Portland Area Mainline Needs Assessment

DRAFT

Alternative 9a – Ramp Metering

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Table of Contents

9a.1 Overview

Ramp metering is used across the country to control the traffic entering a freeway. States that use ramp meters include Washington, California, North Carolina, Minnesota, Arizona, and Nevada. A ramp meter is a traffic signal placed on an on-ramp that turns green for a few seconds and then red for a few seconds. The signals generally allow between one to three vehicles through per green light. This creates breaks in the line of entering vehicles, which can improve traffic conditions on the mainline of the freeway. The key components of this alternative would consist of:

- Installing ramp meters at the on-ramps upstream of the Turnpike mainline section with the highest traffic volume per direction;
- Where traffic volumes warrant, widening the on-ramps to two lanes; and
- Extending the length of the acceleration lanes where needed to accommodate the ramp meter.

9a.2 Key Assumptions

The analysis of this alternative follows a methodology that is based on engineering standards and practices. Descriptions of the assumptions and methods follow.

9a.2.1 Ramp Meter Warrants

Currently, there is no national engineering standard for ramp meter warrants. (A warrant is a description of the conditions that need to be in place in order to install a specific traffic device, i.e., a certain amount of traffic is required before a traffic signal is "warranted.") However, some states have adopted their own set of warrants. For this analysis, the ramp meter warrants of the Nevada Department of Transportation were used to determine at which ramps to place a ramp meter, as their warrants included those for traffic volume thresholds. Specifically, the traffic volume warrant was used to determine which locations were appropriate for the placement of a ramp meter. That warrant, for a freeway section with two mainline lanes in one direction, was 2,650 vehicles per hour (vph); with three mainline lanes in one direction it was 4,250 vph.

9a.2.2 Ramp Meter Lanes

The California Ramp Meter Design Manual states that "ramp meters have practical lower and upper output limits of 240 and 900 [vehicles per hour] per lane, respectively. Ramp meter signals set for flow rates outside this range tend to have high violation rates and cannot effectively control traffic." Therefore, on-ramps with less than 240 vehicles were not selected for a ramp meter installation. Further, on-ramps with more than 900 vehicles were assumed to need two ramp lanes to accommodate ramp meter volumes.

9a.2.3 VISSIM Models

VISSIM is a behavior-based traffic simulation model. It is a reliable and widely used engineering tool to assess complex traffic flows that involve extensive merging, diverging, and weaving. VISSIM models were set up using different signal timing scenarios to determine the throughput of traffic on the chosen ramps. These throughput numbers were then used to determine the traffic reductions that could be attained from ramp metering.

9a.2.4 Traffic Impact Analysis

In the analysis, ramp meters were set up during peak hours with a goal of limiting the on-ramp traffic to the point where the mainline traffic would be under capacity. Table 9a-1 and Table 9a-2 show the forecasted peak hour traffic on the Turnpike and the resulting reductions due to ramp meters. The outlined boxes represent the mainline traffic volume that is most overcapacity. Green rows represent three-lane Turnpike mainline sections; blue rows represent two-lane sections. The other rows represent the on and off-ramps. The ramp reductions are shown for those locations that would need a ramp meter because they are upstream of the Turnpike mainline section with the highest peak hour traffic volume.

Table 9a-1: AM Peak Hour Traffic with Ramp Meters

	2040 Traffic	2040 with Ramp Meters	Ramp Reduction		2040 Traffic	2040 with Ramp Meters	Ramp Reduction
Exit 36 NB on	2,499	1,443	1,056	Exit 36 SB off	906	811	
Exits 36-42	6,047	4,991		Exits 36-42	3,506	3,139	
Exit 42 NB off	505	416		Exit 42 SB on	312	312	
Exit 42 NB on	496	402	94	Exit 42 SB off	332	294	
Exits 42-44	6,038	4,976		Exits 42-44	3,526	3,120	
Exit 44 NB off	1,687	1,390		Exit 44 SB on	1,165	1,165	
Exits 44-45	4,351	3,586		Exits 44-45	2,360	1,955	
Exit 45 NB off	1,557	1,283		Exit 45 SB on	402	402	
Exit 45 NB on	687	687		Exit 45 SB off	1,262	1,001	
Exits 45-46	3,482	2,990		Exits 45-46	3,221	2,554	
Exit 46 NB off	1,065	915		Exit 46 SB on	236	236	
Exit 46 NB on	310	310		Exit 46 SB off	1,581	1,228	
Exits 46-47	2,727	2,386		Exits 46-47	4,566	3,547	
Exit 47 NB off	623	545		Exit 47 SB on	605	402	203
Exit 47 NB on	380	380		Exit 47 SB off	257	204	
Exits 47-48	2,484	2,221		Exits 47-48	4,218	3,349	
Exit 48 NB off	760	680		Exit 48 SB on	923	660	263
Exit 48 NB on	321	321		Exit 48 SB off	636	519	
Exits 48-52	2,044	1,862		Exits 48-52	3,931	3,208	
Exit 52 NB off	510	464		Exit 52 SB on	823	516	307
Exit 52 NB on	178	178		Exit 52 SB off	374	324	
Exits 52-53	1,712	1,575		Exits 52-53	3,482	3,016	
Exit 53 NB off	598	550		Exit 53 SB on	1,191	725	466

Table 9a-2: PM Peak Hour Traffic with Ramp Meters

	2040 Traffic	2040 with Ramp Meters	Ramp Reduction		2040 Traffic	2040 with Ramp Meters	Ramp Reduction
Exit 32 NB on	1,460	1,032	428	Exit 32 SB off	1,761	1,487	
Exits 32-36	5,471	5,044		Exits 32-36	5,771	4,874	
Exit 36 NB off	1,225	1,129		Exit 36 SB on	916	916	
Exit 36 NB on	962	725	238	Exit 36 SB off	1,774	1,446	
Exits 36-42	5,208	4,639		Exits 36-42	6,629	5,404	
Exit 42 NB off	530	472		Exit 42 SB on	703	516	187
Exit 42 NB on	517	362	155	Exit 42 SB off	479	395	
Exits 42-44	5,195	4,529		Exits 42-44	6,405	5,283	
Exit 44 NB off	1,761	1,535		Exit 44 SB on	2,514	1,787	727
Exits 44-45	3,434	2,994		Exits 44-45	3,890	3,496	
Exit 45 NB off	1,104	962		Exit 45 SB on	908	721	187
Exit 45 NB on	1,638	1,032	606	Exit 45 SB off	762	709	
Exits 45-46	3,968	3,064		Exits 45-46	3,744	3,484	
Exit 46 NB off	357	276		Exit 46 SB on	758	601	156
Exit 46 NB on	1,307	804	503	Exit 46 SB off	572	552	
Exits 46-47	4,917	3,592		Exits 46-47	3,558	3,434	
Exit 47 NB off	612	447		Exit 47 SB on	462	402	60
Exit 47 NB on	282	282		Exit 47 SB off	203	199	
Exits 47-48	4,587	3,427		Exits 47-48	3,299	3,231	
Exit 48 NB off	935	698		Exit 48 SB on	972	904	68
Exit 48 NB on	494	494		Exit 48 SB off	392	392	
Exits 48-52	4,147	3,223		Exits 48-52	2,719	2,719	

The Portland Area Comprehensive Transportation System (PACTS) travel demand model was run with the traffic volume restrictions shown in Table 9a-1 and Table 9a-2 to determine the traffic impacts on the Portland area roadways for 2040. The traffic impacts identified included changes in traffic volumes on I-95 and key arterials, and changes in vehicle miles travelled (VMT) and vehicle hours travelled (VHT) for the Portland area.

9a.2.5 Traffic Impact Analysis Findings

Installing ramp meters and limiting traffic onto the Maine Turnpike provided benefits to safety and mobility on the Maine Turnpike, but negatively impacted other off-Turnpike roadways and intersections. A summary of key transportation findings includes:

- Improved safety benefits through anticipated reduction in volume on Maine Turnpike;
- Improve mobility with improved LOS and V/C ratios on all sections of Maine Turnpike between Exits 44 and 53; and
- Impacts to off-Turnpike roadways, notably traffic queues on the ramps that spill back to the toll plazas and to the roadways and intersections immediately adjacent to the Maine Turnpike between Exits 32 and 53. Specifically, the following ramps are expected to have a queue greater than 1500 feet in one or both peak hours:
    - Exit 36 NB on
    - Exit 42 NB on and SB on
    - Exit 44 SB on
    - Exit 45 NB on

- Exit 46 NB on
- Exit 47 SB on
- Exit 48 SB on
- Exit 52 SB on
- Exit 53 SB on

9a.3 Capital and Operating Costs

The capital costs to add ramp meters to selected on-ramps on the Turnpike in the Portland area was estimated to be approximately $10.4 million in 2018 dollars.

Adding ramp meters to selected on-ramps on the Turnpike in the Portland area would increase the total number of lane miles to be maintained by approximately 3 miles and an additional 13 traffic signals. With these additional miles, the additional operating and maintenance costs for this alternative would be $50,000.

No costs were estimated for the off-Turnpike roadway improvements that would be needed.

9a.4 Findings

Installing ramp meters on selected on-ramps in the Portland study area could decrease the traffic volumes on the Maine Turnpike by over 1,300 vehicles in the peak hour to under capacity thresholds (0.99).

This alternative was evaluated against several Measures of Effectiveness (MOEs) which are summarized in the Alternatives Evaluation Matrix, dated April 12, 2018. The key findings from that matrix for this alternative are as follows:

9a.4.1 Key Benefits

The key benefits of Alternative 9a – Ramp Metering are the following:

- Anticipated crash rate reduction of 32.4% on the Maine Turnpike;
- A peak hour demand reduction of 1,327 vehicles on the Turnpike;
- Has a viable funding source; and
- Can be implemented in a short timeframe.

9a.4.2 Key Impacts

The key impacts and challenges of Alternative 9a – Ramp Metering are the following:

- Increase of 20 miles of roadway near or over capacity off-Turnpike due to vehicles diverting Maine Turnpike with the delays to reach the Turnpike due to ramp meters;
- 1.0% increase in regional vehicle hours traveled (VHT);
- Increase in NOx (+0.1%) and HC (+0.3%), reducing air quality; and
- Potential wetland impacts.