KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING / PLANNING
610 SW Alder Street, Suite 700, Portland, OR 97205 P 503.228.5230 F 503.273.8169

DRAFT TECHNICAL MEMORANDUM

NE Jackson School Road - NE Grant Street to NW Evergreen Road

Hillsboro, Oregon

Traffic Operations & Safety Analysis

Project #:19551

Date: November 4, 2016

To: Scott Dreher & Christina Fera-Thomas, City of Hillsboro
From: Joey Bansen, P.E., and Anthony Yi, P.E.
Cc: Ken Ackerman, OTAK

INTRODUCTION

PROJECT BACKGROUND

The City of Hillsboro has commissioned the OTAK project team to develop improvement plans for a 1.5 mile segment of NE Jackson School Road between NE Grant Street and NW Evergreen Road through a mostly residential area of the City. Figure 1 illustrates the location of NE Jackson School Road within the City of Hillsboro. The study segment is a north-south urban collector consisting primarily of a two-lane roadway with paved shoulders, open ditch drainage, intermittent sidewalks, and no bike lanes. The City's *Transportation System Plan Update* (Reference 1) calls for NE Jackson School Road to be widened to three lanes with bicycle and pedestrian facilities, storm drainage, and street lighting. This memorandum documents the existing and future traffic conditions and will help guide the project team towards determining a preferred improvement plan.

SCOPE OF THE TRANSPORTATION ANALYSIS

The scope of this project includes the NE Jackson School Road corridor between NE Grant Street and NW Evergreen Road. The study intersections and overall study area for this project were selected based on a review of the local transportation system and direction provided by the City of Hillsboro. Operational analyses were performed at the following study intersections:

1. NE Jackson School Road/NW Evergreen Road
2. NE Jackson School Road/NE Rogahn Street
3. NE Jackson School Road/NE Estate Drive

4. NE Jackson School Road/NE Harewood Street
5. NE Jackson School Road/NE Sunrise Lane
6. NE Jackson School Road/NE Arrington Road
7. NE Jackson School Road/NE Darnielle Drive

This transportation analysis addresses specific capacity and safety needs along the corridor, and provides recommendations to be carried forward in the development of corridor design alternatives. This technical memorandum includes the following:

- Existing traffic volumes, geometric conditions, traffic conditions, and crash history;
- Expected year 2035 future traffic volumes based on Portland Metro's travel demand model;
- Evaluation of intersection and/or segment improvements based on the anticipated year 2035 volumes;
- Queuing analysis for the study intersections during weekday AM and PM peak hours; and
- Recommendations for intersection and corridor improvements to inform the design process.

ANALYSIS METHODOLOGY

The intersection analyses described in this memorandum were performed in accordance with the procedures stated in the *2000 Highway Capacity Manual* (HCM) (Reference 2). Per City of Hillsboro requirements, peak-60 minute and peak-15 minute flow rates were evaluated and presented within this document. The queuing analysis reflects results using the peak-15 minute flow rates in order to provide queue storage to accommodate a reasonable worst case scenario.

The operational analyses were performed using the *Synchro 7* traffic analysis software. *Synchro* is a software package that analyzes individual signalized and unsignalized intersections; it also enables modeling and optimizing traffic signal timings along a corridor. Synchro implements the methods outlined in the *2000 HCM*.

Site Vicinity Map
Hillsboro, Oregon

Figure
1

Intersection Performance Measures

A number of performance measures are used to gauge the overall quality of the travel experience through an intersection or roadway segment as it is perceived by the traveler. A brief description of each performance measure is provided below:

- *Level of service* (LOS) has been the most commonly used performance measure. LOS uses an "A" to "F" ranking based on the average control delay experienced by motorists. LOS "A" conditions have very low vehicle delay times (10 seconds or less), while LOS "F" conditions have high delay times (over 80 seconds per vehicle at a signalized intersection and over 50 seconds at an unsignalized intersection) that are considered unacceptable to most drivers. *A more detailed description of the LOS concept is presented in Attachment "A."* The attachment also indicates how LOS is measured.
- *Volume-to-capacity ratio* (V/C) compares the volume of traffic to the theoretical capacity of the facility to accommodate traffic. A V/C ratio of 1.0 indicates an intersection is operating at capacity. A V/C ratio over 1.0 indicates the intersection's capacity is exceeded, meaning that a vehicle may have to wait more than one signal cycle length at a signalized intersection before moving through the intersection.

While overall intersection performance is calculated for signalized intersections, performance measures are only calculated for the minor approaches and the major street left-turn movements at two-way stop-controlled intersections. No delay is assumed on the major street through movements; levels of service and volume-to-capacity ratios are only calculated for each minor street lane.

The NE Jackson School Road/NW Evergreen Road intersection is located on a Washington County facility and is subject to Washington County operating standards:

- **Washington County standards allow a maximum V/C ratio of 0.90 during peak hours.**

All of the other study intersections are located on City of Hillsboro facilities and are subject to City of Hillsboro operating standards:

- Signalized Intersections:
  - **The peak hour Volume-to-Capacity (V/C) ratio for each lane group shall be no greater than 0.99.**
  - **Peak hour intersection control delay shall be maintained at 80 seconds per vehicle or less (LOS E or better), using a signal cycle length not to exceed 120 seconds.**
- Unsignalized Intersections:
  - **Peak hour control delay by approach lane group shall be maintained at 50 seconds per vehicle or less (LOS E or better).**
  - **Peak hour V/C ratio for each lane group shall be no greater than 0.99.**

EXISTING CONDITIONS

The existing conditions analysis identifies the current traffic operations, traffic control devices, and geometric characteristics of the transportation facilities within the study area. Specifically, this section contains the existing corridor/intersection lane configurations, traffic control devices, pedestrian and bicycle facilities, transit service, geometric features, and adjacent land uses.

ROADWAY FACILITIES

NE Jackson School Road is currently a two-lane collector roadway (one travel lane in each direction) between NE Grant Street and NW Evergreen Road. Table 1 summarizes the characteristics of the existing transportation facilities in the project vicinity.

Table 1: Existing Transportation Roadway Facilities and Roadway Designations

Roadway	Classification	Cross-Section	Posted Speed	Sidewalks	Bicycle Lanes	On-Street Parking
NE Jackson School Road	Collector	2 Lanes	35 mph (20 mph during school hours)	Partial	No	No
NW Evergreen Road	Arterial	3 Lanes	45 mph	Partial	Yes	No
NE Rogahn Street	Neighborhood Route	2 Lanes	25 mph	Yes	No	Yes
NE Estate Drive	Neighborhood Route	2 Lanes	25 mph (20 mph during school hours)	Yes	No	Yes
NE Harewood Street	Collector	2 Lanes	25 mph	Yes	Yes	No
NE Sunrise Lane	Collector	2 Lanes	25 mph (20 mph during school hours)	No	No	No
NE Arrington Street	Neighborhood Route	2 Lanes	25 mph	No	No	Yes
NE Darnielle Drive	Local Street	2 Lanes	25 mph	No	No	Yes
NE Grant Street	Collector	2 Lanes	25 mph	Yes	No	Yes

[1]Classifications are based on the City of Hillsboro *Transportation System Plan Update*

Pedestrian and Bicycle Facilities

Sidewalks are not continuous along the NE Jackson School Road corridor. Sidewalks are provided intermittently along the west side of NE Jackson School Road north of NE Rogahn Street; while they are present on both sides of the roadway from north of NE Rogahn Street to NE Estate Drive. Sidewalks are generally present on both sides of the street from NE Estate Drive to NE Sunrise Lane, with intermittent gaps on the east side of Jackson School Road. Sidewalks are generally not present between NE Sunrise Lane and NE Grant Street. The longest continuous segment of sidewalk is along the west side of NE Jackson School Road from NE Sunrise Lane to approximately 200 feet north of NE Rogahn Street.

The City of Hillsboro *Transportation System Plan Update* identifies NE Jackson School Road from NE Grant Street to NW Evergreen Road as a *Pedestrian Master Plan Priority Project* for improving sidewalk connectivity.

Striped shoulders of varying widths exist along NE Jackson School Road, but there are no designated bicycle facilities.

The City of Hillsboro *Transportation System Plan Update* also identifies NE Jackson School Road from NE Grant Street to NW Evergreen Road as a *Bicycle Master Plan Priority Project* for planned bike lanes. Bicycle lanes are also included in the *Washington County Pedestrian and Bicycle Plan* (Reference 3), designating NE Jackson School Road as a planned bicycle corridor.

Marked Crosswalks

Two marked crosswalks exist along the study segment of NE Jackson School Road, one at the north leg of the NE Estate Drive intersection and the other at the north leg of the NE Harewood Street intersection. Both intersections are stop-controlled on the minor street leg intersecting NE Jackson School Road. The existing pedestrian crossing at NE Estate Drive is enhanced with rectangular rapid flashing beacons (RRFB) to assist with pedestrians crossing to Jackson Elementary School located west of the intersection.

Estate Drive facing South down Jackson School Road

Harewood Street facing North up Jackson School Road

School Speed Zone

A school speed zone with flashing beacons and 20 mph hour limit exists on Jackson School Road from approximately 220’ north of NE Rogahn Street to approximately 175’ south of NE Tipton Court. There are no specified school hours, but the sign requires the 20 mph speed limit ‘when flashing’.

Existing Transit Service

Transit service is not provided on NE Jackson School Road. The #46 TriMet bus runs east-west on NW Evergreen Road, which intersects the northern terminus of NE Jackson School Road. There is an eastbound and westbound bus stop at the NE Jackson School Road/NW Evergreen Road intersection.

Illumination

NE Jackson School Road has existing roadway luminaires (cobrahead fixtures) spaced approximately 250' to 350' along the corridor, primarily mounted on utility poles. Major and minor intersections generally have luminaires located at the intersections. The adequacy of the existing lighting system was not evaluated, though future street lighting will be evaluated and improved to accommodate the planned widening of the roadway.

PLANNED ROADWAY IMPROVEMENTS

The widening of NE Jackson School Road from NE Grant Street to NW Evergreen Road is identified in the *Metro 2014 Regional Transportation Plan* (RTP) (Reference 4) and the City of Hillsboro *Transportation System Plan Update* as a planned roadway improvement project. The project is included as Project 10826 in the Metro *2014 RTP* to be improved to 3-lanes with bicycle and pedestrian facilities, storm drainage, and street lighting.

The widening of NW Evergreen Road from NW Glencoe Road to NE 25th Avenue is identified in the RTP and the Washington County *Transportation System Plan* (Reference 5) as a planned roadway improvement project. The project is included as Project 10836 in the RTP to be widened to 5-lanes with bicycle lanes and sidewalks. It is a medium-term project to be built within the next 10 to 20 years.

EXISTING TRAFFIC CONDITIONS

Traffic Volumes and Speeds

Traffic volumes and vehicle speeds were collected from recent years at various locations along NE Jackson School Road. 24-hour tube counts including volume, vehicle classification, and 85th percentile speeds were collected by the City of Hillsboro on October 20th, 2015 for the northbound and southbound directions of NE Jackson School Road near NE Rogahn Street, NE Harewood Street, and NE Darnielle Drive. Additional historical traffic volume and speed data were provided by the City of Hillsboro for some minor streets intersecting with NE Jackson School Road. Table 2 summarizes the existing ADT, heavy vehicle percentages, and 85th percentile speeds along NE Jackson School Road and several intersecting streets.

Attachment "B" contains the tube count data.

Table 2: Study Area Traffic Volumes, Vehicle Class Distribution, and Speeds

Count Location		Average Daily Traffic (ADT)	Heavy Vehicle Percentage	85th Percentile Speeds (MPH)	Year Traffic Counts Collected	Source
NE Jackson School Rd	Between NE Rogahn St and NW Evergreen Rd	6,825	5.5%	43	2015	Tube Counts
NE Estate Dr	West of NE Jackson School Rd	2,080	14.7%	30	2015	City of Hillsboro
NE Jackson School Rd	Between NE Harewood St and NE Estate Dr	7,815	5.4%	40	2015	Tube Counts
NE Harewood St	Between NE Estate Dr and NE Jamie Dr	3,185	20.2%	34	2015	City of Hillsboro
NE Kathryn St	Between NE Jackson School Rd and NE 9th Ave	630	22%	31	2013	City of Hillsboro
NE Sunrise Ln	Between NE 9th Ave and NE 10th Ave	2,550	4.5%	33	2015	City of Hillsboro
NE Arrington Rd	Between NE 9th Ave and NE 10th Ave	2,895	4.5%	34	2015	City of Hillsboro
NE Jackson School Rd	Between NE Darnielle Dr and NE Arrington Rd	6,430	9.5%	39	2015	Tube Counts
NE Grant St	Between NE 5th Ave and NE 6th Ave	4,655	5.5%	27	2015	City of Hillsboro

Vehicle Speeds

As shown in Table 2, the measured 85th percentile speed on NE Jackson School Road varies between 39 and 43 MPH in both directions as measured from three separate 24-hour tube counts located near NE Rogahn Street, NE Harewood Street, and NE Darnielle Drive. The posted speed is 35 MPH.

Turning Movement Volumes

Manual turning movement traffic counts were conducted at the study intersections on various mid-week days between September 2014 and December 2015. Table 3 describes the traffic count locations and data collection dates at the seven study intersections.

All study intersections were counted during the weekday morning (7:00 a.m. to 9:00 a.m.) and evening (4:00 p.m. to 6:00 p.m.) peak periods during weeks when Hillsboro schools were in session. The peak traffic hours occurred from 7:30-8:30 a.m. and 4:45-5:45 p.m. Figure 2 and Figure 3 illustrate the peak hour turning movement counts and associated traffic operations.

Attachment "C" contains the turning movement count data.

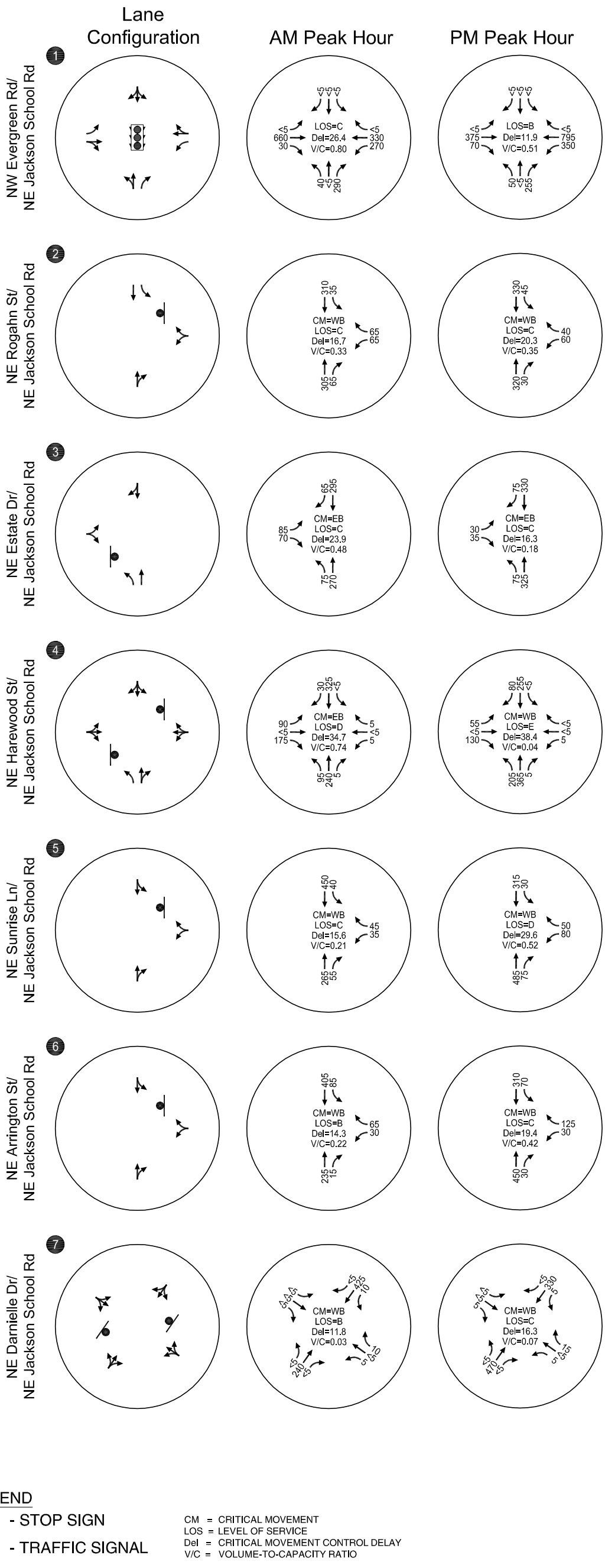
Table 3: Location and Traffic Count Collection Date

Count Location	Collection Date
NE Jackson School Road/NW Evergreen Road	Wednesday, 12/2/2015
NE Jackson School Road/NE Rogahn Street	Tuesday, 11/17/2015
NE Jackson School Road/NE Estate Drive	Tuesday, 9/14/2014
NE Jackson School Road/NE Harewood Street	Tuesday, 9/14/2014
NE Jackson School Road/NE Sunrise Lane	Tuesday, 11/17/2015
NE Jackson School Road/NE Arrington Road	Tuesday, 11/17/2015
NE Jackson School Road/NE Darnielle Drive	Tuesday, 11/17/2015

Existing Peak Hour Traffic Performance

Figure 2 and Figure 3 show the existing lane configurations and traffic operations results for the seven study intersections during the weekday a.m. and p.m. peak hours. Figure 2 provides the results for the peak-15 minute flow rate analysis, and Figure 3 provides the results for the peak-60 minute flow rate analysis. As shown, the study intersections currently operate within the LOS and V/C ratio standards set by the City of Hillsboro and Washington County under both the peak-60 minute and peak-15 minute flow rate analysis scenarios. All intersections operate at LOS "D" or better, except for the NE Harewood Street & NE Jackson School Road intersection, which currently operates at LOS "E" for the side street movements under the peak-15 minute analysis scenario.

Attachment "D" includes the level-of-service worksheets for the existing traffic conditions.



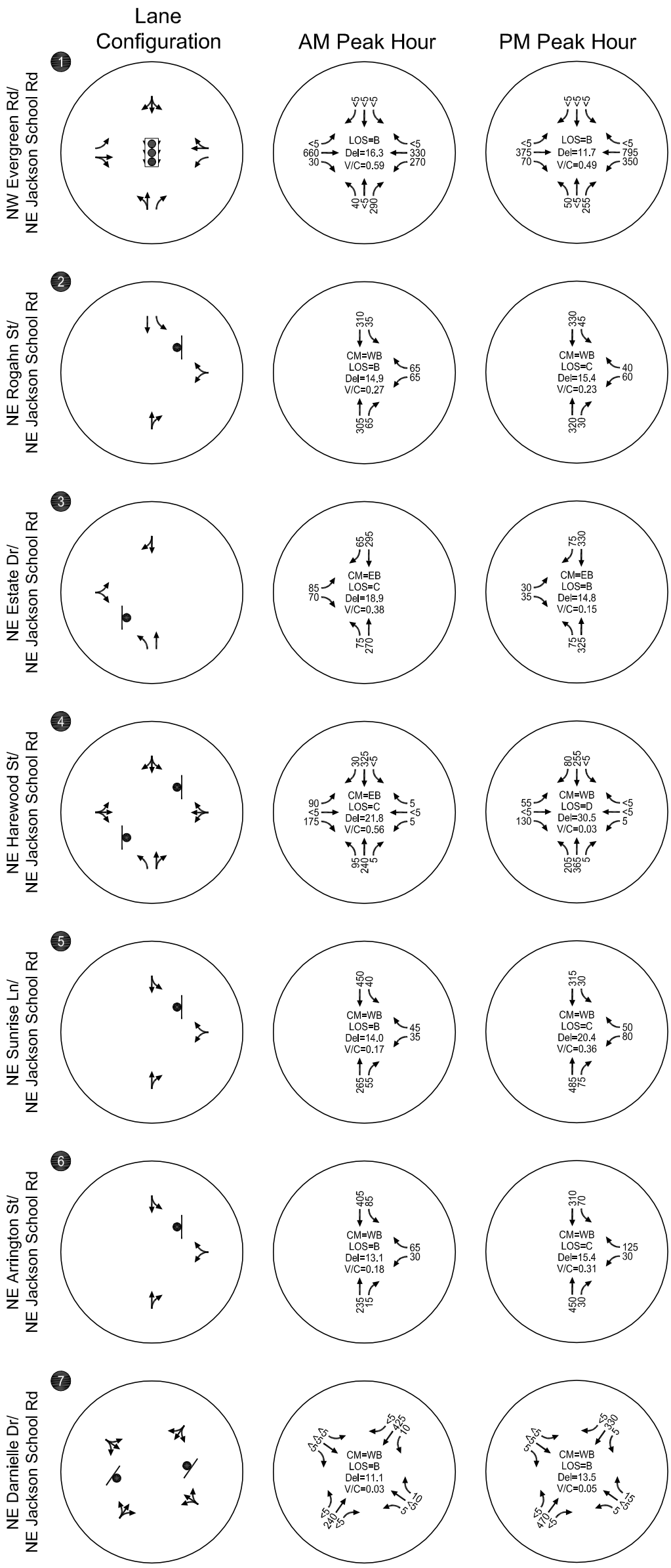
LEGEND

- STOP SIGN
- TRAFFIC SIGNAL

CM = CRITICAL MOVEMENT
LOS = LEVEL OF SERVICE
Del = CRITICAL MOVEMENT CONTROL DELAY
V/C = VOLUME-TO-CAPACITY RATIO

Existing Lane Configurations & Traffic Control Devices
Existing Traffic Conditions - Peak-15 Minute Analysis
Hillsboro, Oregon

Figure 2



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Existing Lane Configurations & Traffic Control Devices
Existing Traffic Conditions - Peak-60 Minute Analysis
Hillsboro, Oregon

Figure 3

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Existing Traffic Signal Warrant Analysis

A signal warrant analysis was conducted for the six existing unsignalized study intersection on NE Jackson School Road to determine is a signal is warranted under current traffic conditions. The Manual on Uniform Traffic Control Devices (MUTCD) (Reference 6) provides guidelines for justifying the installation of traffic signals based on traffic conditions, pedestrian characteristics, crash experience, and physical characteristics of the location. The MUTCD establishes the following nine traffic signal warrants:

- Warrant 1: Eight-Hour Volumes
- Warrant 2: Four-Hour Volumes
- Warrant 3: Peak Hour Volumes
- Warrant 4: Pedestrian Volume
- Warrant 5: School Crossing
- Warrant 6: Coordinated Signal System
- Warrant 7: Crash Experience
- Warrant 8: Roadway Network
- Warrant 9: Intersection Near a Grade Crossing

The signal warrant analysis for this study focused on the first three vehicular volume warrants, using the existing traffic volumes. Results indicate that a traffic signal is not currently warranted at any of the study intersections.

Attachment "E" contains the existing traffic signal warrant worksheets.

Traffic Safety

Historical crash data along the NE Jackson School Road project corridor was reviewed in an effort to identify potential safety issues or trends.

Crash Data

The Oregon Department of Transportation (ODOT) provided the five most recent years of crash data (January 1, 2009 through December 31, 2013) for the segment of NE Jackson School Road between NW Evergreen Road and NE Grant Street, as well as the major intersections along the segment. Table 4 summarizes the number of reported crashes for each intersection or segment by year.

Table 4: Reported Crashes on NE Jackson School Road by Year

Intersection or Segment	2009	2010	2011	2012	2013	Total
NW Evergreen Road & NE Jackson School Road	3	2	4	1	2	**12**
NE Rogahn Street & NE Jackson School Road	0	0	1	0	1	**2**
NE Estate Drive & NE Jackson School Road	0	0	1	1	0	**2**
NE Harewood Street & NE Jackson School Road	1	0	0	3	0	**4**
Segment between NE Harewood Street and NE Sunrise Lane	1	0	0	0	0	**1**
NE Sunrise Lane & NE Jackson School Road	0	1	1	0	1	**3**
Segment between NE Surnsie Lane and NE Hood Street	0	0	0	1	0	**1**
Segment between NE Baldwin Street andNE Arrington Road	0	0	1	0	0	**1**
NE Arrington Road & NE Jackson School Road	1	0	1	3	4	**9**
Segment between NE Grant Street and NE 6th Avenue Drive	0	1	0	0	0	**1**
Total	**6**	**4**	**9**	**9**	**8**	**36**

As shown in Table 4, there were 36 reported crashes in the five years of available data. Exhibit 1 illustrates that 21 of 36 crashes are of an injury severity, and 15 of 36 crashes are of Property Damage Only (PDO) severity. Exhibit 2 illustrates that 14 of the 36 reported crashes are of the rear-end type and 14 of the 36 are of the turning movement type. There were three reported pedestrian crashes and one bicycle crashes in the NE Jackson School Road Study segment. The four total pedestrian and bicycle crashes all resulted in an injury to the non-motorized user.

Based on the reported crash data, one crash trend was identified in the study area, at the NE Arrington Road/NE Jackson School Road intersection.

NE Arrington Road & NE Jackson School Road Intersection

Six (6) of the 9 reported crashes at the intersection were of the rear-end type, where all 6 rear-end crashes involved vehicles traveling in the southbound direction. Based on the crash reports, the 6 crashes in the southbound direction appear to represent a motorist performing a southbound left-turn from NE Jackson School Road. A southbound left-turn storage bay does not currently exist. Constructing a center left-turn lane will provide opportunities for southbound left-turning vehicles to move out of the through lane of traffic to wait for gaps in opposing traffic, decreasing the risk of southbound rear-end crashes at this intersection.

The crash data provided by ODOT is provided in Attachment "F".

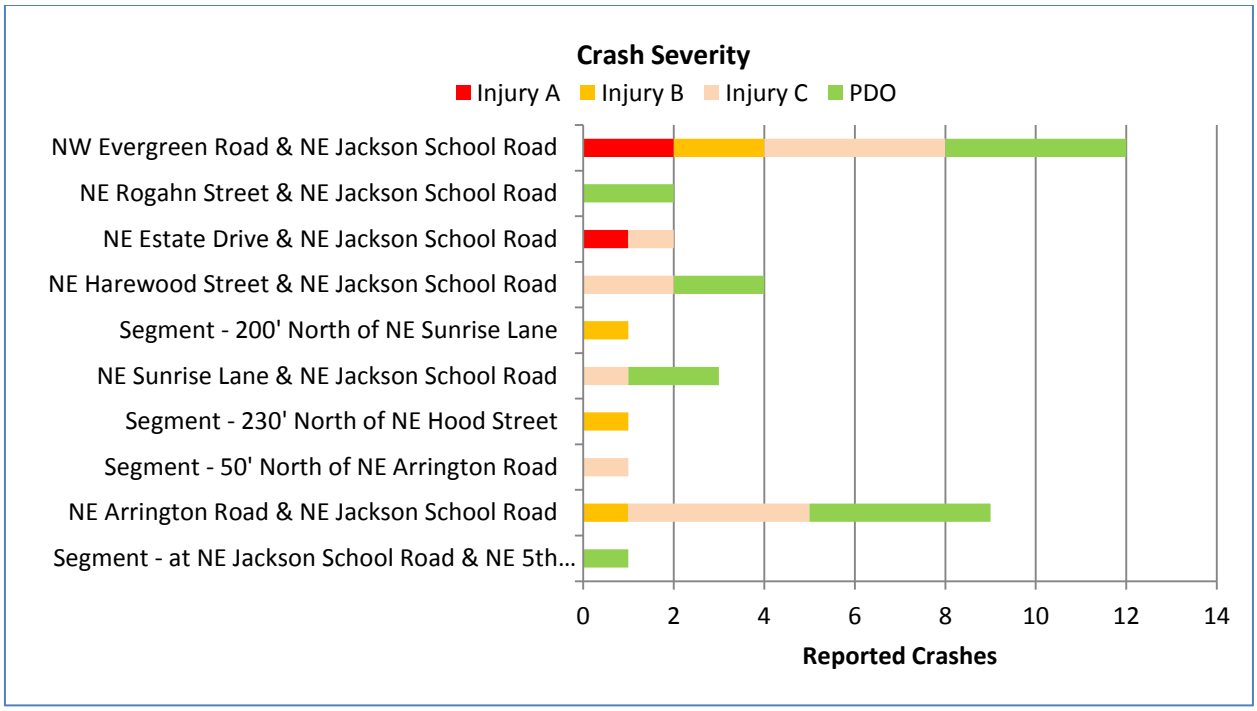


Exhibit 1: Reported Crashes on NE Jackson School Road by Severity

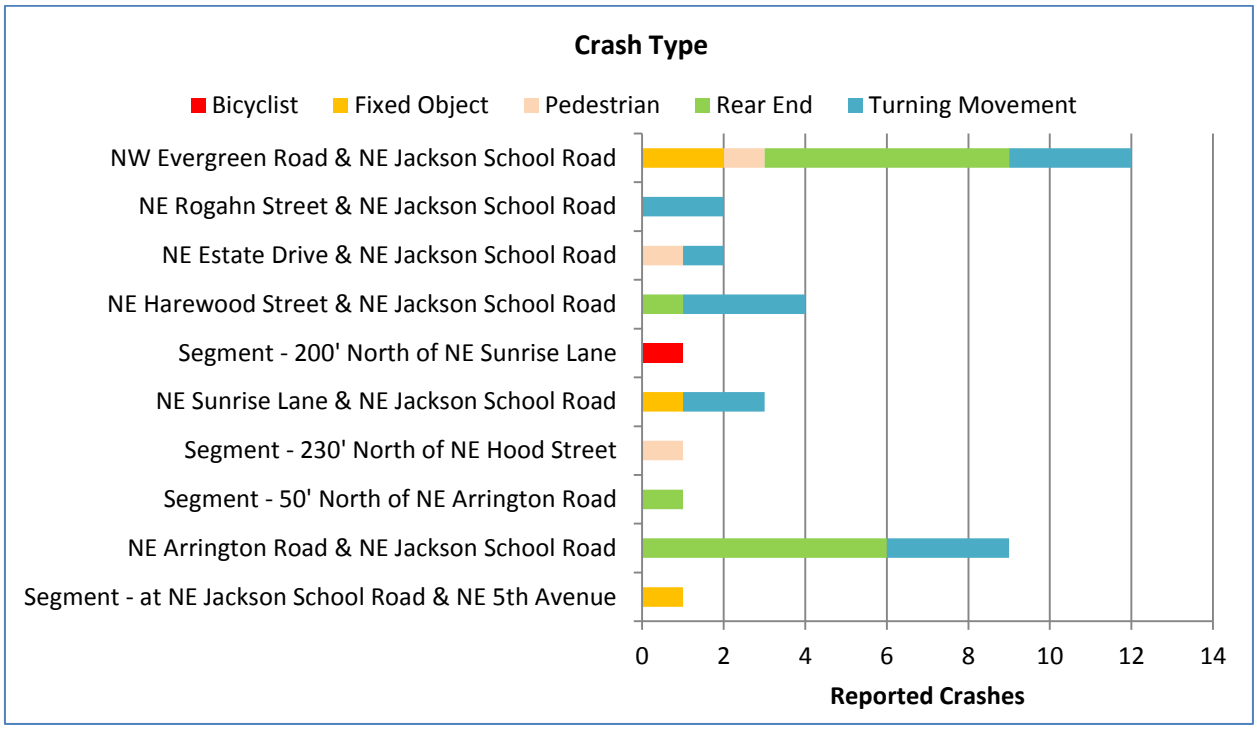


Exhibit 2: Reported Crashes on NE Jackson School Road by Type

YEAR 2035 FUTURE CONDITIONS

The year 2035 represents the design year for identifying long-term geometric and traffic control improvements for the project corridor. The future conditions analysis estimates the future operational characteristics of roadways and other transportation facilities within the study area.

Traffic Volumes

Projected year 2035 weekday a.m. and p.m. peak hour turning-movement volumes are shown in Figure 4 (peak-15 minute analysis) and Figure 5 (Peak 60-minute analysis). These volumes were developed based on existing 2014/2015 turning movement volumes and information obtained from the travel demand models provided by the City of Hillsboro. Specifically, the City provided calibrated base year 2010 models and future year 2035 models that reflect anticipated land use changes and planned transportation improvements within the City and greater region. *Attachment "G" contains the travel demand model volume plots.*

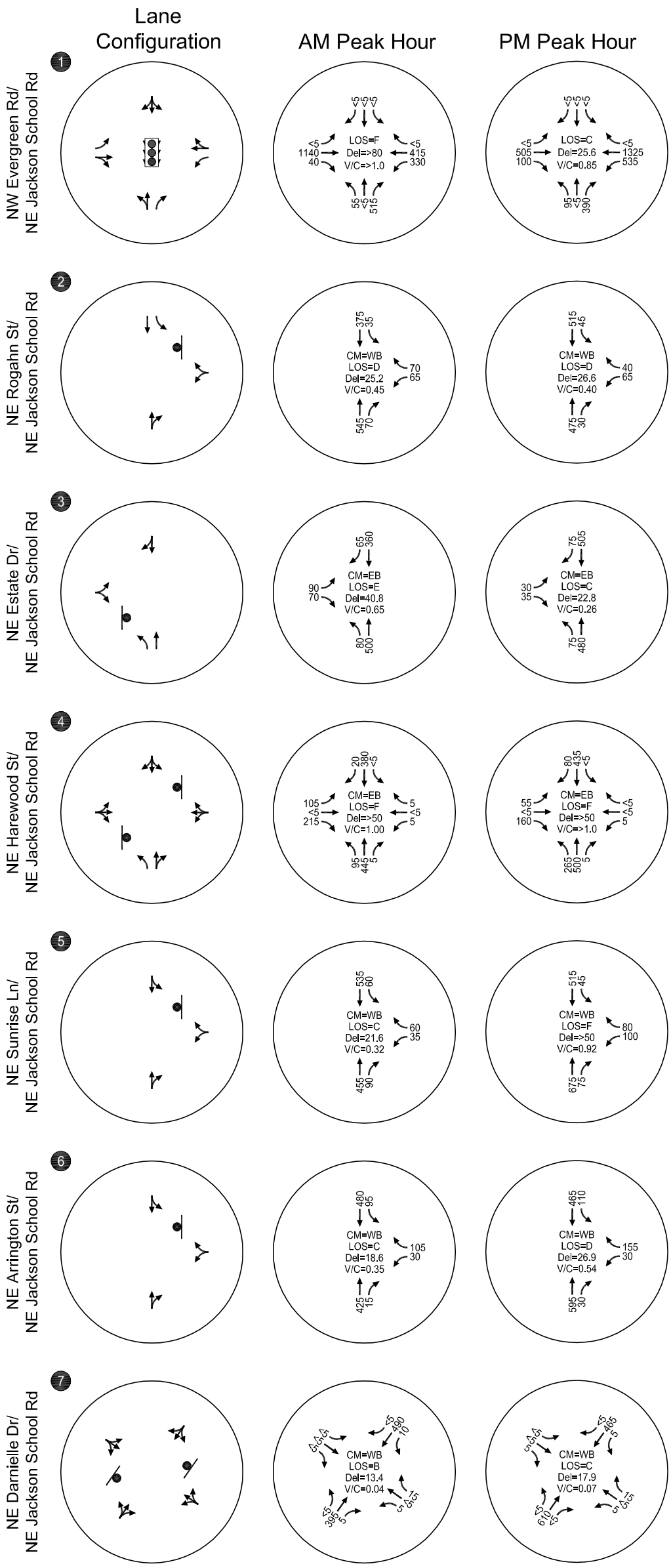
The year 2035 traffic volumes were developed by applying the National Cooperative Highway Research Program (NCHRP) 255 methodology post-processing procedures, in conjunction with engineering judgment and knowledge of the study area. The resulting year 2035 turning movement volumes were compared with existing traffic patterns and in some cases adjusted to better represent the "built-out" nature of the neighborhoods surrounding NE Jackson School Road (i.e. turning movement volumes from side streets that don't accommodate through traffic will not grow significantly). The year 2035 traffic volumes were reviewed and approved by City staff.

Year 2035 No-Build Peak Hour Traffic Performance

The year 2035 turning movement volumes were analyzed assuming the existing lane configurations and traffic control devices. Figure 4 (peak-15 minute analysis) and Figure 5 (peak-60 minute analysis) illustrates the year 2035 No-Build traffic operations analysis for the weekday a.m. and p.m. peak hours. Based on the results, the following three intersections operate below the traffic operations performance thresholds set by the City of Hillsboro and Washington County:

- The NW Evergreen Road/NE Jackson School Road signalized intersection is projected to operate at LOS "F" and V/C ratio greater than 1.0 in the weekday a.m. peak hour.
- The NE Harewood Street/NE Jackson School Road unsignalized intersection is projected to operate at LOS "F" in both the weekday a.m. and p.m. peak hours. The V/C ratio is projected to be 1.0 or greater under the peak-15 minute analysis scenario. The critical movement is the eastbound left-turn from NE Harewood Street.
- The NE Sunrise Lane/NE Jackson School Road unsignalized intersection is projected to operate at LOS "F" in the weekday p.m. peak hour. The critical movement is the westbound left-turn from NE Sunrise Lane.

Attachment "H" contains the year 2035 No-Build traffic operations worksheets.



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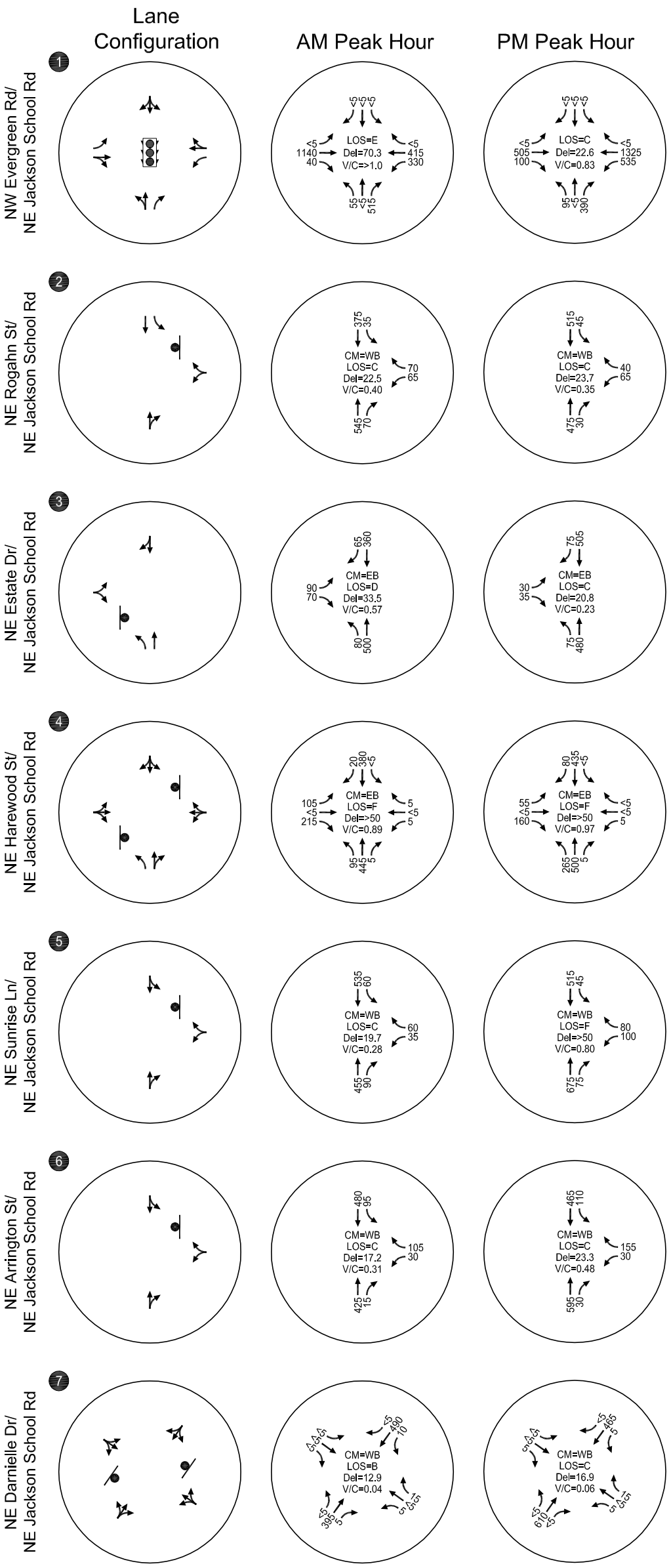
Existing Lane Configurations & Traffic Control Devices
Year 2035 No Build Traffic Conditions - Peak-15 Minute Analysis
Hillsboro, Oregon

Figure 4



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Existing Lane Configurations & Traffic Control Devices
Year 2035 No Build Traffic Conditions - Peak-60 Minute Analysis
Hillsboro, Oregon

Figure 5

Corridor Left-Turn Warrant Analysis

As part of identifying improvements for intersections, an evaluation was performed to determine the need for left-turn lanes at each unsignalized intersection on NE Jackson School Road. Although a continuous 3-lane cross-section is programmed from NE Grant Street to NW Evergreen Road in the City's *Transportation System Plan Update*, the left-turn evaluation was performed to determine if opportunities exist to narrow NE Jackson School Road to a 2-lane section where left-turns are not warranted in order to conserve right-of-way and reduce construction costs.

The Oregon Department of Transportation (ODOT) Analysis Procedures Manual (APM) Chapter 7 (Reference 7) contains criteria for installing left-turn lanes at unsignalized intersections. Three criteria are available for the left-turn warrant determination, of which only Criterion 1 (Vehicle Volume) was applicable to the NE Jackson School Road corridor. The data curves shown in Exhibit 7-1 of the APM were used and are based on a) the left-turn volume and b) the total of the opposing and advancing volumes along the roadway in the design hour. The data curve for 35 MPH roadways indicates that a left-turn lane is warranted for a condition where the sum of opposing plus advancing traffic is greater than 750 vehicles per hour, and the left-turn volume is greater than 10 vehicles per hour.

The 750 vehicle threshold for advancing plus opposing traffic is anticipated to be met for the entire length of NE Jackson School Road. Thus, any side street where 10 or more left-turns are expected from NE Jackson School Road will warrant a left-turn lane (i.e. center two-way left-turn lane).

For side streets where peak hour turning movement volume data was not available, the approximate number of homes the street serves was estimated and an approximation of peak hour traffic turning onto the street from NE Jackson School Road was calculated. The turning traffic was approximated using the ITE Trip Generation Manual (Reference 8) rates for *Single Family Detached housing* (ITE Code 210). Table 5 summarizes the results of the left-turn warrant analysis.

Table 5: Corridor Left-Turn Lane Warrant Summary

Cross Street of Jackson School Road	Movement	PM Peak Hour - Turning Movement or (Trip Generation Estimate)	LT Lane Warrant Met?
NW Evergreen Road	↰ - Northbound-Left	95	Yes *
	↳ - Southbound-Left	-	-
NE Sundance Ct	↰ - Northbound-Left	(3)	No
	↳ - Southbound-Left	-	-
Private Dr - 650' South of Evergreen	↰ - Northbound-Left	(3)	No
	↳ - Southbound-Left	-	-
Private Dr - 150' North of Creek	↰ - Northbound-Left	(2)	No
	↳ - Southbound-Left	-	-
Private Dr - 300' South of Creek	↰ - Northbound-Left	(2)	No
	↳ - Southbound-Left	(3)	No
NE Rogahn St	↰ - Northbound-Left	-	-
	↳ - Southbound-Left	46	Yes *
NE Cambrey Ct	↰ - Northbound-Left	-	-
	↳ - Southbound-Left	(3)	No
NE Estate Dr	↰ - Northbound-Left	73	Yes *
	↳ - Southbound-Left	-	-
NE Tipton Ct	↰ - Northbound-Left	-	-
	↳ - Southbound-Left	(3)	No
NE Harewood St	↰ - Northbound-Left	263	Yes *
	↳ - Southbound-Left	8	No
NE Kathryn St	↰ - Northbound-Left	-	-
	↳ - Southbound-Left	(13)	Yes
NE Sunrise Ln	↰ - Northbound-Left	-	-
	↳ - Southbound-Left	43	Yes
NE Hood St	↰ - Northbound-Left	-	-
	↳ - Southbound-Left	(13)	Yes
NE Baldwin St	↰ - Northbound-Left	-	-
	↳ - Southbound-Left	(13)	Yes
NE Arrington Rd	↰ - Northbound-Left	-	-
	↳ - Southbound-Left	111	Yes
NE Darnielle Dr	↰ - Northbound-Left	0	No
	↳ - Southbound-Left	6	No
NE 6th Ave Dr	↰ - Northbound-Left	(13)	Yes
	↳ - Southbound-Left	-	-

* Left-turn lane currently exists

As shown in Table 5, left-turn lanes from Jackson School Road are generally warranted at all public side streets between NE Grant Street and NE Rogahn Street. The two exceptions in this section are NE Darnielle Drive and NE Tipton Court. NE Darnielle Drive is located approximately 175 feet north of NE

6th Avenue Drive, which warrants a left-turn lane. NE Tipton Court is located approximately 400 feet south of NE Estate Drive and falls within the existing taper for the northbound left-turn lane at NE Estate Drive. Further, the driveways into the Church of Jesus Christ of Latter-day Saints just south of NE Tipton Court would benefit from a two-way left-turn lane for peak periods of church traffic.

NE Cambrey Court does not warrant a left-turn lane from NE Jackson School Road, although it falls within the existing widened cross-section accommodating the northbound left-turn at NE Estate Drive. Thus, the left-turn into NE Cambrey Court can be accommodated with the center two-way left-turn lane.

Several private drives exist north of NE Rogahn Street, each serving between 6 and 13 residences. Based on trip generation estimates for traffic generated by the residences, left-turn lanes are not warranted at any of the private drives. Additionally, NE Sundance Court does not warrant a left-turn lane. This segment of NE Jackson School Road between NE Rogahn Street and NW Evergreen Road presents a potential area where a two-lane cross-section could be maintained. The crossing of the Glencoe Slough creek falls within this segment. However, approximately 15 private driveways serving single homes exist in this segment beyond the 4 private drives. A center two-way left-turn lane would provide benefit to this segment due to the number of access points.

Figure 6 illustrates the existing and warranted left-turn storage bays indicated from the left-turn warrant analysis for the NE Jackson School Road corridor. The warranted left-turn storage bay length has been estimated at 200 feet based on the amount of space needed to taper the upstream striping and provide a left-turn pocket of approximately 100 feet. The actual amount taper and storage length will need to be determined during the future design stage of this project based on the ultimate roadway geometry and other functional design constraints.

Year 2035 Future Build Peak Hour Traffic Performance

The year 2035 turning movement volumes were analyzed assuming improvements to intersections necessary to meet the City of Hillsboro and Washington County intersection performance standards. Improvements were identified based on the intersection deficiencies identified in the year 2035 No-Build conditions, as well as the results of the left-turn lane warrant analysis. Table 6 provides a summary of the improvements proposed for select intersections, described in further detail in following sections. Figure 7 (peak-15 minute analysis) and Figure 8 (peak-60 minute analysis) illustrate the year 2035 intersection improvements and the resultant traffic operations analysis. Based on the evaluations, requirements for intersection improvements and/or intersection control changes were found to be the same for both the peak-60 minute and peak-15 minute analyses.

As shown in Figure 7 and Figure 8, the proposed improvements reduce delay and V/C ratios at the study intersections and meet City of Hillsboro and Washington County intersection performance standards.

LEGEND

Existing Left-Turn Storage Bays

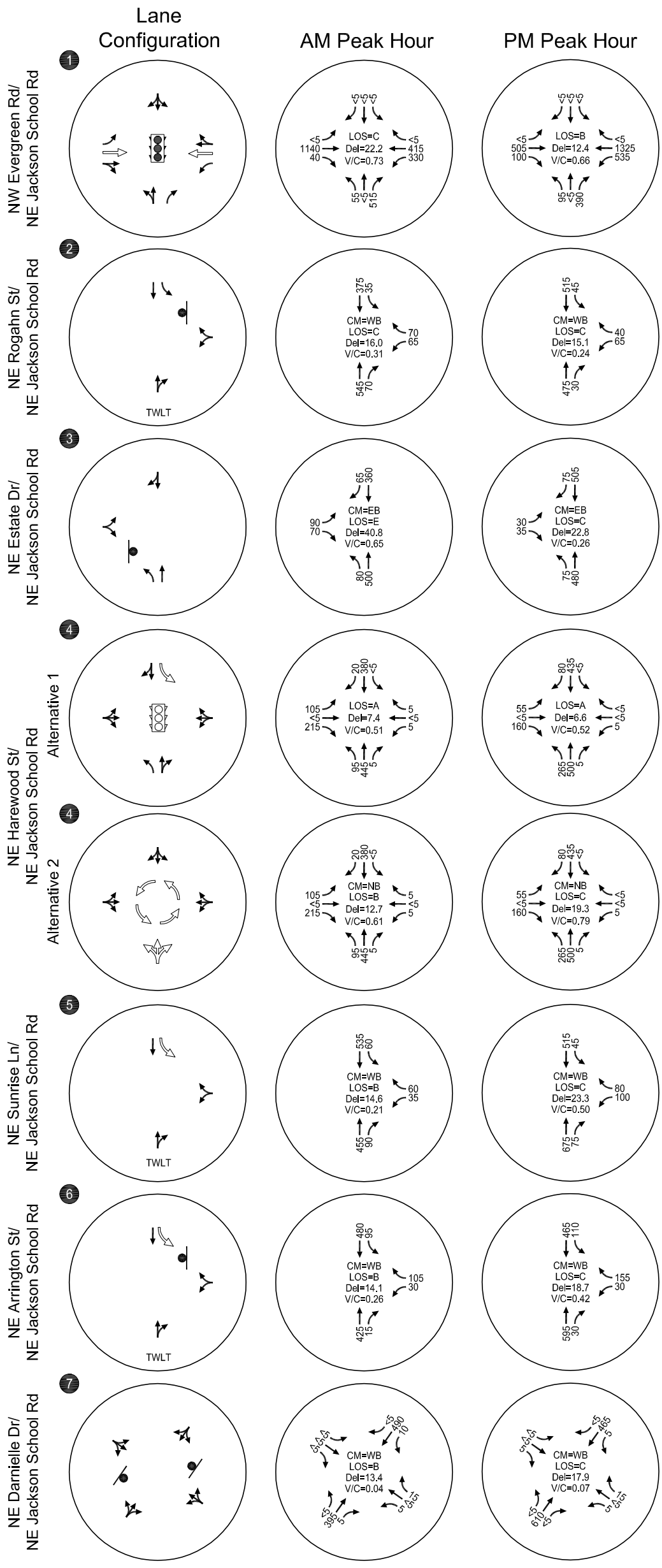
Warranted Left-Turn Storage Bays

Left-Turn Storage Bay Assessment
Year 2035 Traffic Conditions
Hillsboro, Oregon

Figure 6

Kittelson & Associates, Inc.
TRANSPORTATION ENGINEERING/PLANNING

H:\projfile\19551 - Jackson School Road - Grant to Evergreen\dwgs\figs\19551_Fig01.dwg Nov 04, 2016 - 12:35pm - jbbansen Layout Tab: 6_Queues



LEGEND

TWLT - TWO-WAY LEFT-TURN LANE

- PLANNED IMPROVEMENT

- STOP SIGN

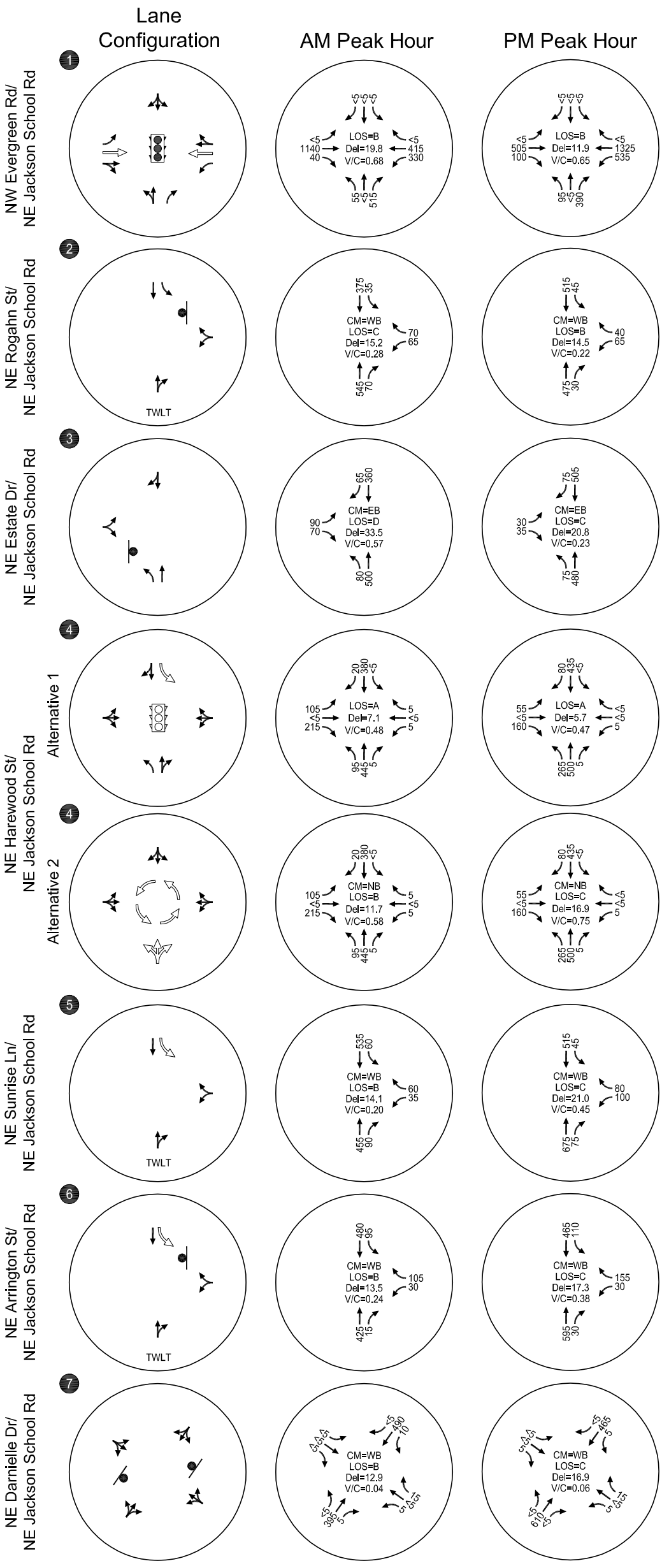
- TRAFFIC SIGNAL

- PROPOSED ROUNDABOUT

CM = CRITICAL MOVEMENT
LOS = LEVEL OF SERVICE
Del = CRITICAL MOVEMENT CONTROL DELAY
V/C = VOLUME-TO-CAPACITY RATIO

Future Lane Configurations & Traffic Control Devices
Year 2035 Build Traffic Conditions - Peak-15 Minute Analysis
Hillsboro, Oregon

Figure 7



LEGEND

TWLT - TWO-WAY LEFT-TURN LANE

- PLANNED IMPROVEMENT
- STOP SIGN
- TRAFFIC SIGNAL
- PROPOSED ROUNDABOUT

CM = CRITICAL MOVEMENT
LOS = LEVEL OF SERVICE
Del = CRITICAL MOVEMENT CONTROL DELAY
V/C = VOLUME-TO-CAPACITY RATIO

Future Lane Configurations & Traffic Control Devices
Year 2035 Build Traffic Conditions - Peak-60 Minute Analysis
Hillsboro, Oregon

Figure 8

Table 6: Proposed Improvements for the Year 2035 Build Conditions

Study Intersection	Proposed Improvement	Justification
NW Evergreen Road/ NE Jackson School Road	Build out NW Evergreen Road to a five-lane cross section.	Identified in the RTP and Washington County TSP to be widened to 5-lanes.
NE Harewood Street/ NE Jackson School Road	Install traffic signal or single-lane roundabout	This intersection will not meet City operational standards as an unsignalized intersection. Traffic signal warrants are met in the near-term. A single-lane roundabout provides adequate capacity.
NE Sunrise Lane/ NE Jackson School Road	Install center turn lane on Jackson School Road (3-lane section) through the intersection.	Southbound left-turn lane is warranted.
NE Arrington Street/ NE Jackson School Road	Install center turn lane on Jackson School Road (3-lane section) through the intersection.	Southbound left-turn lane is warranted. Six (6) reported rear-end crashes in the southbound direction over 5 years.

NW Evergreen Road/NE Jackson School Road

As discussed above, the widening of NW Evergreen Road to 5-lanes from NW Glencoe Road to NE 25th Avenue is identified in the RTP and the Washington County TSP as a planned roadway improvement project. It is a medium-term project to be built within the next 10 to 20 years, so the future 2035 Build scenario assumed the widening to be complete. The widening of NW Evergreen Road adds the needed capacity for the NW Evergreen Road/NE Jackson School Road intersection to operate within Washington County LOS and V/C ratio standards.

NE Rogahn Street/NE Jackson School Road

The NE Rogahn Street/NE Jackson School Road intersection was identified above as meeting left-turn lane warrants by 2035. Maintaining the existing southbound left-turn lane on NE Jackson School Road as well as striping a two-way left-turn lane south of the intersection will allow for two-stage left-turn movements out of NE Rogahn Street. This intersection configuration is anticipated to improve traffic operations compared to the 2035 No-Build scenario.

NE Harewood Street/NE Jackson School Road

The stop-controlled approaches of NE Harewood Street were identified as the critical movements at the intersection under 2035 No-Build conditions. The unsignalized intersection was evaluated with the addition of separate right- and left-turn lanes on NE Harewood Street, and was found to continue to fall below City of Hillsboro intersection performance standards. As discussed in the following section, signal warrants were found to be met as early as year 2016, so the intersection was evaluated with traffic signal control in the 2035 Build scenario. The intersection was found to operate acceptably with single-lane approaches on NE Harewood Street, with permissive left-turn signal phasing.

The intersection was also evaluated as a roundabout in the 2035 Build scenario using the *HCM 2010* capacity models, and was found to operate acceptably with single-lane entries and exits on all approach legs. The critical movement is the northbound entry in both the a.m. and p.m. peak periods, expected to operate no worse than LOS C with a V/C ratio of 0.79. In addition to the operational

benefits, the roundabout would help provide speed control to break up what is otherwise a long straight section of the Jackson School Road corridor.

NE Sunrise Drive/NE Jackson School Road

The NE Sunrise Drive/NE Jackson School Road intersection was identified above as meeting left-turn lane warrants by 2035. Adding a southbound left-turn lane on NE Jackson School Road, as well as striping a two-way left-turn lane south of the intersection to allow for two-stage left-turn movements out of NE Sunrise Drive, is anticipated to improve traffic operations to meet City of Hillsboro LOS and V/C ratio standards.

NE Arrington Street/NE Jackson School Road

The NE Arrington Street/NE Jackson School Road intersection was identified above as meeting left-turn lane warrants by 2035. Adding a southbound left-turn lane on NE Jackson School Road, as well as striping a two-way left-turn lane south of the intersection to allow for two-stage left-turn movements out of NE Arrington Street, is anticipated to improve traffic operations to meet City of Hillsboro LOS and V/C ratio standards. Constructing a center left-turn lane will also provide opportunities for southbound left-turning vehicles to move out of the through lane of traffic to wait for gaps in opposing traffic, decreasing the risk of southbound rear-end crashes at this intersection.

Attachment "I" contains the year 2035 Build Traffic Operations Worksheets.

Traffic Signal Warrant Analysis

A signal warrant analysis was conducted for the NE Harewood Street/NE Jackson School Road intersection to determine whether a new traffic signal is warranted. The signal warrant analysis focused on the first three vehicular volume warrants from the MUTCD, using the future year 2035 traffic volumes. The results of the signal warrant analysis are provided in Table 7. Because the intersection was found to meet signal warrants in 2035, a sensitivity analysis was performed to determine the approximate year the signal would be warranted. Linear growth between the existing 2014/2015 and 2035 traffic volumes was assumed for the sensitivity analysis.

Attachment "J" contains the traffic signal warrant worksheets.

Table 7: Traffic Signal Warrant Analysis Results

MUTCD Warrant	Warrant Met? (Approx. Year Met) NE Harewood Street/NE Jackson School Road
1. Eight-Hour Volume	Yes (2019)
2. Four-Hour Volume	Yes (2016)
3. Peak Hour Volume	Yes (2019)

Year 2035 Build Queuing Analysis

The 95th percentile queues at the study intersections were calculated using both the HCM 2000 methodology and results of a SimTraffic simulation. Queue lengths during the a.m. and p.m. peak hours for the year 2035 traffic conditions using the peak-15 minute intersection flow rates are reported in Table 8. Results for the traffic signal at NE Harewood Street are shown in the table for consistency with the methods used. Queuing at a proposed single-lane roundabout is not anticipated to spill back beyond upstream intersections.

Attachment "K" contains the year 2035 queuing analysis worksheets.

Table 8: Year 2035 Build Analysis 95th Percentile Queues

Cross Street of Jackson School Road	Movement/ Approach	AM Peak Hour		PM Peak Hour		Queue Storage Assuming Minimal Build-out	Adequate Storage?
		HCM 2000 95th Percentile Queue (feet)	SimTraffic 95th Percentile Queue (feet)	HCM 2000 95th Percentile Queue (feet)	SimTraffic 95th Percentile Queue (feet)		
NW Evergreen Road	EBT	477	379	224	200	1000+	Yes
	WBL	200	224	262	266	600	Yes
	WBT	61	38	282	189	1000+	Yes
	NBTL	68	69	101	187	300	Yes
	NBR	247	439	41	151	300	**No***
	SBT	6	16	10	10	50	Yes
NE Rogahn St	WB	32	92	23	67	400	Yes
	SBL	3	48	4	41	150	Yes
NE Estate Dr	EB	45	110	14	60	250	Yes
	NBL	6	66	6	55	250	Yes
NE Harewood St	EBT	55	164	65	114	300	Yes
	WBT	5	14	8	26	100	Yes
	NBL	40	85	116	168	200	Yes
	NBT	150	192	136	137	250	Yes
	SBL	3	0	2	0	100	Yes
	SBT	128	144	137	134	300	Yes
NE Sunrise Ln	WB	20	109	67	300	300	Yes
	SBL	5	65	4	51	150	Yes
NE Arrington Rd	WB	26	65	52	143	300	Yes
	SBL	8	67	11	59	150	Yes
NE Darnielle Dr	SBL	1	21	1	20	150	Yes
	WB	3	43	6	38	300	Yes

*Spills back past NE Sundance Court

EBT = Eastbound-through

EB = Eastbound

WBL = Westbound-left

WBT = Westbound-through

WB = Westbound

NBL = Northbound-left

NBT = Northbound-through

NBTL = Northbound combined through-left

NBR = Northbound-right

SBT = Southbound-through

SBL = Southbound-left

As shown in Table 8, vehicle queues can be accommodated with the lane configurations shown in the 2035 Build scenario. Available queue storage shown in Table 8 is based on the distance between adjacent public street intersections. The exception is the northbound approach at the NW Evergreen Road/NE Jackson School Road intersection, where the right-turn queue is anticipated to be accommodated in its lane but will spill back past NE Sundance Court in the a.m. peak hour. There may be opportunities to adjust the signal timing for the weekday a.m. peak hour conditions in the future to better accommodate the queues.

Interim Improvements Sensitivity Analysis

A sensitivity analysis was performed to determine the approximate year improvements would be needed at key intersections and to inform the potential need for interim improvements to be constructed. Linear growth between the existing 2014/2015 and 2035 traffic volumes was assumed for the sensitivity analysis. The sensitivity analysis was performed using the peak 15-minute flow rates for operations analysis to provide a reasonable worst case scenario.

NW Evergreen Road/NW Jackson School Road

The widening of NW Evergreen Road to 5-lanes was assumed in the 2035 Build scenario. The sensitivity analysis found that the intersection is anticipated to accommodate approximately 8 years of traffic growth, operating adequately until approximately 2024 before the widening of NW Evergreen Road will be required. This timeframe fits with the timeframe outlined in the Metro RTP.

NE Harewood Street/NW Jackson School Road

Traffic growth at the NE Harewood Street/NE Jackson School Road intersection was analyzed to determine when the intersection requires improvements (signalization or roundabout) to meet City of Hillsboro traffic operations performance standards. The sensitivity analysis found that the existing unsignalized intersection configuration is anticipated to accommodate approximately 5 years of growth, operating adequately until approximately 2021 before requiring the identified improvements. The p.m. peak hour was found to be the critical peak period, whereas the existing intersection is anticipated to operate adequately in the a.m. peak hour until approximately 2026.

CROSSWALK EVALUATION

An evaluation of current and potential future pedestrian crossings was performed at key study intersections along NE Jackson School Road. The evaluation consisted of noting existing traffic operations including pedestrian/bicycle crossings, observing yielding and crossing behavior in the field, and considering Washington County's *Mid-block Crossing Policy* (Reference 9).

Pedestrian Volumes

Pedestrians were counted as part of the intersection turning movement counts. In general, the pedestrian peak hour was found to be generally different than the existing peak hour of vehicle traffic. Table 9 illustrates the pedestrian peak hours and the volume of total entering pedestrians at the study intersections proposed to remain unsignalized. The NE Harewood Street/NE Jackson School Road intersection was not included in the evaluation since it is proposed to be either signalized or a roundabout and will include enhanced or signalized pedestrian crossings.

As shown in Table 9, the NE Estate Drive/NE Jackson School Road intersection has the highest existing pedestrian volumes, with the a.m. and p.m. peak hours corresponding with the Jackson Elementary School's beginning and end of class. The quantity of existing pedestrians at the other unsignalized intersections are relatively low. It should be noted that the majority of the counts were conducted in November and December of 2015 during rainy weather.

Table 9: Total Entering Pedestrians during the Pedestrian Peak Hour

Intersection	AM Peak Hour		PM Peak Hour	
	Time	Number of Pedestrians	Time	Number of Pedestrians
NE Rogahn Street & NE Jackson School Road	7:25 – 8:25 AM	2	4:45 – 5:45 PM	1
NE Estate Drive & NE Jackson School Road	7:25 – 8:25 AM	78	3:20 – 4:20 PM	56
NE Sunrise Lane & NE Jackson School Road	7:30 – 8:30 AM	0	4:45 – 5:45 PM	1
NE Arrington Road & NE Jackson School Road	7:50 – 8:50 AM	6	4:30 – 5:30 PM	2
NE Darnielle Road & NE Jackson School Road	7:15 – 8:15 AM	5	5:00 – 6:00 PM	3

Washington County Pedestrian Crossing Policy

Washington County has a midblock crossing policy for assessing existing crosswalks, proposing new crosswalks, and determining the appropriate crosswalk treatment. The crosswalk standards are broken up into tiers, as indicated in Table 10.

Table 10: Washington County Mid-Block Crossing Tier System

Tier	Standard	Additional Treatments Considered
Tier 1	Crosses a 2-lane street with or without an island/refuge – install high visibility mounted signs and markings	Refuge island, curb extensions, staggered pedestrian refuges
Tier 2	Crosses a 3-lane Street with Island/refuge – install high visibility signs and markings	Flashing beacons, pedestrian actuated signal/beacon
Tier 3	Crosses a 3-lane street without island/refuge or 4-lane street with island/refuge – install high visibility signs and markings or pedestrian actuated signal	Pedestrian Actuated Signal/Beacon
Tier 4	Crosses a 4-lane or greater street without an island/refuge – install pedestrian actuated signal or beacon	Pedestrian actuated signal, pedestrian over or undercrossing

Under the Build scenario, the study intersections will fall within Tier 3 because NE Jackson School Road has been identified to be built to a 3-lane cross section without an island/refuge. Under Tier 3, these intersections are candidates for high visibility signs, markings, or pedestrian actuated signal/beacon. The presence of a Rapid Rectangle Flashing Beacon (RRFB) at the NE Estate Drive/NE Jackson School Road intersection is already consistent with the recommendations of this policy.

At the other study intersections, pedestrian movements will benefit from additional crossing treatments such as high visibility signs, markings, or an RRFB, but there are currently few recorded pedestrians using those intersections, as indicated in Table 9.

The Washington County policy also uses Federal Highway Administration's recommendations for installing pedestrian improvements at uncontrolled intersections, which is based on the roadway cross-section, vehicle ADT, and design speed. According to Table 1 of the Washington County policy, the study intersections are candidate sites for marked crosswalks. The policy also highlights a possible increase in pedestrian crash risk if crosswalks are added without other pedestrian facility enhancements.

With the exception of the NE Estate Drive/NE Jackson School Road intersection, the cumulative addition of signing, pavement marking, and RRFB enhancements are appropriate treatments to decrease pedestrian crash risk at the study intersections. In particular, the NE Arrington Road/NE Jackson School Road intersection lies next to UJ Hamby Park, which is a pedestrian attractor. The provision of a crosswalk, signage, or other pedestrian crossing enhancements at (or in the vicinity of) the NE Arrington Road/NE Jackson School intersection would provide pedestrians greater visibility to more safely cross NE Jackson School Road. The specific locations and pedestrian crossing treatments along NE Jackson School Road should be considered based on the needs of the community in this area.

CONCLUSIONS AND RECOMMENDATIONS

Existing Traffic and Geometric Conditions

- There are three existing left-turn lanes on NE Jackson School Road:
  - NE Rogahn Street – southbound left
  - NE Estate Drive – northbound left
  - NE Hardwood Street – northbound left
- The existing 2015 ADT along NE Jackson School Road was measured to be approximately 7,000 vehicles per day.
- The average existing 85th percentile speed measured along NE Jackson School Road was found to be approximately 40 MPH, which exceeds the posted speed of 35 MPH.

Crash Analysis

- A total of 36 crashes were reported along NE Jackson School Road in the past 5 years. Two crash trends were identified at the NW Evergreen Road/NE Jackson School Road and the NE Arrington Road/NE Jackson School Road intersections.
    - NE Arrington Road and NE Jackson School Road:
        - 6 of 9 reported crashes were of the rear end type involving vehicles traveling in the southbound direction.
        - Constructing a southbound left-turn lane is anticipated to decrease the risk of southbound rear-end crashes at this intersection.

Traffic Operations Analysis

- Existing traffic operations at the study intersections were found to operate acceptably (LOS "E" or better) for both the weekday a.m. and p.m. peak periods.
- The following intersections fail for the future year 2035 No-Build traffic operations:
    - The NW Evergreen Road/NE Jackson School Road signalized intersection currently operates at LOS "F" in the weekday a.m. peak hour.
    - The NE Harewood Street/NE Jackson School Road unsignalized intersection currently operates at LOS "F" in the weekday a.m. and p.m. peak hour.
    - The NE Sunrise Lane/NE Jackson School Road unsignalized intersection currently operates at LOS "F" in the weekday p.m. peak hour.
- The following intersections on the NE Jackson School Road Corridor warrant left-turn storage lanes in future year 2035 traffic operations analysis:
        - NE Kathryn Street – Southbound left
        - NE Sunrise Lane – Southbound Left
        - NE Hood Street – Southbound Left
        - NE Baldwin Street – Southbound Left
        - NE Arrington Road – Southbound Left
        - NE 6th Avenue Drive – Northbound Left
- Future Traffic Signal Warrant Analysis:

MUTCD Warrant	Warrant Met? (Approx. Year Met) NE Harewood Street/NE Jackson School Road
1. Eight-Hour Volume	Yes (2019)
2. Four-Hour Volume	Yes (2016)
3. Peak Hour Volume	Yes (2019)

- Proposed improvements have been identified for the following intersections in the year 2035 Build traffic operations analysis:

Study Intersection	Proposed Improvement	Justification
NW Evergreen Road/ NE Jackson School Road	Build out NW Evergreen Road to a five-lane cross section.	Identified in the RTP and Washington County TSP to be widened to 5-lanes.
NE Harewood Street/ NE Jackson School Road	Install traffic signal or single-lane roundabout	This intersection will not meet City operational standards as an unsignalized intersection. Traffic signal warrants are met in the near-term. A single-lane roundabout provides adequate capacity.
NE Sunrise Lane/ NE Jackson School Road	Install center turn lane on Jackson School Road (3-lane section) through the intersection.	Southbound left-turn lane is warranted.
NE Arrington Street/ NE Jackson School Road	Install center turn lane on Jackson School Road (3-lane section) through the intersection.	Southbound left-turn lane is warranted. Six (6) reported rear-end crashes in the southbound direction over 5 years.

- Year 2035 Build Analysis 95th Percentile Queues:
    - Vehicle queues can be accommodated with a minimal build-out of NE Jackson School Road except for the northbound right movement of the NW Evergreen Road/NE Jackson School Road intersection. However, there may be opportunities to adjust the signal timing for the weekday a.m. peak hour conditions in the future to better accommodate long queues which may be present.

Crosswalk Assessment

- An assessment to whether crossing treatments should be performed at future year unsignalized crosswalks was performed. Results of this assessment indicate:
    - The RRFB pedestrian crossing at the NE Estate Drive/NE Jackson School Road intersection will remain the appropriate near-term treatment.
    - Signalized or striped pedestrian crossings will be included with a proposed signal or roundabout, respectively, at NE Harewood Street.
- The provision of a crosswalk, signage, or other pedestrian crossing enhancements at (or in the vicinity of) the NE Arrington Road/NE Jackson School intersection would provide pedestrians greater visibility to more safely cross NE Jackson School Road.

REFERENCES

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8. Institute of Transportation Engineers. *Trip Generation Manual, 9th Edition.* 2012.
9. Washington County. *Approval Process for New Pedestrian Crossings at Mid-Block Locations and Uncontrolled Intersections.* 2010.

ATTACHMENTS

A. Description of Level-of-Service and Volume-to-Capacity Methods and Criteria
B. Average Daily Traffic Count Data
C. Turning Movement Traffic Count Data
D. Existing Conditions Level-of-Service Worksheets
E. Existing Conditions Signal Warrant Analysis Worksheets
F. ODOT Crash Data
G. Travel Demand Model Volume Plots
H. Year 2035 No-Build Conditions Level-of-Service Worksheets
I. Year 2035 Build Conditions Level-of-Service Worksheets
J. Year 2035 Signal Warrant Analysis Worksheets
K. Year 2035 Build Conditions Queuing Analysis Worksheets