KITTELSON & ASSOCIATES, INC.
1001 SW Emkay Dr # 140, Bend, OR 97702
P 503.228.5230 F 503.273.8169

MEMORANDUM #3

Date:	May 15, 2023 — Project #: 27003.004
To:	South Madras Refinement Plan Project Management Team (PMT)
From:	Jacqueline Smith, PE; Matt Kittelson, PE; Daniel Bowers
Project:	South Madras Refinement Plan
Subject:	Technical Memorandum #3 – Analysis Methodology & Assumptions (Task 3.3)

This memorandum documents the methodologies and assumptions associated with the existing and future transportation system operations analyses for the South Madras Refinement Plan. The methodologies and assumptions included in this memorandum are based on guidance provided in the Oregon Department of Transportation (ODOT) Analysis Procedures Manual (APM), and direction provided by City of Madras (City) and ODOT staff. The methodologies and assumptions described in this memorandum will help identify potential gaps and deficiencies in the existing transportation system and the future needs to accommodate growth.

STUDY AREA AND BACKGROUND

The study area is the land located within the City limits bordered by the Colfax Lane to the south, Culver Highway to the west, Adams Drive to the east, and J Street to the north. The study segments and intersections include locations along key corridors including US-97, Culver Highway (OR361), and Adams Drive. Figure 1 illustrates the study area.

STUDY INTERSECTIONS

Three-hour evening commute traffic counts (3:00-6:00 PM) will be collected in April 2023 at the following study intersections:

- US 97 NB/J Street
- US 97 SB/J Street
- US 97/Bard Lane
- US 97/ Fairgrounds Road
- US 97/Hall Road
- US 97/Colfax Lane
- Culver Hwy/Colfax Lane
- Culver Hwy/Fairgrounds Road
- Culver Hwy/J Street
- Adams Drive/Bard Lane

- Adams Drive/Hall Road

In addition to the turning movement counts, 48-hour volume, speed, and vehicle classification counts will be collected at the following locations:

- US 97 approximately 300 feet north of Fairgrounds Road
- US 97 approximately 600 feet north of Colfax Lane
- Culver Hwy approximately 300 feet south of Fairgrounds Road

Figure 1 illustrates the location of the identified study intersections and the tube count locations. Both the turning movement counts and the tube counts will be collected consistent with Task 4.1f of the Work Order Contract (WOC) scope of work.

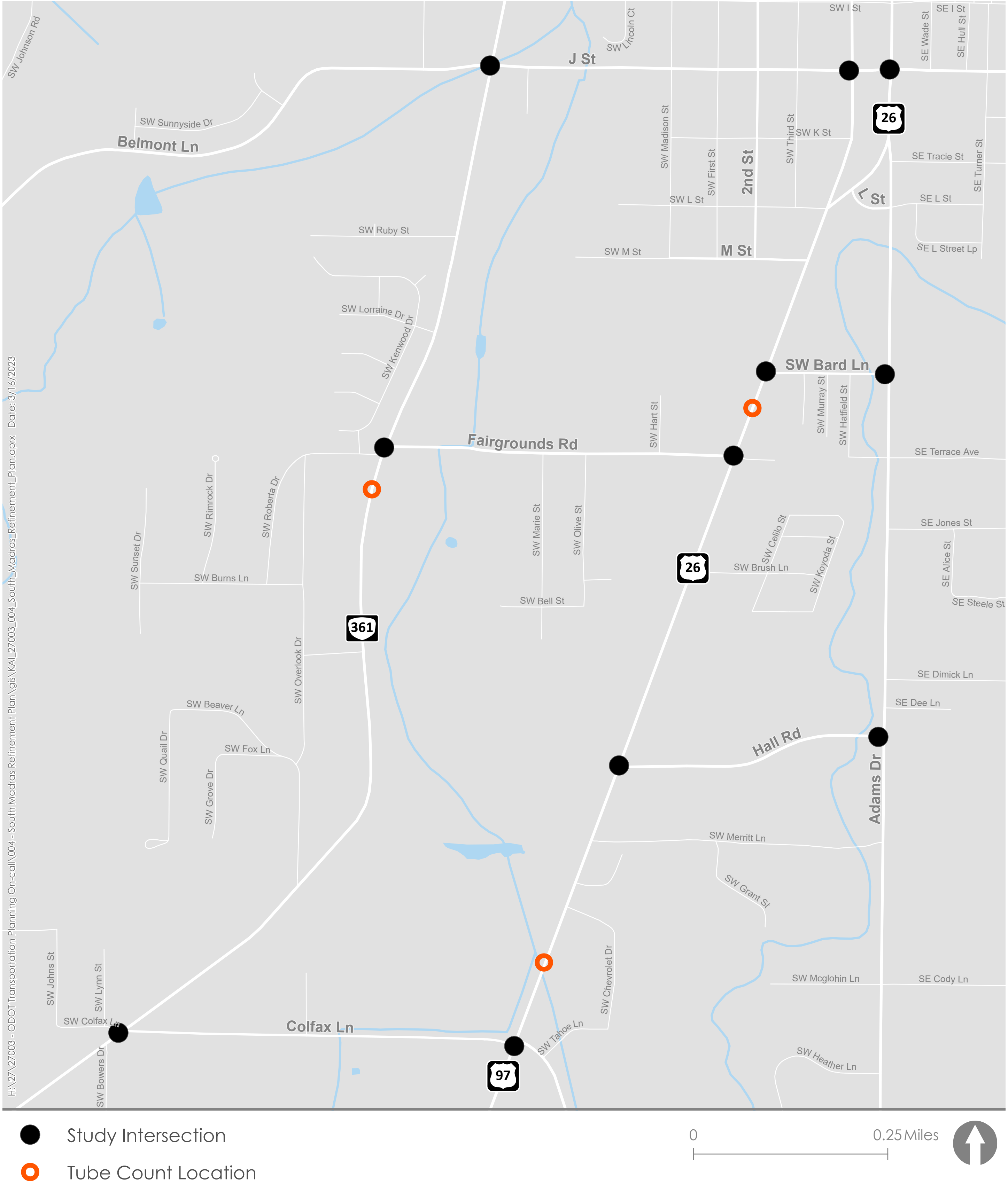

Figure 1

Study Area
South Madras, Oregon

KITTELSON & ASSOCIATES

PEAK HOUR DEVELOPMENT

The traffic counts will be reviewed to identify a system-wide PM peak hour for the operational analysis. Additionally, the 24-hour tube count data will be evaluated to determine if there are other peak hour trends at different times to the PM peak period that may warrant further evaluation.

SEASONAL ADJUSTMENT FACTOR

Per Task 4.2.B, all traffic counts along the state routes should reflect 30th highest hour conditions. Version 2 of the APM identifies three methods for identifying seasonal adjustment factors for highway traffic volumes, of which the **On-Site Automatic Traffic Recorders (ATR)** have been identified by ODOT as the most accurate method of use per Section 5.4.1 of the APM.

"The On-Site ATR Method is used when an ATR is within or near the project area. If located outside of the project area, there should be no major intersections between the ATR and the project area, and it should be within a minimal distance so that the traffic characteristics such as road class, number of lanes, rural/urban area, etc., are comparable. It is also important to check that the project area's AADT in the Transportation Volume Table is within +/- 10% of the ATRs AADT.".

ATR 16-002 is located within the study area and was selected as the most appropriate seasonal adjustment factor for the entirety of the study area based on its proximity and similar seasonal variation along both US97 and Culver Highway.

The seasonal adjustment factor was determined by averaging the monthly ADT over the course of the most recent 5-year period (2017-2021). Table 2 summarizes adjustment factor from the On-Site ATR.

Table 1: On-Site ATR Method Seasonal Adjustment Method

ATR Station	ATR Location	Seasonal Adjustment Factor	Applied Area
ATR 16-002	US97; THE DALLES-CALIFORNIA HIGHWAY NO. 4; 0.18 miles north of Madras-Prineville Highway No. 360 (US26)	1.21	US 97 corridor, Culver Highway, side streets

FORECAST YEAR VOLUME DEVELOPMENT

Per task 4.3.A of the scope, the baseline year 2045 (20-year planning horizon) will be used as the future design year.

Since there is no Travel Demand Model for Jefferson County or the City of Madras, forecast traffic volumes will be developed for the study intersections in accordance with the **Zonal Cumulative Analysis** methodology described in the APM. This methodology is suggested when analyzing entire cities of up to 10,000 residents. This methodology combines growth in regional traffic volumes with growth in local traffic volumes associated with projected household and employment growth in the city. The traffic volume projection process includes three steps (trip generation, trip distribution, and trip assignment). The process accounts for the following four categories of vehicle trips:

1. *External-External (through trips):* vehicles with an origin and destination outside the UGB. An example of an external-external trip is someone traveling from Portland to Bend through Madras.
2. *External-Internal (inbound trips):* vehicles with an origin outside the UGB and a destination inside the UGB. An example of an external-internal trip is someone who works in Redmond but returns home to Madras.
3. *Internal-External (outbound trips):* vehicles with an origin inside the UGB and a destination outside the UGB. An example of an internal-external trip is someone who works in Madras but returns home to Prineville.
4. *Internal-Internal (local trips):* vehicles with an origin and destination inside the UGB. An example of an internal-internal trip is someone who travels from their home to the grocery store without leaving Madras.

Using these vehicle trip types, the basic steps for a zonal cumulative analysis are:

1. Identify the study area and divide into transportation analysis zones (TAZ).
2. Identify vacant lands, in-process developments, comprehensive plan allowed land uses/densities, and development rates using Census data and GIS data from the City.
3. Develop trip generation estimates for new residential, retail/commercial, office, and other uses by TAZ.
4. Determine the through trip percentages and E-E trips for the external station (external zone).
5. Determine the I-E and E-I trips at each external station (external zone).
6. Determine the trip distribution for the I-E and E-I trips for each internal TAZ.
7. Determine the trip distribution for I-I trips.
8. Calculate network link travel times.
9. Assign total trips to the network and the study intersections.

The methodology above will be used to estimate the growth potential of the developable lands within the study areas. Forecast traffic volumes growth external to the study areas will be developed based on information provided in the Statewide Integrated Model (SWIM). SWIM provides base and forecast year traffic volume projections that reflect anticipated land use changes and planned transportation improvements. The SWIM model is up-to-date and readily available with base year 2019 and future year 2045 traffic volume projections.

INTERSECTION OPERATIONAL STANDARDS

Per Task 4.2.B, the following performance measures and information will be provided for each of the study intersections, regardless of jurisdictional control:

- Volume-to-capacity (v/c) ratio;
- Level-of-service (LOS);
- Delay;
- 95th Percentile queuing (non-simulation based); and
- Turning movement counts.

This information will be provided in tables, figures, and/or technical appendices, but where possible will be provided in figures to give the general public a more clear and relatable understanding of the analysis results.

ODOT Mobility Targets

ODOT assesses intersection operations based on established mobility targets (as defined by the volume-to-capacity (v/c) ratio). Table 6 of the *Oregon Highway Plan* (OHP) provides the mobility targets for facilities outside the Portland Metro area (Note that Highway Design Manual standards will be used to evaluate potential solutions in Technical Memorandum #6.1, Develop System Concepts). There are two state facilities within the study area: US 97 (The Dalles-California Highway) which is designated by the OHP as Statewide Freight Route and OR361 (Culver

Highway) which is designated by the OHP as a District Highway. US97 is designated as an Expressway beginning approximately 600 feet north of Colfax Lane continuing south through the project limits.

Six of the eleven study intersections are located on US 97. Table 6 of the OHP states that a freight route on a statewide highway outside of an MPO but within an urban growth boundary should maintain a mobility target v/c ratio less than 0.85 if speeds are less than or equal to 35 mph and a target v/c ratio less than 0.80 if the speed limit is greater than 35 mph. The posted speed is 45 mph from Colfax Lane to north of Hall Road, where it changes to 35 mph, and then it changes again to 25 mph at the couplet. The expressway designation also identifies a mobility target v/c ratio less than 0.85. The OHP also states that non-state highway unsignalized intersection approaches should adhere to the volume to capacity ratio for District/Local Interest Roads. Therefore, the mobility standard for the side street approaches to US 97 intersections within the study area is a v/c ratio less than 0.95 for speed limits less than or equal to 35 mph and 0.90 for speed limits greater than 35 mph.

Three of the eleven study intersections are located on Culver Highway. Culver Highway is classified as a district highway, and the speed limit is greater than 45 mph through the study limits of this project. Table 6 of the OHP states that the maximum v/c ratio for District/Local Interest Roads should be 0.90. This includes both the main line (district highway) and the side streets (local interest roads).

Table 10-2 of the ODOT 2023 Highway Design Manual (HDM) provides V/C ratios used to assist in identifying future system deficiencies and evaluating future alternatives on state highways. The ODOT HDM states that a statewide (NHS) freight route inside an urban growth boundary and outside an MPO should be designed for a mobility target v/c ratio less than 0.70 for a new roadway. Additionally, the HDM states that district highways and local interest roads should be designed for a mobility target v/c of 0.80 where speed limits are less than 45 mph and 0.75 where speed limits exceed 45 mph. Depending on the operational efficiencies of various identified alternative improvements, an alternative mobility standard may be presented within the refinement planning process.

The remaining two intersections are owned and maintained by the City of Madras, which has an adopted performance standard of Level of Service (LOS) E or better for unsignalized intersections shown in the City of Madras Transportation System Plan (TSP). Table 1 shows the intersection control and mobility targets for the study intersections.

Table 2: Study Intersection Control and Mobility Targets

Study Int. #	Intersection	Classification / Jurisdiction	Intersection Control	Mobility Target	
1	US 97 NB/J Street	ODOT	Unsignalized	Side-Street: OHP: v/c<0.95 Mainline: OHP: v/c<0.85	HDM: v/c<0.70
2	US 97 SB/J Street	ODOT	Unsignalized	Side-Street: OHP: v/c<0.95 Mainline: OHP: v/c<0.85	HDM: v/c<0.70
3	US 97/Bard Lane	ODOT	Unsignalized	Side-Street: OHP: v/c<0.95 Mainline: OHP: v/c<0.85	HDM: v/c<0.70
4	US 97/ Fairgrounds Road	ODOT	Unsignalized	Side-Street: OHP: v/c<0.95 Mainline: OHP: v/c<0.85	HDM: v/c<0.70
5	US 97/Hall Road	ODOT	Unsignalized	Side-Street: OHP: v/c<0.90 Mainline: OHP: v/c<0.80	HDM: v/c<0.70
6	US 97/Colfax Lane	ODOT	Unsignalized	Side-Street: OHP: v/c<0.90 Mainline: OHP: v/c<0.80	HDM: v/c<0.70
7	Culver Hwy/Colfax Lane	ODOT	Unsignalized	Side-Street: OHP: v/c<0.90 Mainline: OHP: v/c<0.90	HDM: v/c<0.75
8	Culver Hwy/Fairgrounds Road	ODOT	Unsignalized	Side-Street: OHP: v/c<0.90 Mainline: OHP: v/c<0.90	HDM: v/c<0.75
9	Culver Hwy/J Street	ODOT	Unsignalized	Side-Street: OHP: v/c<0.90 Mainline: OHP: v/c<0.90	HDM: v/c<0.75
10	Adams Drive/Bard Lane	City	Unsignalized	LOS E	

Study Int. #	Intersection	Classification / Jurisdiction	Intersection Control	Mobility Target
11	Adams Drive/Hall Road	City	Unsignalized	LOS E

ANALYSIS MODEL PARAMETERS

The bullets below identify the proposed sources of data and methodologies to be used to analyze traffic conditions in Madras. Analyses of all state facilities will be conducted according to the most-recent version of the APM, unless otherwise agreed upon by both ODOT's Transportation Planning and Analysis Unit (TPAU) and the consultant team.

1. *Intersection/Roadway Geometry* (lane numbers and arrangements, cross-section elements, signal phasing, etc.) will be reviewed through aerial photography and confirmed through a field review. Available as-built data may also be used to verify existing roadway geometry. The analysis models will be built on scaled roadway line work from GIS or aerial photography in HCM supported analysis software.

2. *Operational Data* (such as posted speeds, intersection control, parking, right-turn on red, etc.) will be field verified. Data will be reviewed during a field visit and supplemented by available GIS data, aerials, photos, and the ODOT Video Log.

3. *Peak Hour Factors* (PHF) will be calculated for each intersection and applied to the existing conditions analyses. Where applicable, corridor or regional PHFs may be developed. PHFs of 0.95 will be used for the future analysis for high-order facilities (arterials), with 0.90 applied to medium-order facilities (collectors) and 0.85 applied to local roads. If the existing PHF is greater than these default future values, the existing PHF will be applied.

4. Traffic Operations
   a. Highway Capacity Manual (HCM) methodology shall be used for intersection analyses of the design hour conditions. The existing and future no-build analysis will utilize HCM supportive software for signalized and stop controlled study intersections. Roundabout alternatives will be analyzed using Sidra or HCS7 software. All input assumptions will be applied the same among the software. Level-of-service, delay, and volume-to-capacity ratios will be reported at each of the study intersections regardless of roadway jurisdiction.

   b. Queuing analysis methodology will be based on 95th percentile queue lengths as appropriate; ODOT's two-way stop-controlled intersection calculator tool will be used to estimate queue lengths for two-way stop-controlled intersections. Microsimulation is not proposed as part of the long-range planning effort.

Input Assumptions

This analysis will be consistent with the HCM procedures. Table 3 lists the proposed input parameters.

Table 3. Operations Parameters/Assumptions

Arterial Intersection Parameters	Existing Conditions
Peak Hour Factor	From traffic counts
Conflicting Bikes and Pedestrian per Hour	From traffic counts, as available
Ideal Saturation Flow Rate (for all movements)	1,750 passenger cars per hour green per lane
Lane Width	12 feet unless field observations suggest otherwise
Percent Heavy Vehicles	From traffic counts by movement, as available
95th percentile vehicle queues	HCM summary output

CRASH ANALYSIS

Per Task 4.2D, the most recent five years of crash data, as provided by ODOT, will be reviewed at the study intersections and study segments (where tube count data was collected). Any intersections or roadway segments that are identified as a Top 5% and 10% Safety Priority Index System (SPIS) site will be included in the crash data.

Intersection crash rates at each location will be compared to the 90th percentile rates, critical crash rates and the excess proportion of specific crash types, per the APM. Crash rates will also be compared to the ODOT Crash Tables II and IV severe injury and fatal crash rates. Any locations where the rates are exceeded, we will identify potential countermeasures using the ODOT All Roads Transportation Safety (ARTS) crash reduction factors.

ACTIVE TRANSPORTATION ANALYSIS

Per Task 4.2.C, the scope of work, existing gaps in the sidewalks, bicycle network, and transit network along the primary routes will be identified. Quantitative and qualitative analysis of active transportation facilities will be performed consistent with APM, Version 2 and include:

1. Qualitative (multimodal) assessment for transit modes;
2. A qualitative assessment of transit service and identification of underserved areas.
3. Gaps in intermodal connectivity (reference the City of Madras TSP for existing deficiencies).
4. Identification of safety concerns
5. Identification of barriers (gaps, topography)
6. Level of bicycle traffic stress (BLTS and pedestrian traffic stress (PLTS) analysis
7. Identification of treatments to achieve BLTS and PLTS 1 or 2 (i.e. separation) where existing conditions currently exceed.

NEXT STEPS

We look forward to your review of the assumptions and parameters documented herein and proposed to be used as part of the South Madras Refinement Plan Existing and Future conditions and alternative analyses.