



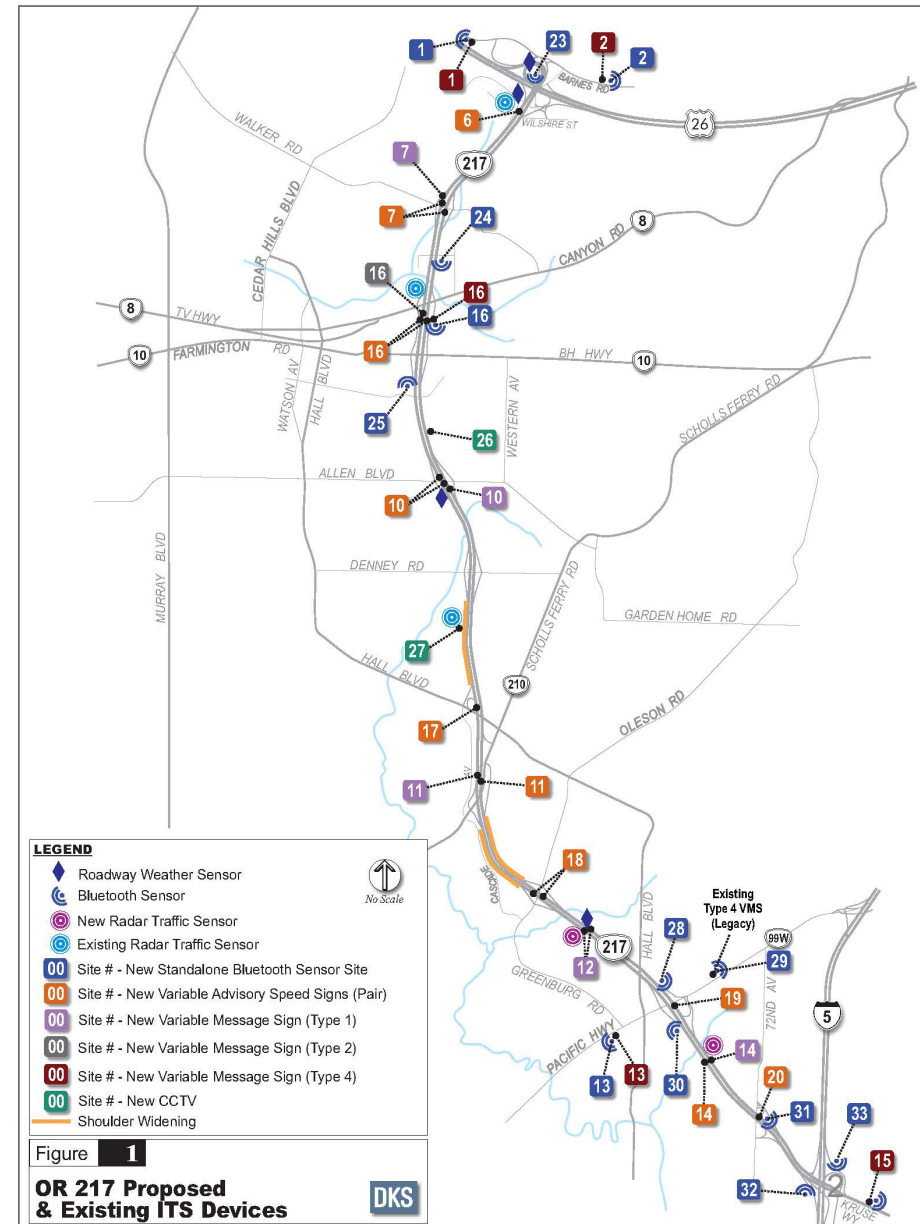
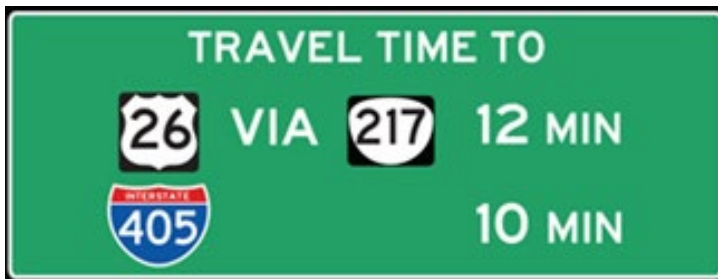
Weather Responsive Variable Speed Limit Systems in Oregon

Galen McGill
Oregon DOT
June 2019

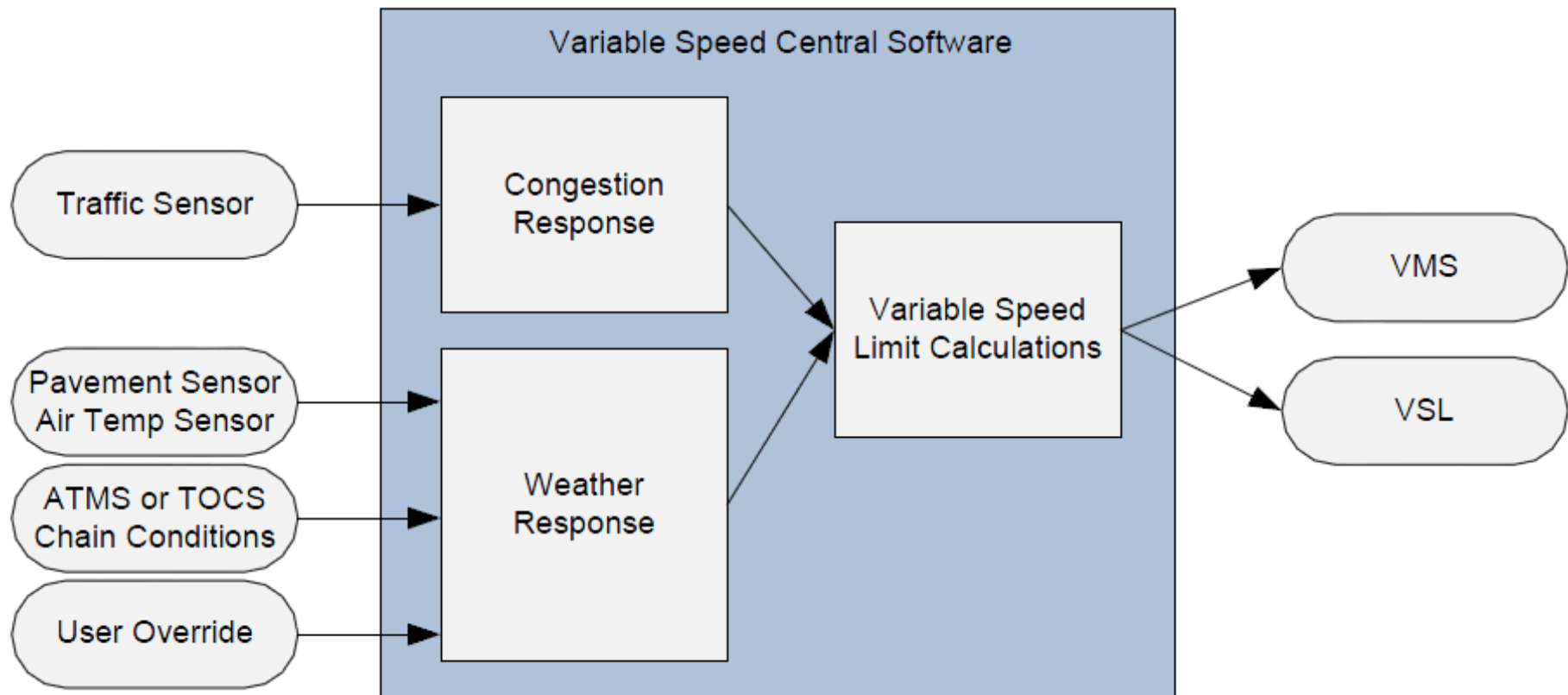


OR-217 VSL Overview

- 7.5 mile highway connecting I-5 and US-26
- 2-3 lane freeway with 122,000 ADT
- Signs provide travel time, weather warning, and advisory speed limits
- Congestion and weather response



ATM Operation Overview



TRAVEL TIME TO:
 26 5 MIN
 185TH VIA 26 10 MIN

USE CAUTION

CONGESTION AHEAD
 2 MILES

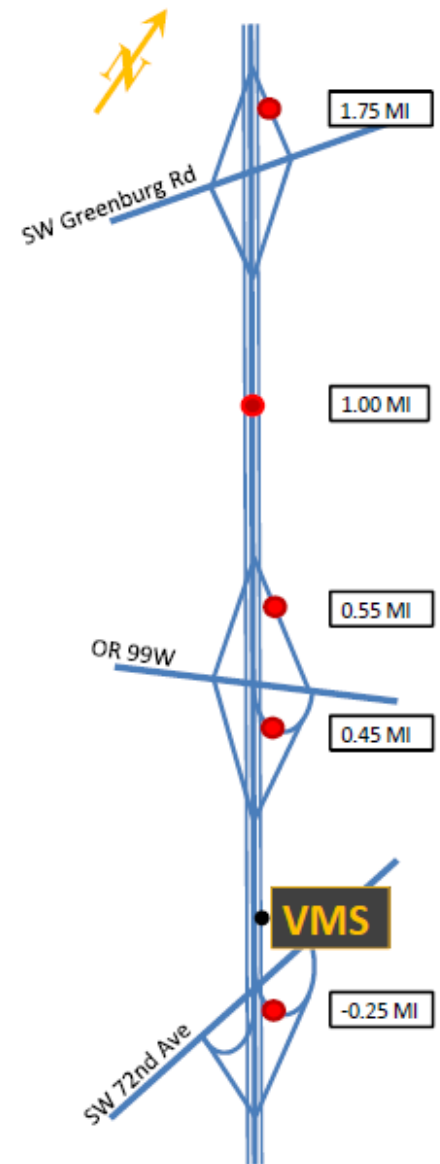
CONGESTION AHEAD
 1 MILE

CONGESTION AHEAD
 1/2 MILE

USE CAUTION

TRAVEL TIME TO:
 26 10 MIN
 185TH VIA 26 20 MIN

TOD	Friction Index	-0.25 72nd	0.5 Mile 99W Loop	0.5 Mile 99W Slip	1 Mile S. Greenburg	2 Miles Greenburg	99W VAS Speed
6:30 AM	74	60	56	56	55	53	50
6:31 AM		50	59	57	53	57	
6:32 AM	74	55	48	46	53	56	45
6:33 AM		55	44	44	47	54	50
6:35 AM	74	59	51	40	49	54	50
6:36 AM	74	53	47	47	51	51	blank
6:37 AM		50	48	43	49	49	
6:38 AM	74	52	48	44	45	50	45
6:39 AM		57	49	48	51	48	
6:40 AM	74	56	48	50	48	51	45
6:41 AM		56	48	40	49	50	45
6:42 AM	73	50	52	43	42	50	50
6:43 AM		55	47	47	44	50	45
6:44 AM	73	53	45	39	45	50	
6:45 AM		57	48	36	43	47	40
6:46 AM	71	54	45	34	43	44	40
6:47 AM		53	50	38	40	48	
6:48 AM	69	52	52	47	37	43	45
6:49 AM		55	47	44	43	42	
6:50 AM	66	56	47	42	45	47	45
6:51 AM		52	47	48	44	47	40
6:52 AM	69	55	50	48	43	42	
6:53 AM		53	48	48	40	42	45
6:54 AM	69	53	45	35	38	46	
6:55 AM		51	44	43	39	42	45
6:56 AM	67	55	42	36	38	36	45
6:57 AM		49	41	39	34	16	
6:58 AM	68	48	37	35	32	12	45
6:59 AM		41	29	33	32	26	
7:00 AM		56	34	39	18	35	
7:01 AM		54	35	23	19	34	
7:02 AM		50	28	14	21	32	45
7:03 AM		48	16	19	27	31	
7:04 AM		32	17	17	28	20	
7:05 AM		42	19	20	31	17	
7:06 AM	67	37	23	25	29	27	
7:07 AM		30	32	28	27	28	
7:08 AM	64	27	31	28	18	34	40
7:09 AM		21	32	23	18	36	40
7:10 AM	64	23	24	14	28	36	40
7:11 AM		20	11	16	29	39	45
7:12 AM	65	15	16	27	31	40	40
7:13 AM		16	20	26	31	38	35
7:14 AM	65	10	26	28	30	40	30
7:15 AM		10	27	31	30	42	
7:16 AM	64	12	32	31	28	37	
7:17 AM		15	30	26	29	40	
7:18 AM	64	17	30	24	32	37	
7:19 AM		14	29	25	33	34	
7:20 AM	65	15	29	25	32	35	
7:21 AM		17	28	31	33	23	
7:22 AM	66	15	31	32	36	12	
7:23 AM		13	30	36	29	17	
7:24 AM	69	13	34	36	17	19	
7:25 AM		13	34	24	17	12	
7:26 AM	71	14	29	13	21	6	
7:27 AM		15	12	17	17	16	
7:28 AM	71	17	14	16	14	26	30
7:29 AM		17	19	10	13	34	40
7:30 AM	72	11	14	7	16	35	30
7:31 AM		14	5	10	20	38	
7:32 AM	73	10	6	15	28	26	
7:33 AM		13	8	17	29	19	
7:34 AM	73	13	17	25	31	21	
7:35 AM		11	23	26	18	31	



OR-217 Weather Response Curve Warning



- Curve warning signs were added to 4 ramps connecting OR-217 to the adjacent freeways
- The signs are weather responsive displaying icy or wet conditions
- Signs are activated via grip factor, surface temperature, and surface condition data

OR-217 Congestion vs. Weather Responses

- 89% of speed reductions were due to congestion and 11% were due to weather
- Highest weather activations were during Winter months in the 1st and 4th quarter
- Weather based speed reductions occurred mainly during off-peak hours (6:00PM to 6:00AM)
- Table quantities are the combination of all 28 variable speed signs

	2015				2016				Total	
System	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Activations	Percent
Congestion	258,540	288,975	332,514	399,649	338,566	359,056	353,452	431,618	2,762,370	89%
Weather	59,695	4,789	5,358	97,573	54,639	0	1,910	122,053	346,017	11%

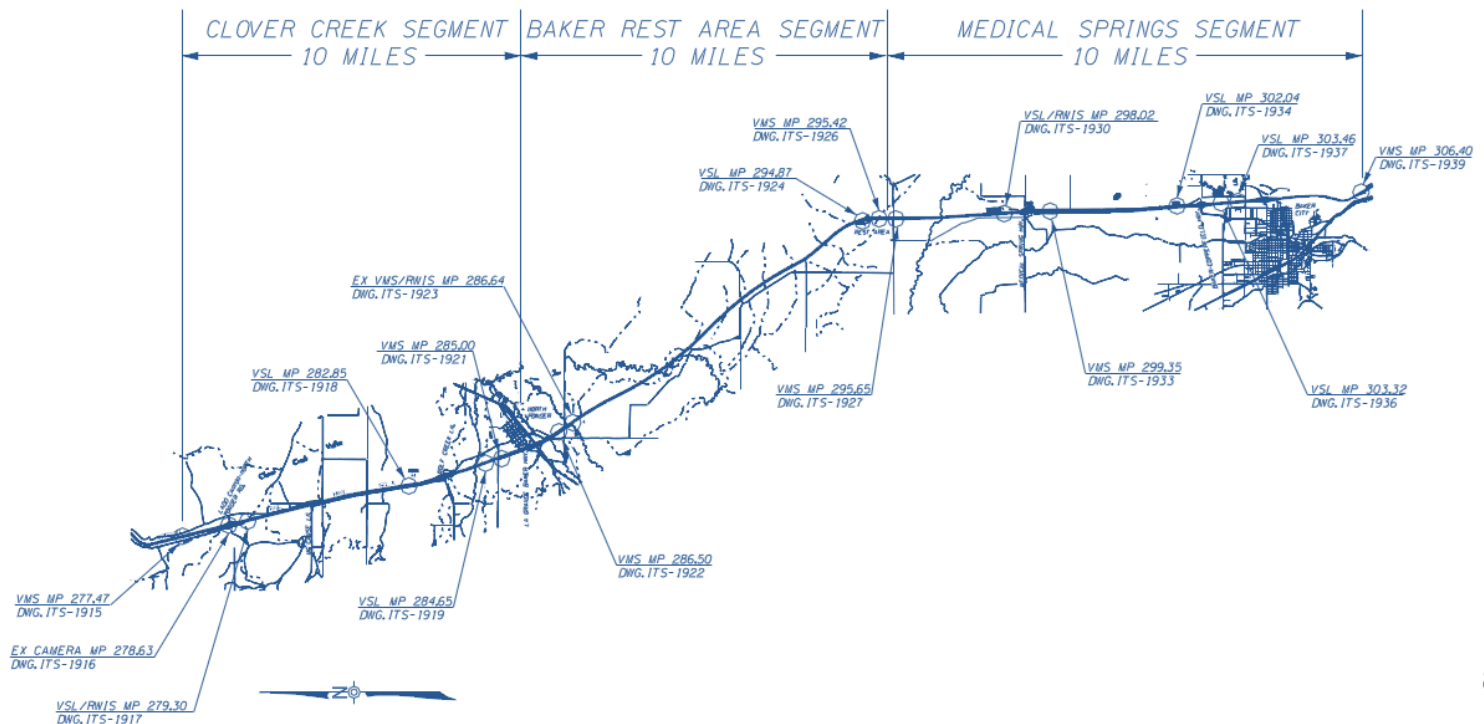
OR-217 VSL Driver Compliance

- There are 6 advisory speed limit options for congestion response and 2 for weather response in accordance with OAR 734-020-0019
- The difference between measured and posted advisory speeds are lower for weather based speed reductions

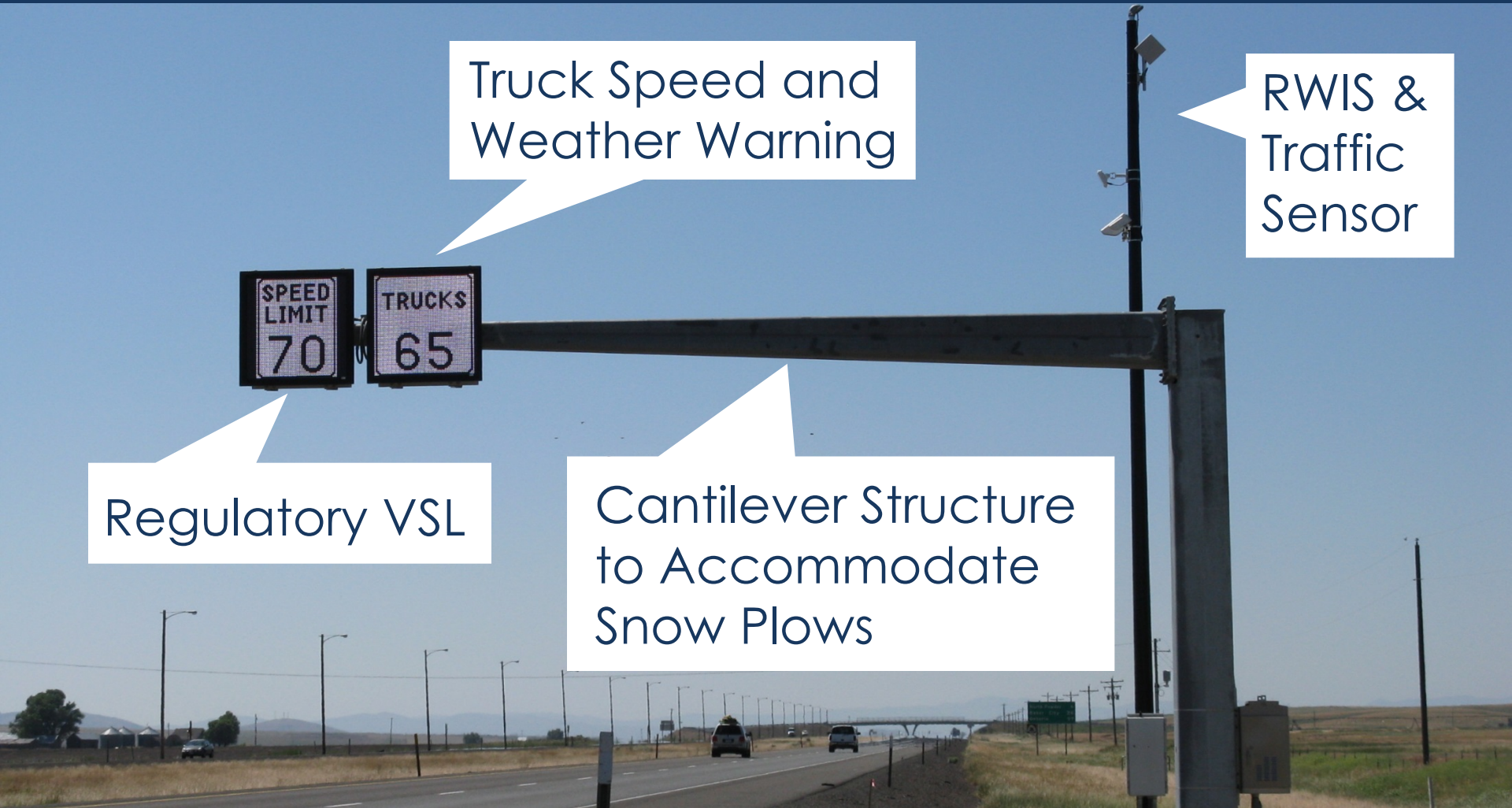
Activation Source	Advisory Speed	Obs. Speed, Avg	Difference between Observed & Advisory Speed, mph	Difference, %	Overall difference by system, mph	Number of Obs.
Congestion	25	25.0	0.0	0%	1.5	1,304,666
Congestion	30	34.2	4.2	14%		424,447
Congestion	35	43.5	8.5	24%		804,813
Congestion	40	43.8	3.8	9%		473,935
Congestion	45	48.7	3.7	8%		702,660
Congestion	50	45.4	-4.6	-9%		1,244,624
Weather	35	36.4	1.4	4%	-2.5	20,915
Weather	45	42.4	-2.6	-6%		522,539

Baker Valley VSL Overview

- 30 mile corridor on I-84, Oregon's primary east/west route
- 2 lane freeway with 10,500 ADT, 37% trucks
- Signs provide regulatory speed limits and weather warning
- Weather response only operation



Baker Valley Signs and Messages















Baker Valley Monitoring Equipment



Equipment is comprised of a pavement sensor, a temperature sensor, a humidity sensor, traffic sensor, and a camera.

Baker Valley Condition Table for Speed Reduction

Condition Code	Surface Condition Classification	Grip Factor	Visibility	Air Temperature	Condition Speed for 65 MPH Max Speed Limit Highways	Condition Speed for 70 MPH Max Speed Limit Highways	Weather Message	Actual Sign Message for 70 MPH Highways
1	Moist, Wet	Greater Than Threshold	Greater Than Threshold	Greater Than Threshold	Maximum Speed	70 MPH 65 MPH for Trucks	None	
2	Moist, Wet	Greater Than Threshold	Greater Than Threshold	Less Than Threshold	Maximum Speed	70 MPH 65 MPH for Trucks	None	
3	Moist, Wet	Greater Than Threshold	Less Than Threshold	Greater Than Threshold	Maximum Speed - 10 MPH	55 MPH	Low Visibility	
4	Moist, Wet	Greater Than Threshold	Less Than Threshold	Less Than Threshold	Maximum Speed - 10 MPH	55 MPH	Low Visibility	
5	Moist, Wet	Less Than Threshold	Greater Than Threshold	Greater Than Threshold	Maximum Speed - 20 MPH	45 MPH	Slippery When Wet Sign	
6	Moist, Wet	Less Than Threshold	Greater Than Threshold	Less Than Threshold	Maximum Speed - 20 MPH	45 MPH	Slippery When Wet Sign	
7	Moist, Wet	Less Than Threshold	Less Than Threshold	Greater Than Threshold	Minimum Speed (30 MPH)	30 MPH	Slippery When Wet Sign	
8	Moist, Wet	Less Than Threshold	Less Than Threshold	Less Than Threshold	Minimum Speed (30 MPH)	30 MPH	Slippery When Wet Sign	
9	Frosty, Snowy, Icy, or Slushy	Greater Than Threshold	Greater Than Threshold	Greater Than Threshold	Maximum Speed	70 MPH 65 MPH for Trucks	None	
10	Frosty, Snowy, Icy, or Slushy	Greater Than Threshold	Greater Than Threshold	Less Than Threshold	Maximum Speed	70 MPH 65 MPH for Trucks	None	
11	Frosty, Snowy, Icy, or Slushy	Greater Than Threshold	Less Than Threshold	Greater Than Threshold	Maximum Speed - 10 MPH	55 MPH	Low Visibility	
12	Frosty, Snowy, Icy, or Slushy	Greater Than Threshold	Less Than Threshold	Less Than Threshold	Maximum Speed - 10 MPH	55 MPH	Low Visibility	

Law Enforcement Data Portal

Variable Speed Reporter

Dashboard

Map

History

Help

Corridor: Baker Valley EB (277-305) ▼

Segment: -- All Segments -- ▼

Baker Valley EB (277-305)

Corridor Type: Regulatory

Max Speed: 70

Refreshed At: 6/19/2019 15:01:46

Segment / Sign

Reason / Updated

Next Speed / Current Message

I-84 MP 277.47 EB Clover Creek

No Impact

70

I-84 MP277.47 EB (Clover Creek) VSL

14:28



I-84 MP 279.30 EB Clover Creek

No Impact

70

I-84 MP279.30 EB (Clover Creek) VSL

14:28



I-84 MP 284.65 EB Wolf Creek

No Impact

70

User Override Manual Operation

Reason for Override	Speed	Command Priority	Duration (Default)
(70 MPH) Black Ice / Packed Snow *	45	Recommended	30 min
(70 MPH) Black Ice / Packed Snow – Escalated *	30	Recommended	30 min
(70 MPH) Condition B / B1 - Chain Requirement in Effect *	45	Recommended	30 min
(70 MPH) Condition C - Chain Requirement in Effect *	35	Recommended	30 min
(70 MPH) High Winds *	55	Recommended	30 min
(70 MPH) Ice / Packed Snow - Plus Low Visibility *	30	Recommended	30 min
(70 MPH) Standing Water / Spots of Ice *	55	Recommended	30 min
(70 MPH) Visibility Less Than 500 Feet *	55	Recommended	30 min
Black Ice / Packed Snow	Posted Speed - 20	Recommended	30 min
Black Ice / Packed Snow - Escalated	Minimum Slow Speed	Recommended	30 min
Condition B / B1 - Chain Requirement in Effect	45	Recommended	30 min
Condition C - Chain Requirement in Effect	35	Recommended	30 min
High Winds	Posted Speed - 10	Recommended	30 min
Ice / Packed Snow - Plus Low Visibility	Minimum Slow Speed	Recommended	30 min
Standing Water / Spots of Ice	Posted Speed - 10	Recommended	30 min
Visibility Less Than 500 Feet	Posted Speed - 10	Recommended	30 min
Temp Work Zone Speed Order ##### (Example: J9098C)	TBD	Recommended	Work Zone Duration
System Failure - Faulty Data	Posted Speed (Max)	Recommended	48 hours

*Only used for where maximum speed limit is 70MPH, e.g Baker Valley VSL system.

As of January, 2019

DSC/DST-111 Pavement Sensors

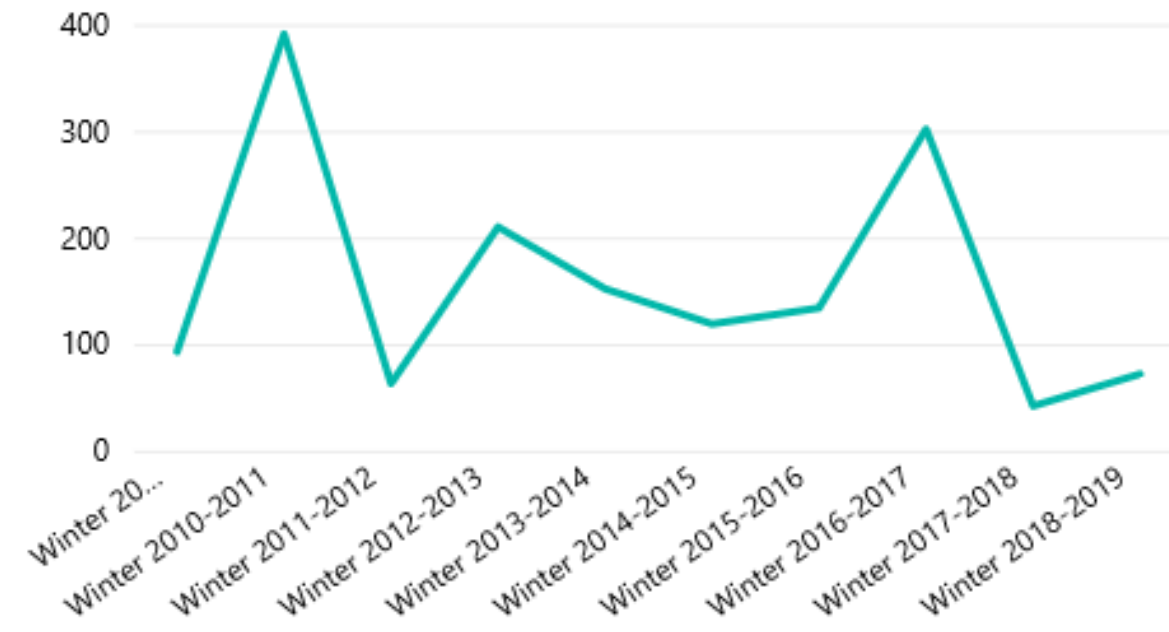
Snow covers only one lane causing a difference of pavement friction from one lane to the next.



ATM Operations	Winter 2016-2017	Winter 2017-2018	Winter 2018-2019
Override Count Total	215	19	26

Baker Valley Crash Count

Crash Count by Season



Season	Crash	Fatal Crash	Total
Winter 2009-2010	91	3	94
Winter 2010-2011	392		392
Winter 2011-2012	63	1	64
Winter 2012-2013	211		211
Winter 2013-2014	153		153
Winter 2014-2015	119	1	120
Winter 2015-2016	134	1	135
Winter 2016-2017	302	1	303
Winter 2017-2018	43		43
Winter 2018-2019	73		73
Total	1581	7	1588

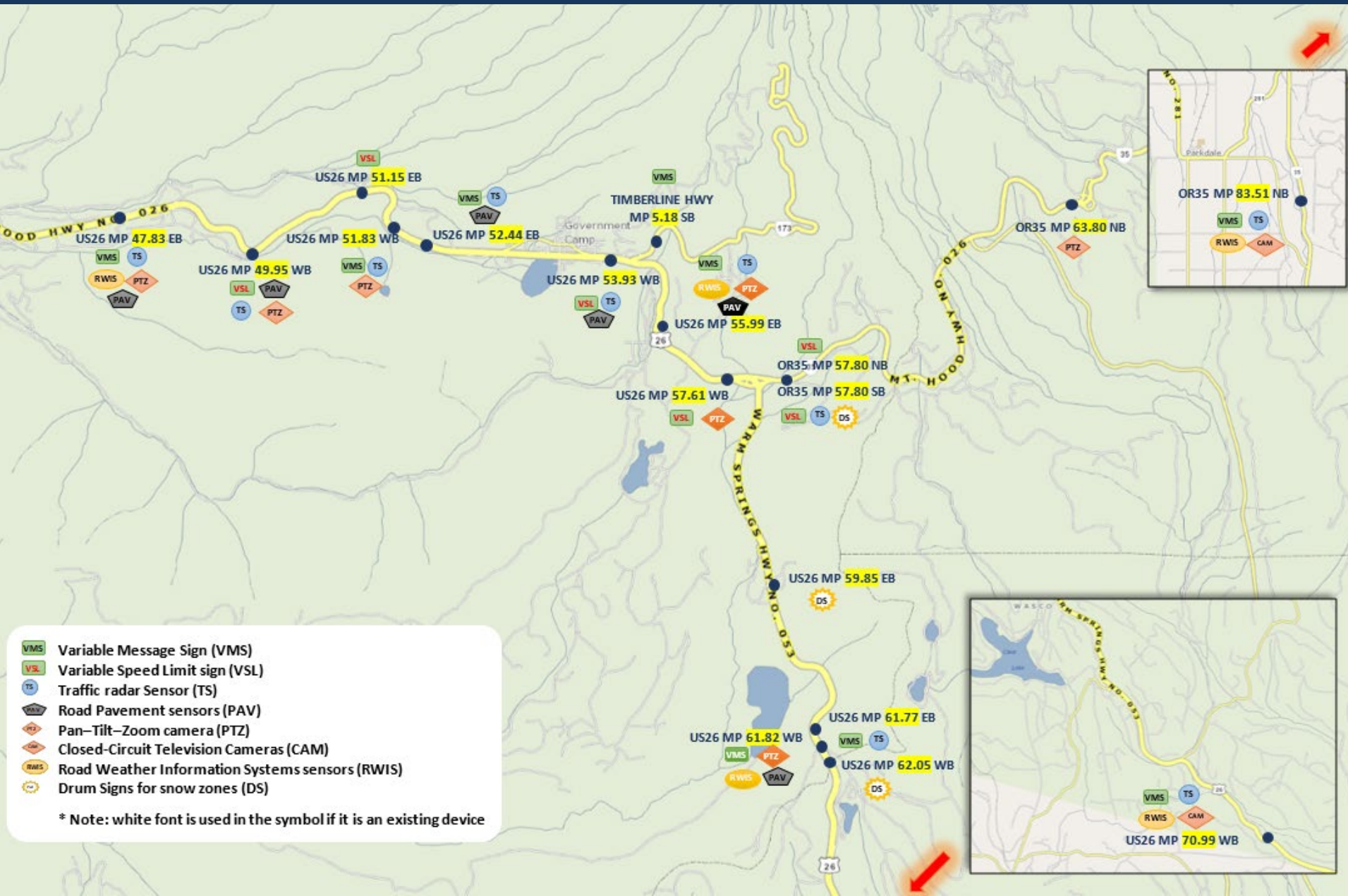


Baker Valley Activations

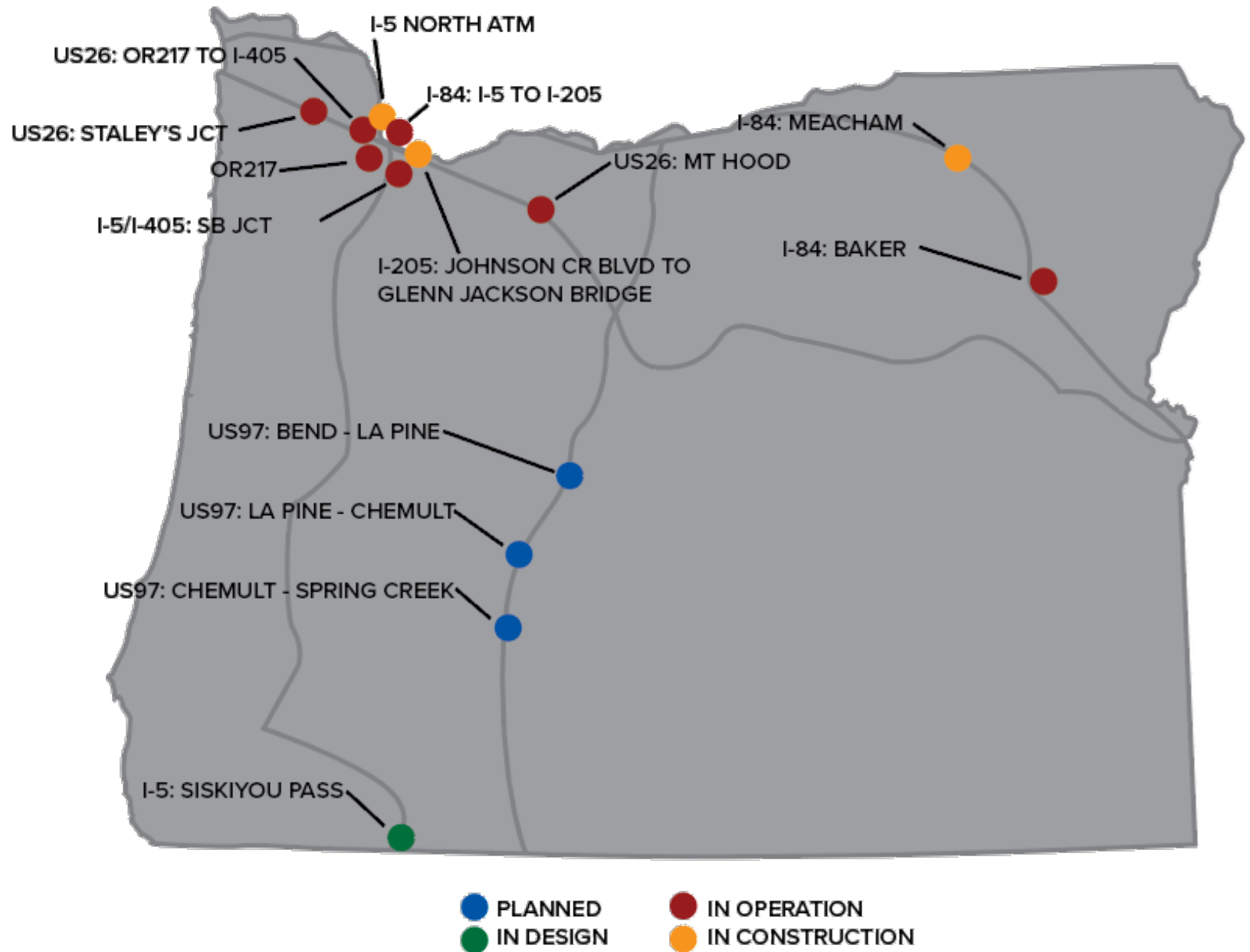
Activations				
Speed	Winter 2016-2017	Winter 2017-2018	Winter 2018-2019	Total
<input type="checkbox"/> 30	318	81	112	511
<input type="checkbox"/> 35	112			112
<input type="checkbox"/> 45	2840	1304	1366	5510
<input type="checkbox"/> 50	148	8		156
<input type="checkbox"/> 55	2277	1514	2097	5888
<input type="checkbox"/> 60	85		14	99
<input type="checkbox"/> 65	325			325
Total	6105	2907	3589	12601



Mt Hood ATM System



Oregon ATM Systems



Thank you.