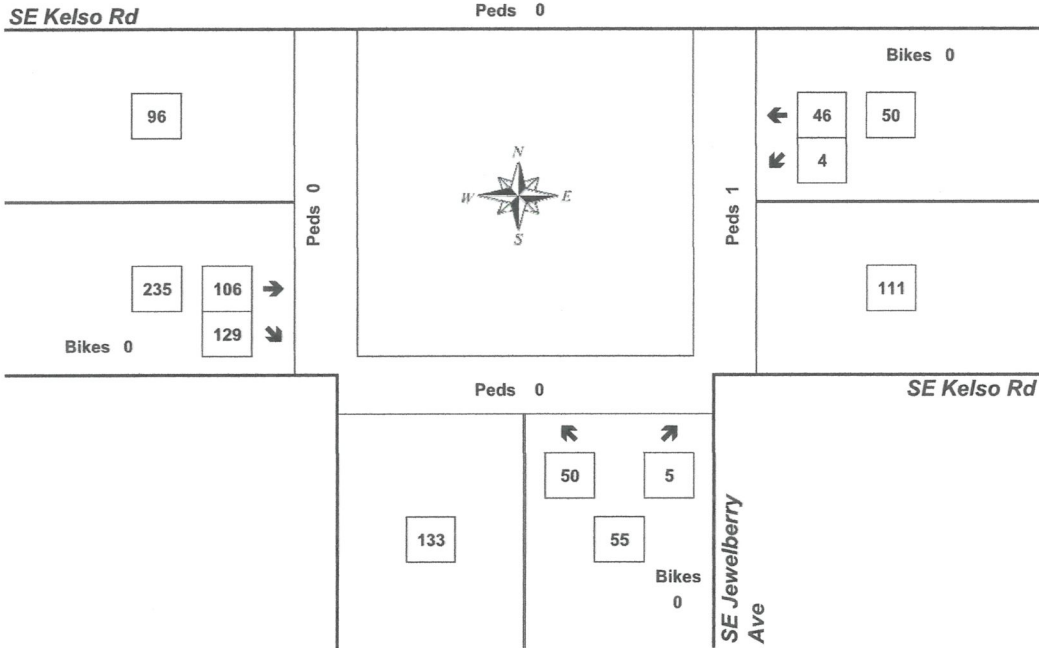


Clay Carney
(503) 833-2740

SE Jewelberry Ave & SE Kelso Rd

4:55 PM to 5:55 PM
Wednesday, October 18, 2017

Bikes
0



Approach	PHF	HV%	Volume
EB	0.92	0.0%	235
WB	0.66	2.0%	50
NB	0.65	0.0%	55
SB	0.00	0.0%	0
Intersection	0.89	0.3%	340

Count Period: 4:00 PM to 6:00 PM

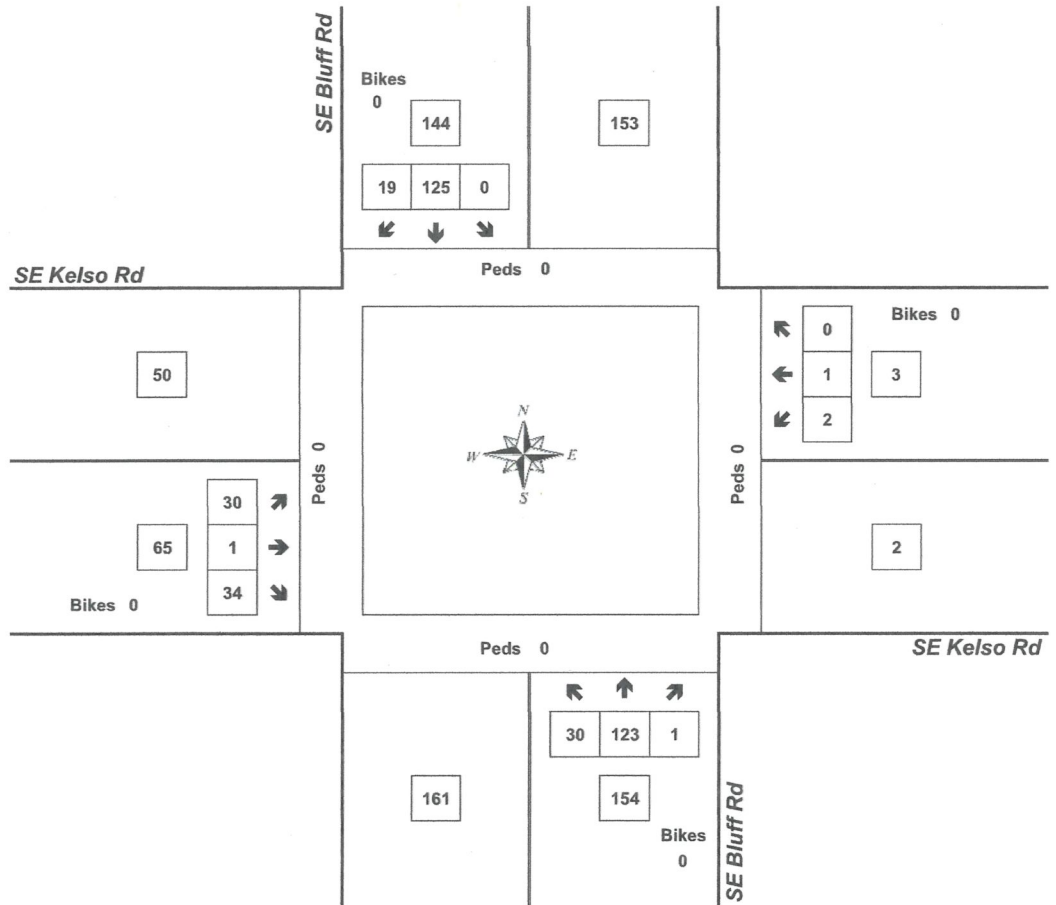
Peak Hour Summary



Clay Carney
(503) 833-2740

SE Bluff Rd & SE Kelso Rd

7:00 AM to 8:00 AM
Thursday, October 19, 2017



Approach	PHF	HV%	Volume
EB	0.60	3.1%	65
WB	0.38	0.0%	3
NB	0.70	3.2%	154
SB	0.59	2.8%	144
Intersection	0.67	3.0%	366

Count Period: 7:00 AM to 9:00 AM

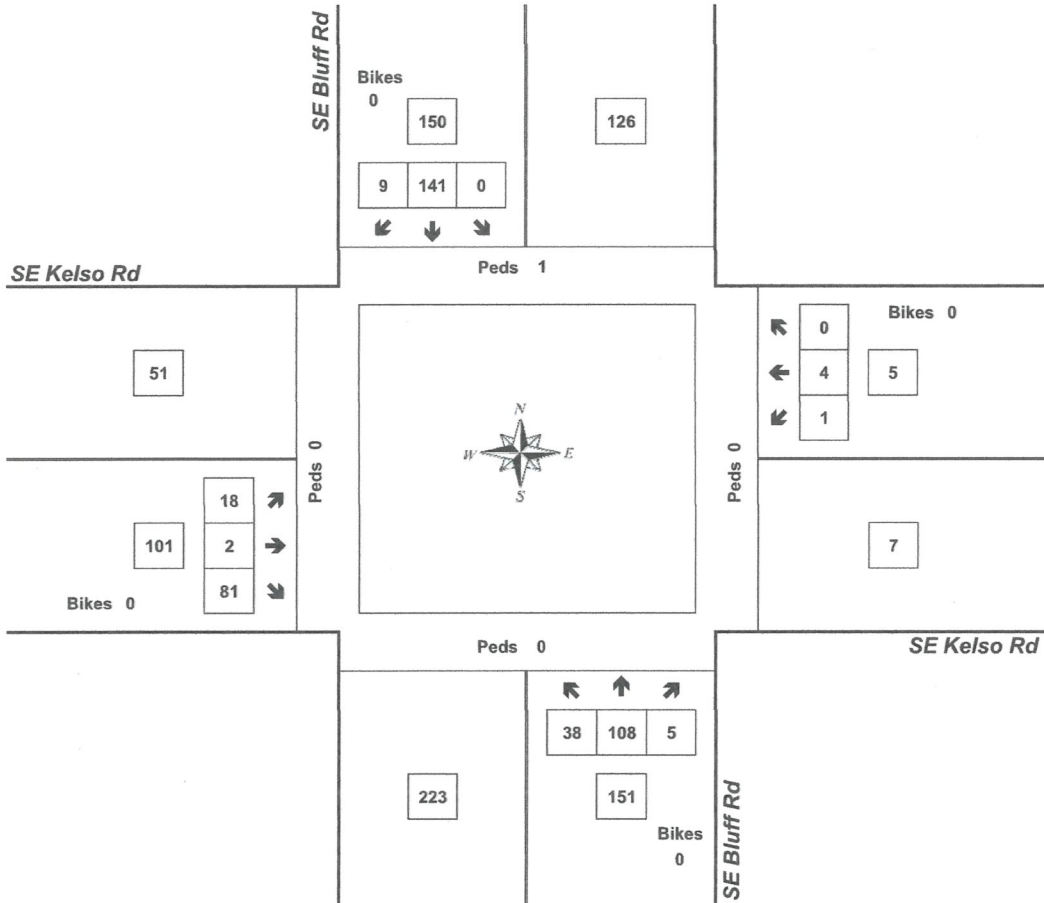
Peak Hour Summary



Clay Carney
(503) 833-2740

SE Bluff Rd & SE Kelso Rd

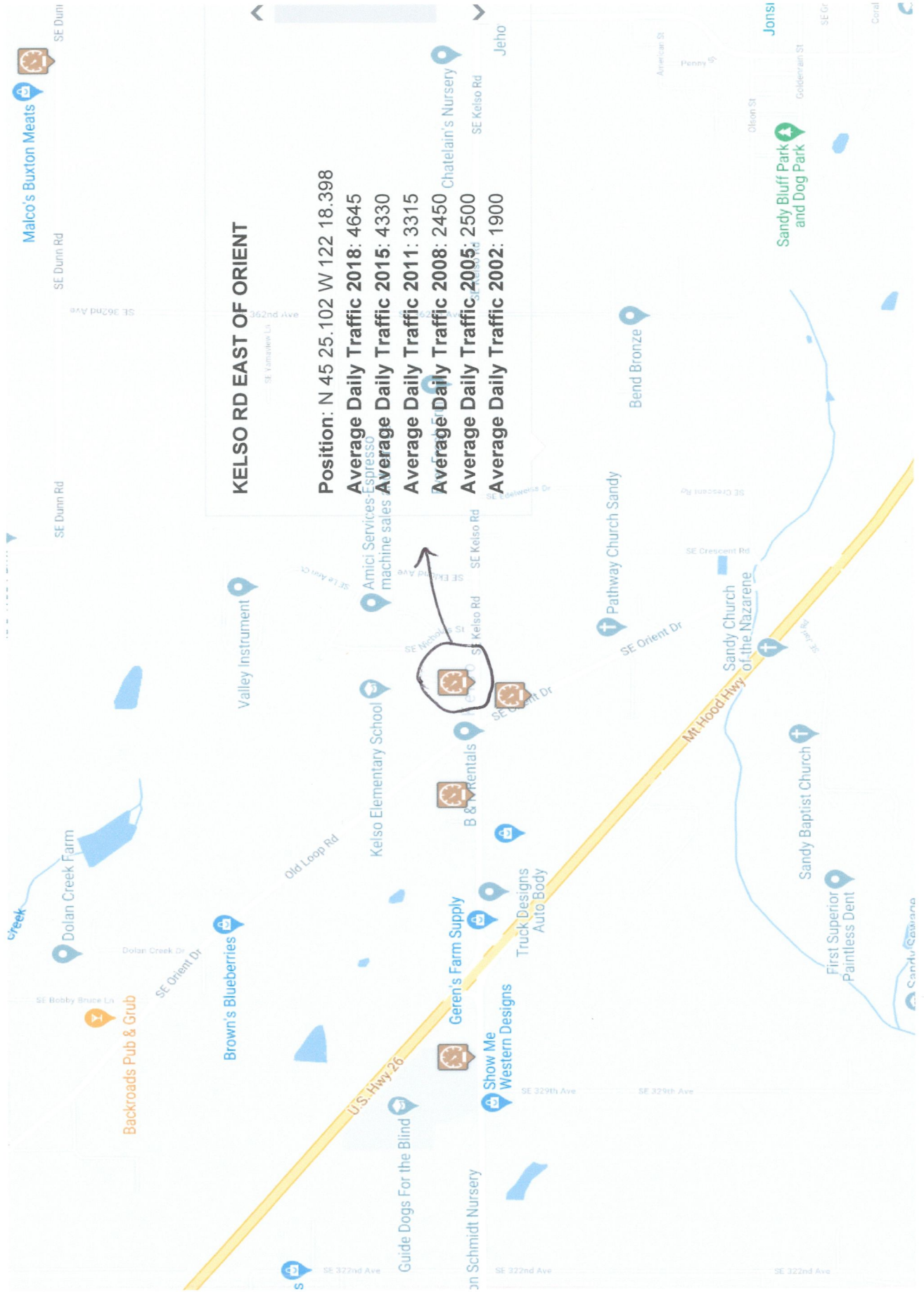
4:45 PM to 5:45 PM
Wednesday, October 18, 2017

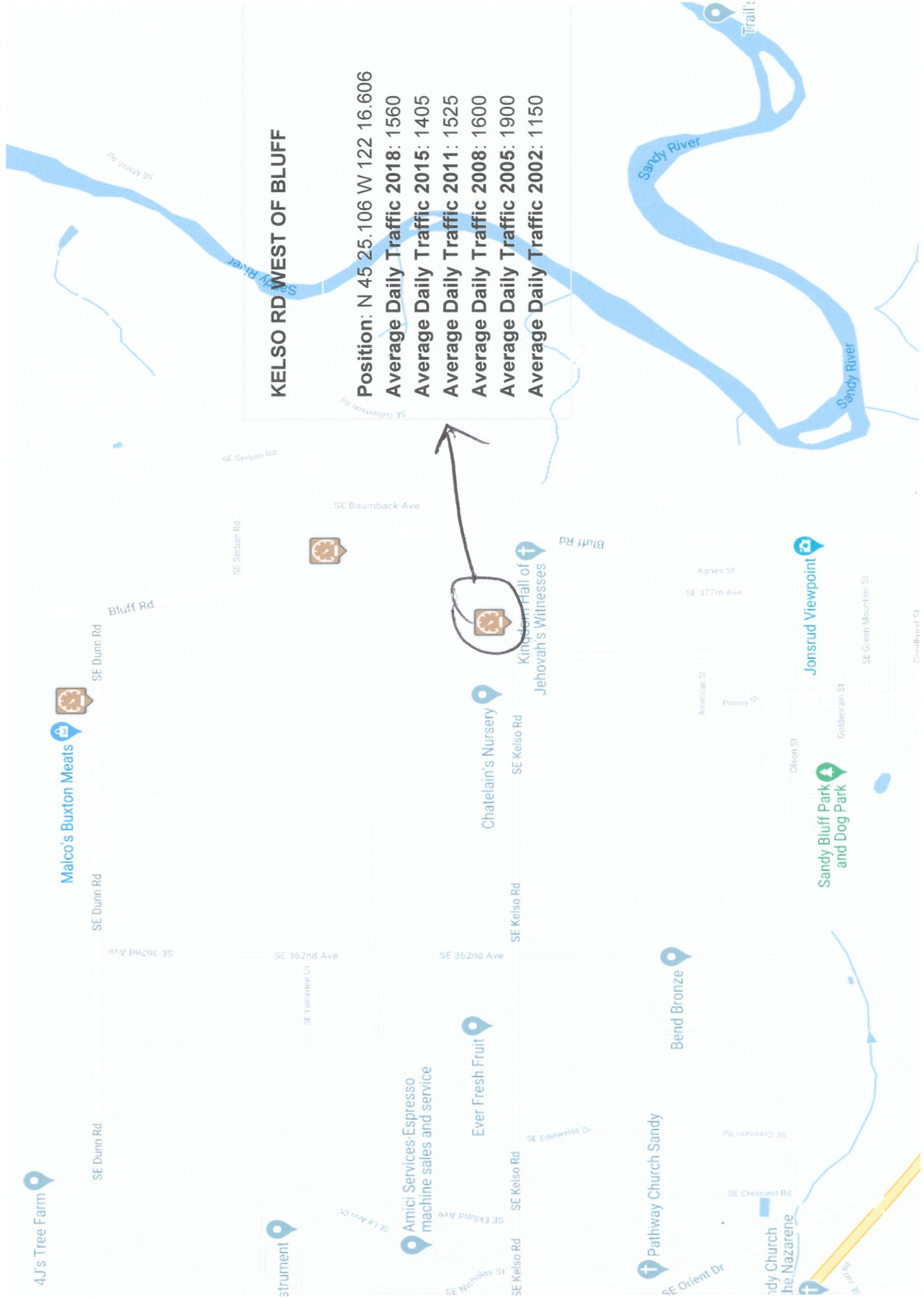


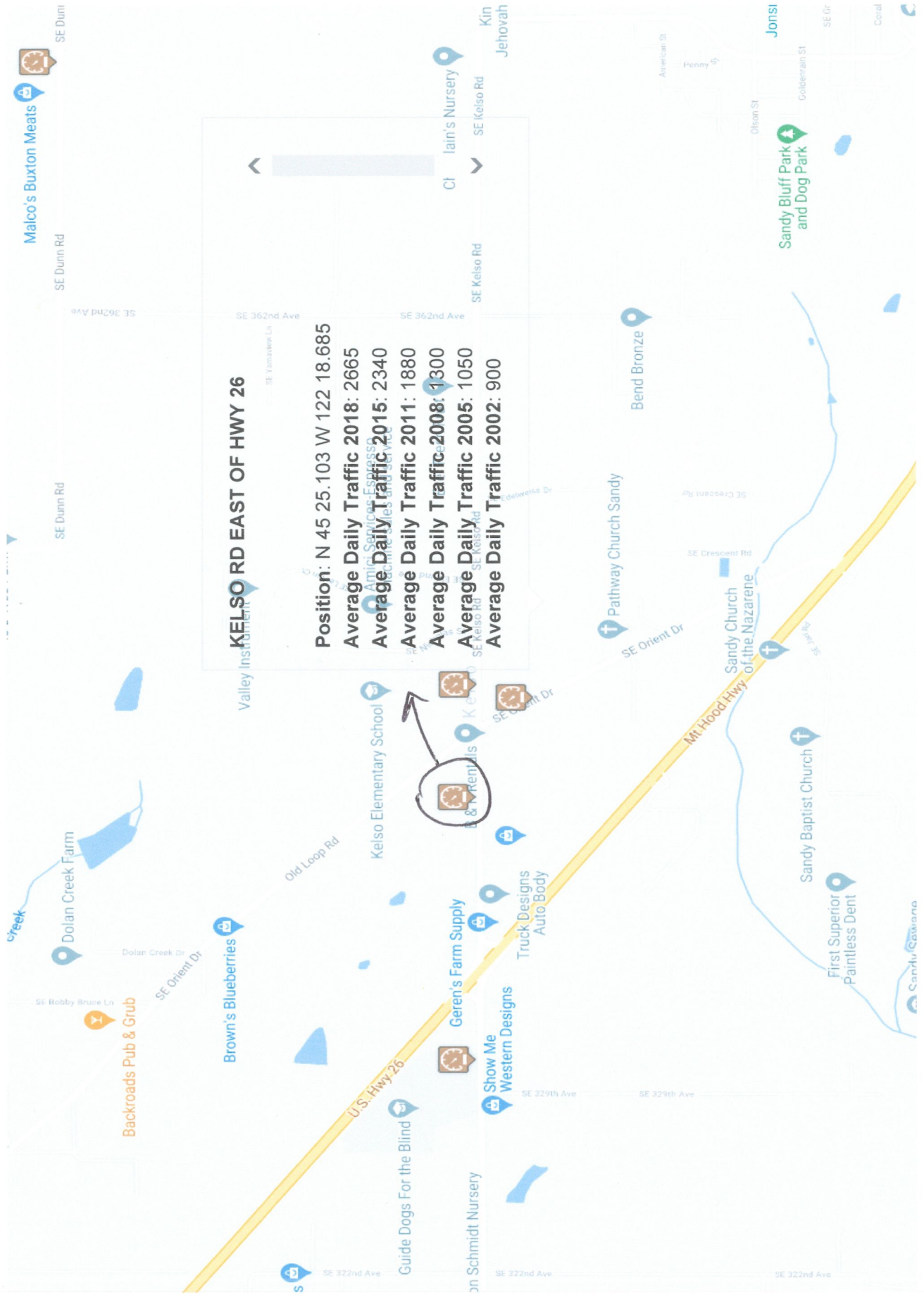
Approach	PHF	HV%	Volume
EB	0.94	0.0%	101
WB	0.63	0.0%	5
NB	0.73	1.3%	151
SB	0.83	1.3%	150
Intersection	0.82	1.0%	407

Count Period: 4:00 PM to 6:00 PM

APPENDIX B
HISTORICAL TRAFFIC COUNTS







**APPENDIX C
COLLISION DATA**

Intersectional Crashes at SE Kelso Rd & SE Orient Dr
 January 1, 2014 through December 31, 2018

COLLISION TYPE	FATAL CRASHES	NON- FATAL CRASHES	PROPERTY DAMAGE ONLY	TOTAL PEOPLE KILLED	PEOPLE INJURED	TRUCKS	DRY SURF	WET SURF	DAY	DARK	INTER- SECTION RELATED	OFF- ROAD
YEAR: 2017												
ANGLE	0	3	1	4	0	0	2	2	3	1	4	0
BACKING	0	0	1	1	0	0	1	0	0	1	1	0
REAR-END	0	1	0	1	0	0	0	1	1	0	1	0
TURNING MOVEMENTS	0	2	1	3	0	0	2	1	2	1	3	0
2017 TOTAL	0	6	3	9	0	0	5	4	6	3	9	0
YEAR: 2016												
ANGLE	0	1	2	3	0	0	2	1	2	1	3	0
REAR-END	0	1	0	1	0	0	1	0	1	0	1	0
TURNING MOVEMENTS	0	0	1	1	0	0	1	0	1	0	1	0
2016 TOTAL	0	2	3	5	0	0	4	1	4	1	5	0
YEAR: 2015												
ANGLE	0	2	1	3	0	0	2	1	2	1	3	0
REAR-END	0	0	1	1	0	0	0	0	1	0	1	0
TURNING MOVEMENTS	0	1	0	1	0	0	0	1	1	0	1	0
2015 TOTAL	0	3	2	5	0	0	2	2	4	1	5	0
YEAR: 2014												
ANGLE	0	3	1	4	0	0	3	1	4	0	4	0
REAR-END	0	1	0	1	0	0	0	0	1	0	1	0
TURNING MOVEMENTS	0	1	0	1	0	0	1	0	1	0	1	0
2014 TOTAL	0	5	1	6	0	0	4	1	6	0	6	0
FINAL TOTAL	0	16	9	25	0	0	15	8	20	5	25	0

Disclaimers: Effective 2016, collection of "Property Damage Only" (PDO) crash data elements was reduced for vehicles and participants. Age, Gender, License, Error and other elements are no longer available for PDO crash reporting. Please keep this in mind when comparing 2016 PDO crash data to prior years.

A higher number of crashes may be reported as of 2011 compared to prior years. This does not necessarily reflect an increase in annual crashes. The higher numbers may result from a change to an internal departmental process that allows the Crash Analysis and Reporting Unit to add previously unavailable, non-fatal crash reports to the annual data file. Please be aware of this change when comparing pre-2011 crash statistics. For all disclaimers, see https://www.oregon.gov/ODOT/Data/documents/Crash_Data_Disclaimers.pdf.

CDS380 12/9/2020

OREGON DEPARTMENT OF TRANSPORTATION - POLICY, DATA AND ANALYSIS DIVISION
TRANSPORTATION DATA SECTION - CRASH ANALYSIS AND REPORTING UNIT
COUNTY ROAD CRASH LISTING

CLACKAMAS COUNTY

Intersectional Crashes at SE Kelso Rd & SE Orient Dr
January 1, 2014 through December 31, 2018

SER#	INVEST UNLOC?	E L M D C J	H R L K	DATE DAY/TIME	MILEPNT DIST FROM INTERSECT	COUNTY ROADS		RD CHAR DIRECT LOCTN	INT-TYP (MEDIAN) LEGS (#LANES)	INT-REL TRAF-CONTL	OFF-RD RNDBT DRVWY	WTHR SURF LIGHT SVRTY	CRASH_TYP COLL TYP	SPL USE TRLR QTY V#	MOVE FROM TO	PRTC INJ P#	A S G E SVRTY E X
						FIRST STREET	SECOND STREET										
04136	N N N	N	N	10/4/2017	3.38	SE KELSO RD-OLD 23006	SE KELSO RD-OLD 23006	INTER W	CROSS N	STOP SIGN	N	CLR	O-1STOP	01 NONE	9 BACK		
NONE		N	N	Wed 6P				06	0		N	DRY	BACK	N/A	E W	01	DRVR NONE 00 U
No	45 25	6.17	-122	18 30.46							N	DLIT	PDO	PSNGR CAR			
05410	N N N	N	N	12/18/2017	3.38	SE KELSO RD-OLD 23006	SE KELSO RD-OLD 23006	INTER CN	CROSS N	STOP SIGN	N	RAIN	ANGL-OTH	01 NONE	0 STRGHT		
NONE		N	N	Mon 4P				02	0		N	WET	TURN	PRVTE	S N		
No	45 25	6.17	-122	18 30.46							N	DUSK	INJ	PSNGR CAR		01	DRVR NONE 20 F
05258	N N N	N	N	12/11/2017	3.38	SE KELSO RD-OLD 23006	SE KELSO RD-OLD 23006	INTER CN	CROSS N	STOP SIGN	N	CLR	ANGL-OTH	01 NONE	0 STRGHT		
NONE		N	N	Mon 11A				03	0		N	DRY	ANGL	PRVTE	N S		
No	45 25	6.17	-122	18 30.46							N	DAY	INJ	PSNGR CAR		01	DRVR INJB 33 F
01954	N N N	N	N	5/22/2014	0.74	SE ORIENT DR	SE ORIENT DR	INTER UN	CROSS N	STOP SIGN	N	UNK	S-1STOP	01 NONE	0 STRGHT		
NONE		N	N	Thu 7A				06	0		N	UNK	REAR	PRVTE	UN UN		
No	45 25	6.17	-122	18 30.46							N	DAY	INJ	PSNGR CAR		01	DRVR NONE 00 F
05091	N N N	N	N	12/1/2015	0.74	SE ORIENT DR	SE ORIENT DR	INTER SE	CROSS N	STOP SIGN	N	UNK	S-1STOP	01 NONE	0 STRGHT		
NONE		N	N	Tue 9A				06	0		N	UNK	REAR	PRVTE	SE NW		
No	45 25	6.17	-122	18 30.46							N	DAY	PDO	PSNGR CAR		01	DRVR NONE 38 M

CDS380 12/9/2020

OREGON DEPARTMENT OF TRANSPORTATION - POLICY, DATA AND ANALYSIS DIVISION
TRANSPORTATION DATA SECTION - CRASH ANALYSIS AND REPORTING UNIT
COUNTY ROAD CRASH LISTING

CLACKAMAS COUNTY
D
R

Intersectional Crashes at SE Kelso Rd & SE Orient Dr
January 1, 2014 through December 31, 2018

SER#	INVEST UNLOC?	P E A / D C J	G M H R L K	S W	C O	DATE	MILEPNT DIST FROM INTERSECT	0.74	SE ORIENT DR	RD CHAR DIRECT LOCTN	INT-TYP (MEDIAN) LEGS (#LANES)	INT-REL TRAF-CONTL	OFF-RD WTHR RNDBT DRYWY	WTHR SURF LIGHT SVRTY	CRASH_TYP COLL SVRTY	MOVE FROM TO	SPL USE TRLR QTY V#	PRTC INJ P#	A S G E SVRTY E X
02786	N N N	N	N	N	N	6/21/2016	0.74	0.74	SE ORIENT DR	INTER NW 06	CROSS N STOP SIGN	N STOP SIGN	N CLR N DRY N DAY	S-1STOP REAR INJ	STRGHT NW SE	NONE 0 PSNGR CAR	01	DRVR NONE 18 M	03 38 M
00613	N N N	N	N	N	N	2/15/2017	0.74	0.74	SE ORIENT DR	INTER NW 06	CROSS N STOP SIGN	N STOP SIGN	N RAIN N WET N DAY	S-1STOP REAR INJ	STRGHT NW SE	NONE 0 PSNGR CAR	01	DRVR NONE 16 M	02 03
03693	N N N	N	N	N	N	9/20/2014	0.74	0.74	SE ORIENT DR	INTER CN 01	CROSS N STOP SIGN	N STOP SIGN	N CLR N DRY N DAY	ANGL-OTH ANGL INJ	STRGHT NW SE	NONE 0 PSNGR CAR	01	DRVR NONE 77 F	02 03 04

Intersectional Crashes at Kelso Rd & Bluff Rd
January 1, 2014 through December 31, 2018

COLLISION TYPE	FATAL CRASHES	NON- FATAL CRASHES	PROPERTY DAMAGE ONLY	TOTAL CRASHES	TOTAL PEOPLE KILLED	TOTAL PEOPLE INJURED	TRUCKS	DRY SURF	WET SURF	DAY	DARK	INTER- SECTION RELATED	INTER- SECTION OFF- ROAD
TURNING MOVEMENTS	0	1	0	1	0	2	0	1	0	0	1	1	0
2016 TOTAL	0	1	0	1	0	2	0	1	0	0	1	1	0
YEAR: 2014													
FIXED / OTHER OBJECT	0	1	0	1	0	1	0	0	1	1	0	1	1
REAR-END	0	0	1	1	0	0	0	0	1	0	1	1	0
2014 TOTAL	0	1	1	2	0	1	0	0	2	1	1	2	1
FINAL TOTAL	0	2	1	3	0	3	0	1	2	1	2	3	1

Disclaimers: Effective 2016, collection of "Property Damage Only" (PDO) crash data elements was reduced for vehicles and participants. Age, Gender, License, Error and other elements are no longer available for PDO crash reporting. Please keep this in mind when comparing 2016 PDO crash data to prior years.

A higher number of crashes may be reported as of 2011 compared to prior years. This does not necessarily reflect an increase in annual crashes. The higher numbers may result from a change to an internal departmental process that allows the Crash Analysis and Reporting Unit to add previously unavailable, non-fatal crash reports to the annual data file. Please be aware of this change when comparing pre-2011 crash statistics. For all disclaimers, see https://www.oregon.gov/ODO/T/DO/T/DO/T/Data/documents/Crash_Data_Disclaimers.pdf.

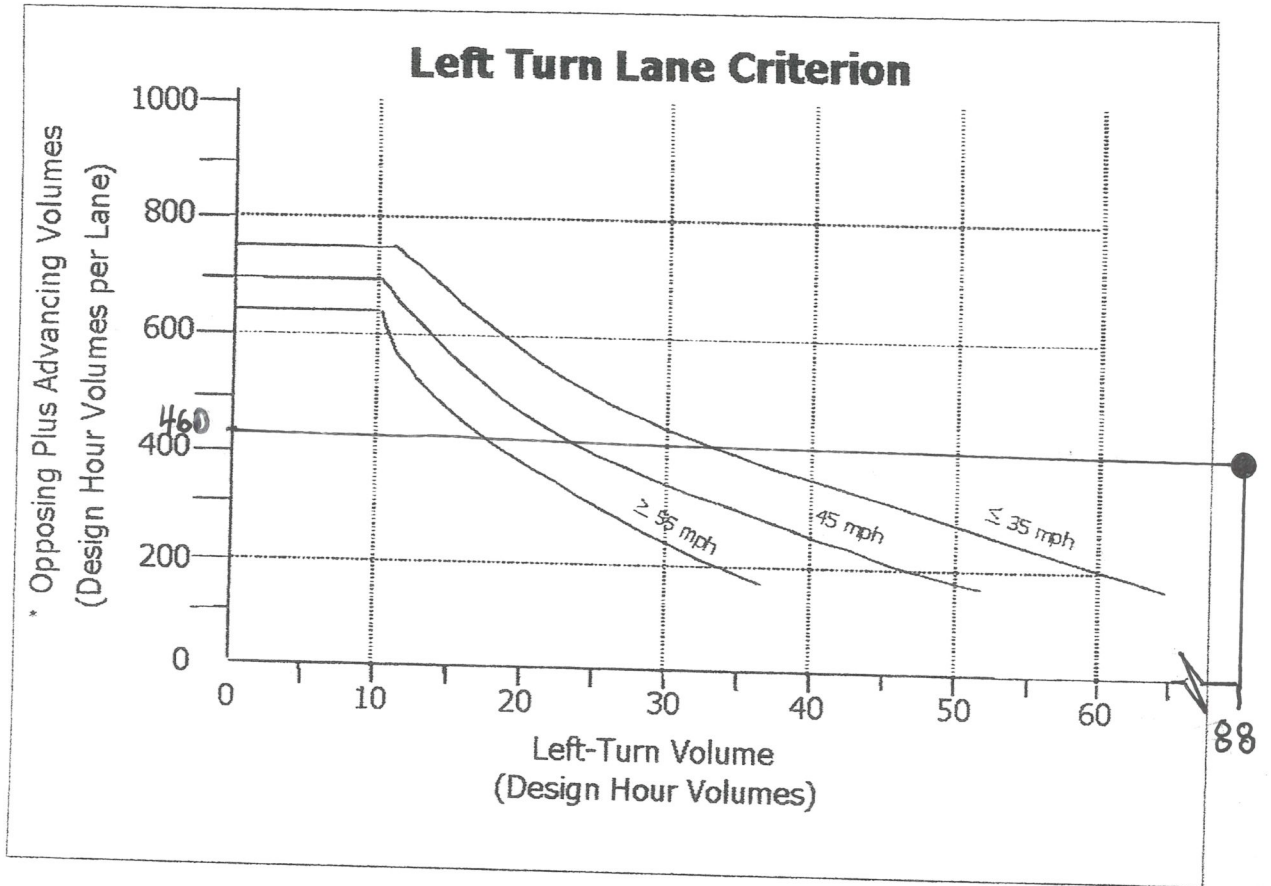
OREGON DEPARTMENT OF TRANSPORTATION - POLICY, DATA AND ANALYSIS DIVISION
 TRANSPORTATION DATA SECTION - CRASH ANALYSIS AND REPORTING UNIT
 URBAN NON-SYSTEM CRASH LISTING

CITY OF SANDY, CLACKAMAS COUNTY

Intersectional Crashes at Kelso Rd & Bluff Rd
 January 1, 2014 through December 31, 2018

SER#	INVEST UNLOC?	P E A / C O	D A Y / T I M E	F C	CITY STREET	RD CHAR	INT-TYP	INT-REL	OFF-RD	WTHR	CRASH	SPCL	MOVE	PRTC	INJ	A	S	
NO	45	25	5.93	-122	16	23.21	1	0	0	0	0	0	0	01	DRVR	INJC	29	M
NO	45	25	5.93	-122	16	23.21	1	0	0	0	0	0	0	01	DRVR	INJC	29	M
01794	Y	N	N	N	05/10/2014	16	BLUFF RD	16	0	0	0	0	0	01	DRVR	INJC	29	M
CITY	N	N	N	N	Sat	12P	0	0	0	0	0	0	0	01	DRVR	INJC	29	M
No	45	25	5.93	-122	16	23.21	1	0	0	0	0	0	0	01	DRVR	INJC	29	M
04081	N	N	N	N	10/14/2014	16	BLUFF RD	16	0	0	0	0	0	01	DRVR	INJC	29	M
NONE	N	N	N	N	Tue	11P	0	0	0	0	0	0	0	01	DRVR	INJC	29	M
No	45	25	5.93	-122	16	23.21	1	0	0	0	0	0	0	01	DRVR	INJC	29	M
04061	N	N	N	N	09/05/2016	16	BLUFF RD	16	0	0	0	0	0	01	DRVR	INJC	29	M
NONE	N	N	N	N	Mon	8P	0	0	0	0	0	0	0	01	DRVR	INJC	29	M
No	45	25	5.93	-122	16	23.21	1	0	0	0	0	0	0	01	DRVR	INJC	29	M

APPENDIX D
LEFT TURN LANE CRITERION



SE ORIENT DRIVE & SE KELSO ROAD
 EXISTING CONDITIONS
 PM PEAK HOUR, SB TRAFFIC

LEFT TURN LANE JUSTIFIED

APPENDIX E
LEVEL OF SERVICE COMPUTER PRINTOUTS

ALL-WAY STOP CONTROL ANALYSIS

General Information		Site Information	
Analyst	DSK	Intersection	Kelso Road & Orient Dr.
Agency/Co.		Jurisdiction	City of Sandy
Date Performed	3/2/2021	Analysis Year	2021
Analysis Time Period	AM Peak Hour		

Project ID Existing	
East/West Street: Kelso Road	North/South Street: Orient Dr.

Volume Adjustments and Site Characteristics						
Approach	Eastbound			Westbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	6	58	10	31	158	90
%Thrus Left Lane						
Approach	Northbound			Southbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	6	104	32	69	82	7
%Thrus Left Lane						

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.90		0.90		0.90		0.90	
Flow Rate (veh/h)	81		309		156		174	
% Heavy Vehicles	1		15		3		41	
No. Lanes	1		1		1		1	
Geometry Group	1		1		1		1	
Duration, T	0.25							

Saturation Headway Adjustment Worksheet								
Prop. Left-Turns	0.1		0.1		0.0		0.4	
Prop. Right-Turns	0.1		0.3		0.2		0.0	
Prop. Heavy Vehicle	0.0		0.1		0.0		0.4	
hLT-adj	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
hadj, computed	-0.0		0.1		-0.1		0.8	

Departure Headway and Service Time								
hd, initial value (s)	3.20		3.20		3.20		3.20	
x, initial	0.07		0.27		0.14		0.15	
hd, final value (s)	5.29		5.07		5.19		5.96	
x, final value	0.12		0.43		0.22		0.29	
Move-up time, m (s)	2.0		2.0		2.0		2.0	
Service Time, t _s (s)	3.3		3.1		3.2		4.0	

Capacity and Level of Service								
	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Capacity (veh/h)	331		559		406		424	
Delay (s/veh)	9.00		11.91		9.68		11.35	
LOS	A		B		A		B	
Approach: Delay (s/veh)	9.00		11.91		9.68		11.35	
LOS	A		B		A		B	
Intersection Delay (s/veh)	10.96							
Intersection LOS	B							

ALL-WAY STOP CONTROL ANALYSIS

General Information		Site Information	
Analyst	DSK	Intersection	Kelso Road & Orient Dr.
Agency/Co.	Kelly Engineering	Jurisdiction	City of Sandy
Date Performed	3/2/2021	Analysis Year	2023
Analysis Time Period	AM Peak Hour		

Project ID Year 2023 w/o Project

East/West Street: Kelso Road

North/South Street: Orient Dr.

Volume Adjustments and Site Characteristics

Approach	Eastbound			Westbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	6	63	11	34	170	96
%Thrus Left Lane						

Approach	Northbound			Southbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	6	109	34	72	86	7
%Thrus Left Lane						

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.90		0.90		0.90		0.90	
Flow Rate (veh/h)	88		331		164		182	
% Heavy Vehicles	1		15		3		41	
No. Lanes	1		1		1		1	
Geometry Group	1		1		1		1	
Duration, T	0.25							

Saturation Headway Adjustment Worksheet

Prop. Left-Turns	0.1		0.1		0.0		0.4	
Prop. Right-Turns	0.1		0.3		0.2		0.0	
Prop. Heavy Vehicle	0.0		0.1		0.0		0.4	
hLT-adj	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
hadj, computed	-0.1		0.1		-0.1		0.8	

Departure Headway and Service Time

hd, initial value (s)	3.20		3.20		3.20		3.20	
x, initial	0.08		0.29		0.15		0.16	
hd, final value (s)	5.40		5.15		5.31		6.08	
x, final value	0.13		0.47		0.24		0.31	
Move-up time, m (s)	2.0		2.0		2.0		2.0	
Service Time, t _s (s)	3.4		3.2		3.3		4.1	

Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Capacity (veh/h)	338		581		414		432	
Delay (s/veh)	9.23		12.70		9.99		11.76	
LOS	A		B		A		B	
Approach: Delay (s/veh)	9.23		12.70		9.99		11.76	
LOS	A		B		A		B	
Intersection Delay (s/veh)	11.50							
Intersection LOS	B							

ALL-WAY STOP CONTROL ANALYSIS

General Information		Site Information	
Analyst	DSK	Intersection	Kelso Road & Orient Dr.
Agency/Co.	Kelly Engineering	Jurisdiction	City of Sandy
Date Performed	3/2/2021	Analysis Year	2023
Analysis Time Period	AM Peak Hour		

Project ID Year 2023 with Project

East/West Street: Kelso Road

North/South Street: Orient Dr.

Volume Adjustments and Site Characteristics

Approach	Eastbound			Westbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	6	65	11	35	177	101
%Thrus Left Lane						

Approach	Northbound			Southbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	6	109	34	74	86	7
%Thrus Left Lane						

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.90		0.90		0.90		0.90	
Flow Rate (veh/h)	90		346		164		184	
% Heavy Vehicles	1		15		3		41	
No. Lanes	1		1		1		1	
Geometry Group	1		1		1		1	
Duration, T	0.25							

Saturation Headway Adjustment Worksheet

Prop. Left-Turns	0.1		0.1		0.0		0.4	
Prop. Right-Turns	0.1		0.3		0.2		0.0	
Prop. Heavy Vehicle	0.0		0.1		0.0		0.4	
hLT-adj	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
hadj, computed	-0.0		0.1		-0.1		0.8	

Departure Headway and Service Time

hd, initial value (s)	3.20		3.20		3.20		3.20	
x, initial	0.08		0.31		0.15		0.16	
hd, final value (s)	5.45		5.17		5.37		6.14	
x, final value	0.14		0.50		0.24		0.31	
Move-up time, m (s)	2.0		2.0		2.0		2.0	
Service Time, t _s (s)	3.5		3.2		3.4		4.1	

Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Capacity (veh/h)	340		596		414		434	
Delay (s/veh)	9.31		13.17		10.10		11.92	
LOS	A		B		B		B	
Approach: Delay (s/veh)	9.31		13.17		10.10		11.92	
LOS	A		B		B		B	
Intersection Delay (s/veh)	11.79							
Intersection LOS	B							

ALL-WAY STOP CONTROL ANALYSIS

General Information		Site Information	
Analyst	DSK	Intersection	Kelso Road & Orient Dr.
Agency/Co.	Kelly Engineering	Jurisdiction	City of Sandy
Date Performed	3/2/2021	Analysis Year	2021
Analysis Time Period	PM Peak Hour		

Project ID Existing	
East/West Street: Kelso Road	North/South Street: Orient Dr.

Volume Adjustments and Site Characteristics						
Approach	Eastbound			Westbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	12	101	22	32	62	58
%Thrus Left Lane						
Approach	Northbound			Southbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	6	142	52	88	167	11
%Thrus Left Lane						

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.91		0.91		0.91		0.91	
Flow Rate (veh/h)	147		166		219		291	
% Heavy Vehicles	2		4		1		2	
No. Lanes	1		1		1		1	
Geometry Group	1		1		1		1	
Duration, T	0.25							

Saturation Headway Adjustment Worksheet								
Prop. Left-Turns	0.1		0.2		0.0		0.3	
Prop. Right-Turns	0.2		0.4		0.3		0.0	
Prop. Heavy Vehicle	0.0		0.0		0.0		0.0	
hLT-adj	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
hadj, computed	-0.0		-0.1		-0.1		0.1	

Departure Headway and Service Time								
hd, initial value (s)	3.20		3.20		3.20		3.20	
x, initial	0.13		0.15		0.19		0.26	
hd, final value (s)	5.50		5.40		5.10		5.20	
x, final value	0.22		0.25		0.31		0.42	
Move-up time, m (s)	2.0		2.0		2.0		2.0	
Service Time, t _g (s)	3.5		3.4		3.1		3.2	

Capacity and Level of Service								
	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Capacity (veh/h)	397		416		469		541	
Delay (s/veh)	10.09		10.18		10.39		11.90	
LOS	B		B		B		B	
Approach: Delay (s/veh)	10.09		10.18		10.39		11.90	
LOS	B		B		B		B	
Intersection Delay (s/veh)	10.83							
Intersection LOS	B							

ALL-WAY STOP CONTROL ANALYSIS

General Information		Site Information	
Analyst	DSK	Intersection	Kelso Road & Orient Dr.
Agency/Co.	Kelly Engineering	Jurisdiction	City of Sandy
Date Performed	3/2/2021	Analysis Year	2023
Analysis Time Period	PM Peak Hour		

Project ID Year 2023 w/o Project

East/West Street: Kelso Road

North/South Street: Orient Dr.

Volume Adjustments and Site Characteristics

Approach	Eastbound			Westbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	13	110	23	35	66	62
%Thrus Left Lane						

Approach	Northbound			Southbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	6	147	56	93	175	12
%Thrus Left Lane						

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.91		0.91		0.91		0.91	
Flow Rate (veh/h)	159		178		228		307	
% Heavy Vehicles	2		4		1		2	
No. Lanes	1		1		1		1	
Geometry Group	1		1		1		1	
Duration, T	0.25							

Saturation Headway Adjustment Worksheet

Prop. Left-Turns	0.1		0.2		0.0		0.3	
Prop. Right-Turns	0.2		0.4		0.3		0.0	
Prop. Heavy Vehicle	0.0		0.0		0.0		0.0	
hLT-adj	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
hadj, computed	-0.0		-0.1		-0.1		0.1	

Departure Headway and Service Time

hd, initial value (s)	3.20		3.20		3.20		3.20	
x, initial	0.14		0.16		0.20		0.27	
hd, final value (s)	5.64		5.53		5.24		5.32	
x, final value	0.25		0.27		0.33		0.45	
Move-up time, m (s)	2.0		2.0		2.0		2.0	
Service Time, t _s (s)	3.6		3.5		3.2		3.3	

Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Capacity (veh/h)	409		428		478		557	
Delay (s/veh)	10.50		10.60		10.82		12.65	
LOS	B		B		B		B	
Approach: Delay (s/veh)	10.50		10.60		10.82		12.65	
LOS	B		B		B		B	
Intersection Delay (s/veh)	11.36							
Intersection LOS	B							

ALL-WAY STOP CONTROL ANALYSIS

General Information		Site Information	
Analyst	DSK	Intersection	Kelso Road & Orient Dr.
Agency/Co.	Kelly Engineering	Jurisdiction	City of Sandy
Date Performed	3/2/2021	Analysis Year	2023
Analysis Time Period	PM Peak Hour		

Project ID Year 2023 with Project

East/West Street: Kelso Road

North/South Street: Orient Dr.

Volume Adjustments and Site Characteristics

Approach	Eastbound			Westbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	13	118	23	36	71	65
%Thrus Left Lane						

Approach	Northbound			Southbound		
	L	T	R	L	T	R
Movement						
Volume (veh/h)	6	147	58	98	175	12
%Thrus Left Lane						

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Configuration	LTR		LTR		LTR		LTR	
PHF	0.91		0.91		0.91		0.91	
Flow Rate (veh/h)	168		188		230		312	
% Heavy Vehicles	2		4		1		2	
No. Lanes	1		1		1		1	
Geometry Group	1		1		1		1	
Duration, T	0.25							

Saturation Headway Adjustment Worksheet

Prop. Left-Turns	0.1		0.2		0.0		0.3	
Prop. Right-Turns	0.1		0.4		0.3		0.0	
Prop. Heavy Vehicle	0.0		0.0		0.0		0.0	
hLT-adj	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
hRT-adj	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
hHV-adj	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
hadj, computed	-0.0		-0.1		-0.1		0.1	

Departure Headway and Service Time

hd, initial value (s)	3.20		3.20		3.20		3.20	
x, initial	0.15		0.17		0.20		0.28	
hd, final value (s)	5.71		5.60		5.33		5.40	
x, final value	0.27		0.29		0.34		0.47	
Move-up time, m (s)	2.0		2.0		2.0		2.0	
Service Time, t _s (s)	3.7		3.6		3.3		3.4	

Capacity and Level of Service

	Eastbound		Westbound		Northbound		Southbound	
	L1	L2	L1	L2	L1	L2	L1	L2
Capacity (veh/h)	418		438		480		562	
Delay (s/veh)	10.78		10.90		11.05		13.07	
LOS	B		B		B		B	
Approach: Delay (s/veh)	10.78		10.90		11.05		13.07	
LOS	B		B		B		B	
Intersection Delay (s/veh)	11.67							
Intersection LOS	B							

TWO-WAY STOP CONTROL SUMMARY

General Information			Site Information					
Analyst	DSK		Intersection	Kelso Road & Bluff Road				
Agency/Co.	Kelly Engineering		Jurisdiction	City of Sandy				
Date Performed	3/2/2021		Analysis Year	2021				
Analysis Time Period	AM Peak Hour							
Project Description Existing								
East/West Street: Kelso Road			North/South Street: Bluff Road					
Intersection Orientation: North-South			Study Period (hrs): 0.25					
Vehicle Volumes and Adjustments								
Major Street	Northbound			Southbound				
Movement	1	2	3	4	5	6		
	L	T	R	L	T	R		
Volume (veh/h)	32	132	1	0	134	20		
Peak-Hour Factor, PHF	0.67	0.67	0.67	0.67	0.67	0.67		
Hourly Flow Rate, HFR (veh/h)	47	197	1	0	199	29		
Percent Heavy Vehicles	3	--	--	3	--	--		
Median Type	Undivided							
RT Channelized			0			0		
Lanes	0	1	0	0	1	0		
Configuration	LTR			LTR				
Upstream Signal		0			0			
Minor Street	Eastbound			Westbound				
Movement	7	8	9	10	11	12		
	L	T	R	L	T	R		
Volume (veh/h)	32	1	36	2	1	0		
Peak-Hour Factor, PHF	0.67	0.67	0.67	0.67	0.67	0.67		
Hourly Flow Rate, HFR (veh/h)	47	1	53	2	1	0		
Percent Heavy Vehicles	3	0	0	0	0	0		
Percent Grade (%)	0			0				
Flared Approach		N			N			
Storage		0			0			
RT Channelized			0			0		
Lanes	0	1	0	0	1	0		
Configuration		LTR			LTR			
Delay, Queue Length, and Level of Service								
Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	47	0		3			101	
C (m) (veh/h)	1334	1369		427			601	
v/c	0.04	0.00		0.01			0.17	
95% queue length	0.11	0.00		0.02			0.60	
Control Delay (s/veh)	7.8	7.6		13.5			12.2	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--		13.5			12.2	
Approach LOS	--	--		B			B	

TWO-WAY STOP CONTROL SUMMARY

General Information			Site Information					
Analyst	DSK		Intersection	Kelso Road & Bluff Road				
Agency/Co.	Kelly Engineering		Jurisdiction	City of Sandy				
Date Performed	3/2/2021		Analysis Year	2023				
Analysis Time Period	AM Peak Hour							
Project Description Year 2023 w/o Project								
East/West Street: Kelso Road			North/South Street: Bluff Road					
Intersection Orientation: North-South			Study Period (hrs): 0.25					
Vehicle Volumes and Adjustments								
Major Street	Northbound			Southbound				
Movement	1	2	3	4	5	6		
	L	T	R	L	T	R		
Volume (veh/h)	34	139	1	0	139	21		
Peak-Hour Factor, PHF	0.67	0.67	0.67	0.67	0.67	0.67		
Hourly Flow Rate, HFR (veh/h)	50	207	1	0	207	31		
Percent Heavy Vehicles	3	--	--	3	--	--		
Median Type	Undivided							
RT Channelized			0			0		
Lanes	0	1	0	0	1	0		
Configuration	LTR			LTR				
Upstream Signal		0			0			
Minor Street	Eastbound			Westbound				
Movement	7	8	9	10	11	12		
	L	T	R	L	T	R		
Volume (veh/h)	36	1	41	2	1	0		
Peak-Hour Factor, PHF	0.67	0.67	0.67	0.67	0.67	0.67		
Hourly Flow Rate, HFR (veh/h)	53	1	61	2	1	0		
Percent Heavy Vehicles	3	0	0	0	0	0		
Percent Grade (%)	0			0				
Flared Approach		N			N			
Storage		0			0			
RT Channelized			0			0		
Lanes	0	1	0	0	1	0		
Configuration		LTR			LTR			
Delay, Queue Length, and Level of Service								
Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	50	0		3			115	
C (m) (veh/h)	1323	1357		405			586	
v/c	0.04	0.00		0.01			0.20	
95% queue length	0.12	0.00		0.02			0.72	
Control Delay (s/veh)	7.8	7.7		14.0			12.6	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--		14.0			12.6	
Approach LOS	--	--		B			B	

TWO-WAY STOP CONTROL SUMMARY

General Information				Site Information			
Analyst	DSK			Intersection	Kelso Road & Bluff Road		
Agency/Co.	Kelly Engineering			Jurisdiction	City of Sandy		
Date Performed	3/2/2021			Analysis Year	2023		
Analysis Time Period	AM Peak Hour						
Project Description Year 2023 with Project							
East/West Street: Kelso Road				North/South Street: Bluff Road			
Intersection Orientation: North-South				Study Period (hrs): 0.25			
Vehicle Volumes and Adjustments							
Major Street	Northbound			Southbound			
Movement	1	2	3	4	5	6	
	L	T	R	L	T	R	
Volume (veh/h)	37	139	1	0	139	22	
Peak-Hour Factor, PHF	0.67	0.67	0.67	0.67	0.67	0.67	
Hourly Flow Rate, HFR (veh/h)	55	207	1	0	207	32	
Percent Heavy Vehicles	3	--	--	3	--	--	
Median Type	Undivided						
RT Channelized			0			0	
Lanes	0	1	0	0	1	0	
Configuration	LTR			LTR			
Upstream Signal		0			0		
Minor Street	Eastbound			Westbound			
Movement	7	8	9	10	11	12	
	L	T	R	L	T	R	
Volume (veh/h)	37	1	51	2	1	0	
Peak-Hour Factor, PHF	0.67	0.67	0.67	0.67	0.67	0.67	
Hourly Flow Rate, HFR (veh/h)	55	1	76	2	1	0	
Percent Heavy Vehicles	3	0	0	0	0	0	
Percent Grade (%)		0			0		
Flared Approach		N			N		
Storage		0			0		
RT Channelized			0			0	
Lanes	0	1	0	0	1	0	
Configuration		LTR			LTR		
Delay, Queue Length, and Level of Service							
Approach	Northbound	Southbound	Westbound			Eastbound	
Movement	1	4	7	8	9	10	11
Lane Configuration	LTR	LTR		LTR			LTR
v (veh/h)	55	0		3			132
C (m) (veh/h)	1322	1357		389			595
v/c	0.04	0.00		0.01			0.22
95% queue length	0.13	0.00		0.02			0.84
Control Delay (s/veh)	7.8	7.7		14.3			12.8
LOS	A	A		B			B
Approach Delay (s/veh)	--	--		14.3			12.8
Approach LOS	--	--		B			B

TWO-WAY STOP CONTROL SUMMARY							
General Information				Site Information			
Analyst	DSK			Intersection	Kelso Road & Bluff Road		
Agency/Co.	Kelly Engineering			Jurisdiction	City of Sandy		
Date Performed	3/2/2021			Analysis Year	2021		
Analysis Time Period	PM Peak Hour						
Project Description Existing							
East/West Street: Kelso Road				North/South Street: Bluff Road			
Intersection Orientation: North-South				Study Period (hrs): 0.25			
Vehicle Volumes and Adjustments							
Major Street	Northbound			Southbound			
Movement	1	2	3	4	5	6	
	L	T	R	L	T	R	
Volume (veh/h)	41	116	5	0	152	10	
Peak-Hour Factor, PHF	0.82	0.82	0.82	0.82	0.82	0.82	
Hourly Flow Rate, HFR (veh/h)	50	141	6	0	185	12	
Percent Heavy Vehicles	1	--	--	1	--	--	
Median Type	Undivided						
RT Channelized			0			0	
Lanes	0	1	0	0	1	0	
Configuration	LTR			LTR			
Upstream Signal		0			0		
Minor Street	Eastbound			Westbound			
Movement	7	8	9	10	11	12	
	L	T	R	L	T	R	
Volume (veh/h)	19	2	87	1	4	0	
Peak-Hour Factor, PHF	0.82	0.82	0.82	0.82	0.82	0.82	
Hourly Flow Rate, HFR (veh/h)	23	2	106	1	4	0	
Percent Heavy Vehicles	0	0	0	0	0	0	
Percent Grade (%)	0			0			
Flared Approach		N			N		
Storage		0			0		
RT Channelized			0			0	
Lanes	0	1	0	0	1	0	
Configuration		LTR			LTR		
Delay, Queue Length, and Level of Service							
Approach	Northbound	Southbound	Westbound			Eastbound	
Movement	1	4	7	8	9	10	11
Lane Configuration	LTR	LTR		LTR			LTR
v (veh/h)	50	0		5			131
C (m) (veh/h)	1382	1441		476			759
v/c	0.04	0.00		0.01			0.17
95% queue length	0.11	0.00		0.03			0.62
Control Delay (s/veh)	7.7	7.5		12.6			10.7
LOS	A	A		B			B
Approach Delay (s/veh)	--	--		12.6			10.7
Approach LOS	--	--		B			B

TWO-WAY STOP CONTROL SUMMARY

General Information				Site Information			
Analyst	DSK			Intersection	Kelso Road & Bluff Road		
Agency/Co.	Kelly Engineering			Jurisdiction	City of Sandy		
Date Performed	3/2/2021			Analysis Year	2023		
Analysis Time Period	PM Peak Hour						
Project Description Year 2023 w/o Project							
East/West Street: Kelso Road				North/South Street: Bluff Road			
Intersection Orientation: North-South				Study Period (hrs): 0.25			

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound			
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume (veh/h)		43	122	5	0	160	11
Peak-Hour Factor, PHF		0.82	0.82	0.82	0.82	0.82	0.82
Hourly Flow Rate, HFR (veh/h)		52	148	6	0	195	13
Percent Heavy Vehicles		1	–	–	1	–	–
Median Type	Undivided						
RT Channelized				0			0
Lanes		0	1	0	0	1	0
Configuration		LTR			LTR		
Upstream Signal			0			0	

Minor Street	Eastbound			Westbound			
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume (veh/h)		13	2	92	1	4	0
Peak-Hour Factor, PHF		0.82	0.82	0.82	0.82	0.82	0.82
Hourly Flow Rate, HFR (veh/h)		15	2	112	1	4	0
Percent Heavy Vehicles		0	0	0	0	0	0
Percent Grade (%)		0			0		
Flared Approach		N			N		
Storage		0			0		
RT Channelized				0			0
Lanes		0	1	0	0	1	0
Configuration		LTR			LTR		

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound			
	Movement	1	4	7	8	9	10	11	12
Lane Configuration		LTR	LTR		LTR			LTR	
v (veh/h)		52	0		5			129	
C (m) (veh/h)		1369	1433		460			772	
v/c		0.04	0.00		0.01			0.17	
95% queue length		0.12	0.00		0.03			0.60	
Control Delay (s/veh)		7.7	7.5		12.9			10.6	
LOS		A	A		B			B	
Approach Delay (s/veh)		--	--		12.9			10.6	
Approach LOS		--	--		B			B	

TWO-WAY STOP CONTROL SUMMARY

General Information				Site Information				
Analyst	DSK			Intersection	Kelso Road & Bluff Road			
Agency/Co.	Kelly Engineering			Jurisdiction	City of Sandy			
Date Performed	3/2/2021			Analysis Year	2023			
Analysis Time Period	PM Peak Hour							
Project Description Year 2023 with Project								
East/West Street: Kelso Road				North/South Street: Bluff Road				
Intersection Orientation: North-South				Study Period (hrs): 0.25				
Vehicle Volumes and Adjustments								
Major Street	Northbound			Southbound				
Movement	1	2	3	4	5	6		
	L	T	R	L	T	R		
Volume (veh/h)	54	122	5	0	160	12		
Peak-Hour Factor, PHF	0.82	0.82	0.82	0.82	0.82	0.82		
Hourly Flow Rate, HFR (veh/h)	65	148	6	0	195	14		
Percent Heavy Vehicles	1	--	--	1	--	--		
Median Type	Undivided							
RT Channelized			0			0		
Lanes	0	1	0	0	1	0		
Configuration	LTR			LTR				
Upstream Signal		0			0			
Minor Street	Eastbound			Westbound				
Movement	7	8	9	10	11	12		
	L	T	R	L	T	R		
Volume (veh/h)	14	2	98	1	4	0		
Peak-Hour Factor, PHF	0.82	0.82	0.82	0.82	0.82	0.82		
Hourly Flow Rate, HFR (veh/h)	17	2	119	1	4	0		
Percent Heavy Vehicles	0	0	0	0	0	0		
Percent Grade (%)	0			0				
Flared Approach		N			N			
Storage		0			0			
RT Channelized			0			0		
Lanes	0	1	0	0	1	0		
Configuration		LTR			LTR			
Delay, Queue Length, and Level of Service								
Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	LTR	LTR		LTR			LTR	
v (veh/h)	65	0		5			138	
C (m) (veh/h)	1368	1433		437			761	
v/c	0.05	0.00		0.01			0.18	
95% queue length	0.15	0.00		0.03			0.66	
Control Delay (s/veh)	7.8	7.5		13.3			10.8	
LOS	A	A		B			B	
Approach Delay (s/veh)	--	--		13.3			10.8	
Approach LOS	--	--		B			B	

TWO-WAY STOP CONTROL SUMMARY								
General Information				Site Information				
Analyst	DSK			Intersection	Kelso Road & site access			
Agency/Co.	Kelly Engineering			Jurisdiction	City of Sandy			
Date Performed	3/2/2021			Analysis Year	2023			
Analysis Time Period	AM Peak Hour							
Project Description Year 2023 with Project								
East/West Street: Kelso Road				North/South Street: site access				
Intersection Orientation: East-West				Study Period (hrs): 0.25				
Vehicle Volumes and Adjustments								
Major Street	Eastbound			Westbound				
Movement	1	2	3	4	5	6		
	L	T	R	L	T	R		
Volume (veh/h)		159	4	4	271			
Peak-Hour Factor, PHF	0.82	0.80	0.80	0.80	0.80	0.82		
Hourly Flow Rate, HFR (veh/h)	0	198	4	4	338	0		
Percent Heavy Vehicles	0	--	--	0	--	--		
Median Type	Undivided							
RT Channelized			0				0	
Lanes	0	1	0	0	1	0		
Configuration			TR	LT				
Upstream Signal		0			0			
Minor Street	Northbound			Southbound				
Movement	7	8	9	10	11	12		
	L	T	R	L	T	R		
Volume (veh/h)	13		11					
Peak-Hour Factor, PHF	0.80	0.82	0.80	0.82	0.82	0.82		
Hourly Flow Rate, HFR (veh/h)	16	0	13	0	0	0		
Percent Heavy Vehicles	0	0	0	1	0	0		
Percent Grade (%)		0			0			
Flared Approach		N			N			
Storage		0			0			
RT Channelized			0				0	
Lanes	0	0	0	0	0	0		
Configuration		LR						
Delay, Queue Length, and Level of Service								
Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		4		29				
C (m) (veh/h)		1382		613				
v/c		0.00		0.05				
95% queue length		0.01		0.15				
Control Delay (s/veh)		7.6		11.2				
LOS		A		B				
Approach Delay (s/veh)	--	--	11.2					
Approach LOS	--	--	B					

TWO-WAY STOP CONTROL SUMMARY

General Information				Site Information				
Analyst	DSK			Intersection	Kelso Road & site access			
Agency/Co.	Kelly Engineering			Jurisdiction	City of Sandy			
Date Performed	3/2/2021			Analysis Year	2023			
Analysis Time Period	PM Peak Hour							
Project Description Year 2023 with Project								
East/West Street: Kelso Road				North/South Street: site access				
Intersection Orientation: East-West				Study Period (hrs): 0.25				
Vehicle Volumes and Adjustments								
Major Street	Eastbound			Westbound				
Movement	1	2	3	4	5	6		
	L	T	R	L	T	R		
Volume (veh/h)		266	15	12	108			
Peak-Hour Factor, PHF	0.82	0.80	0.80	0.80	0.80	0.82		
Hourly Flow Rate, HFR (veh/h)	0	332	18	14	134	0		
Percent Heavy Vehicles	0	--	--	0	--	--		
Median Type	Undivided							
RT Channelized			0			0		
Lanes	0	1	0	0	1	0		
Configuration			TR	LT				
Upstream Signal		0			0			
Minor Street	Northbound			Southbound				
Movement	7	8	9	10	11	12		
	L	T	R	L	T	R		
Volume (veh/h)	9		7					
Peak-Hour Factor, PHF	0.80	0.82	0.80	0.82	0.82	0.82		
Hourly Flow Rate, HFR (veh/h)	11	0	8	0	0	0		
Percent Heavy Vehicles	0	0	0	1	0	0		
Percent Grade (%)		0			0			
Flared Approach		N			N			
Storage		0			0			
RT Channelized			0			0		
Lanes	0	0	0	0	0	0		
Configuration		LR						
Delay, Queue Length, and Level of Service								
Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		LT		LR				
v (veh/h)		14		19				
C (m) (veh/h)		1220		589				
v/c		0.01		0.03				
95% queue length		0.03		0.10				
Control Delay (s/veh)		8.0		11.3				
LOS		A		B				
Approach Delay (s/veh)	--	--	11.3					
Approach LOS	--	--	B					

APPENDIX F
REFERENCES

References

1. Trip Generation Manual, 10th Edition, 2017, Institute of Transportation Engineers.
2. Highway Capacity Manual, 2000 and 2010, Transportation Research Board, National Research Council.
3. Discussions with staff from Clackamas County.
4. Discussions with staff from the City of Sandy.
5. The City of Sandy, Pre-Application Conference Notes, Sandy Woods Phase 2, March 11, 2020.
6. Clackamas County Memorandum, Department of Transportation and Development, March 11, 2020.
7. Sandy Bluff Annex 6 Subdivision & Future Development, Transportation Impact Study, Lancaster Engineering, 321 SW 4th Ave., Suite 400, Portland, OR 97204.