



Variable Speed Limits

Current & Planned Systems

Transportation Engineering Conference

Presented by:

Dennis Mitchell, PE

ODOT

April 29, 2015





Presentation

Slides





Staley's Jct.

I-84: I-5 to I-205
US26: 217 to I-405
OR 217
I-5 / I-405 SB Jct.

Mt. Hood
2016

Meacham

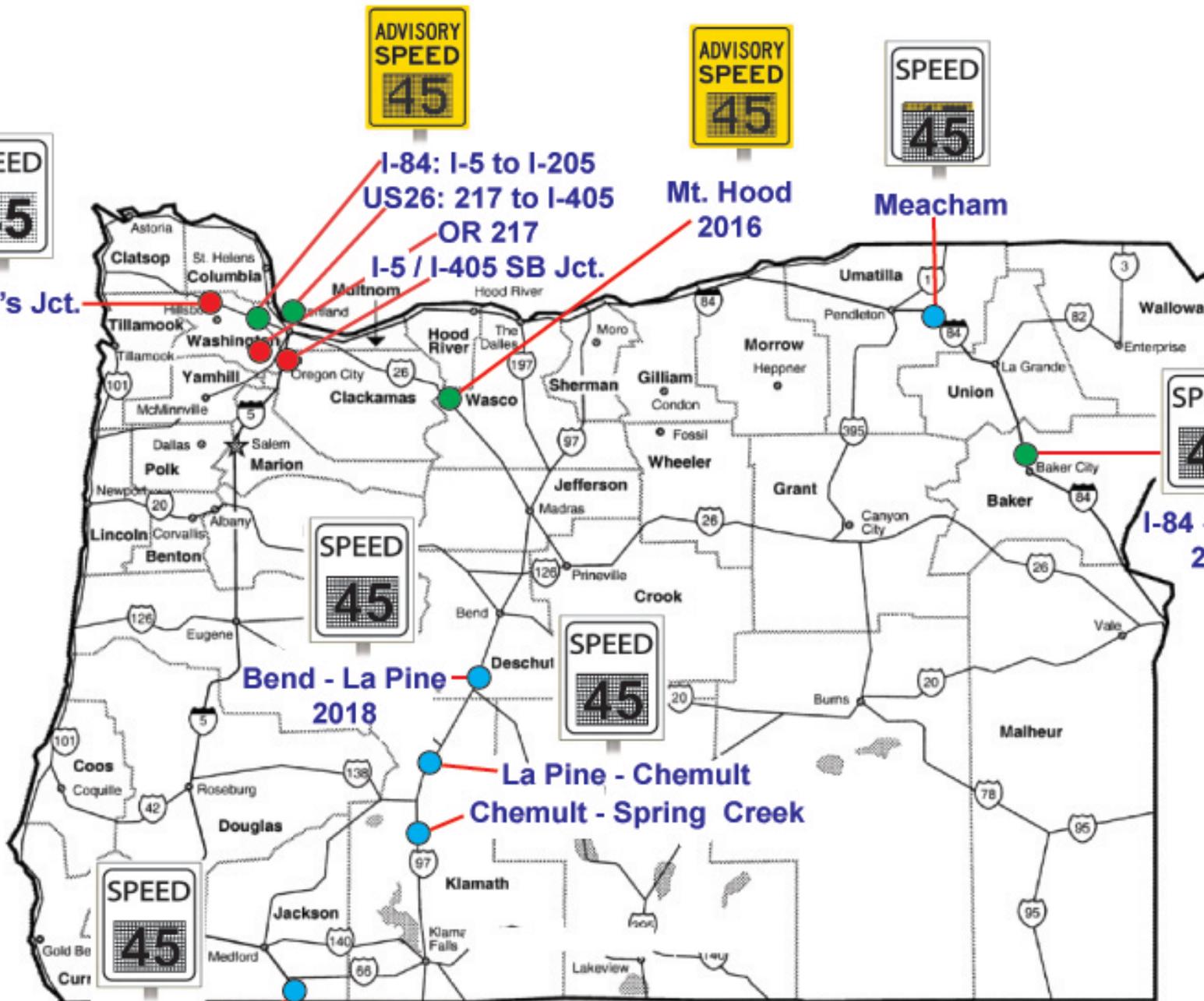
I-84 - Baker
2016

Bend - La Pine
2018

La Pine - Chemult
Chemult - Spring Creek

Siskiyou Pass

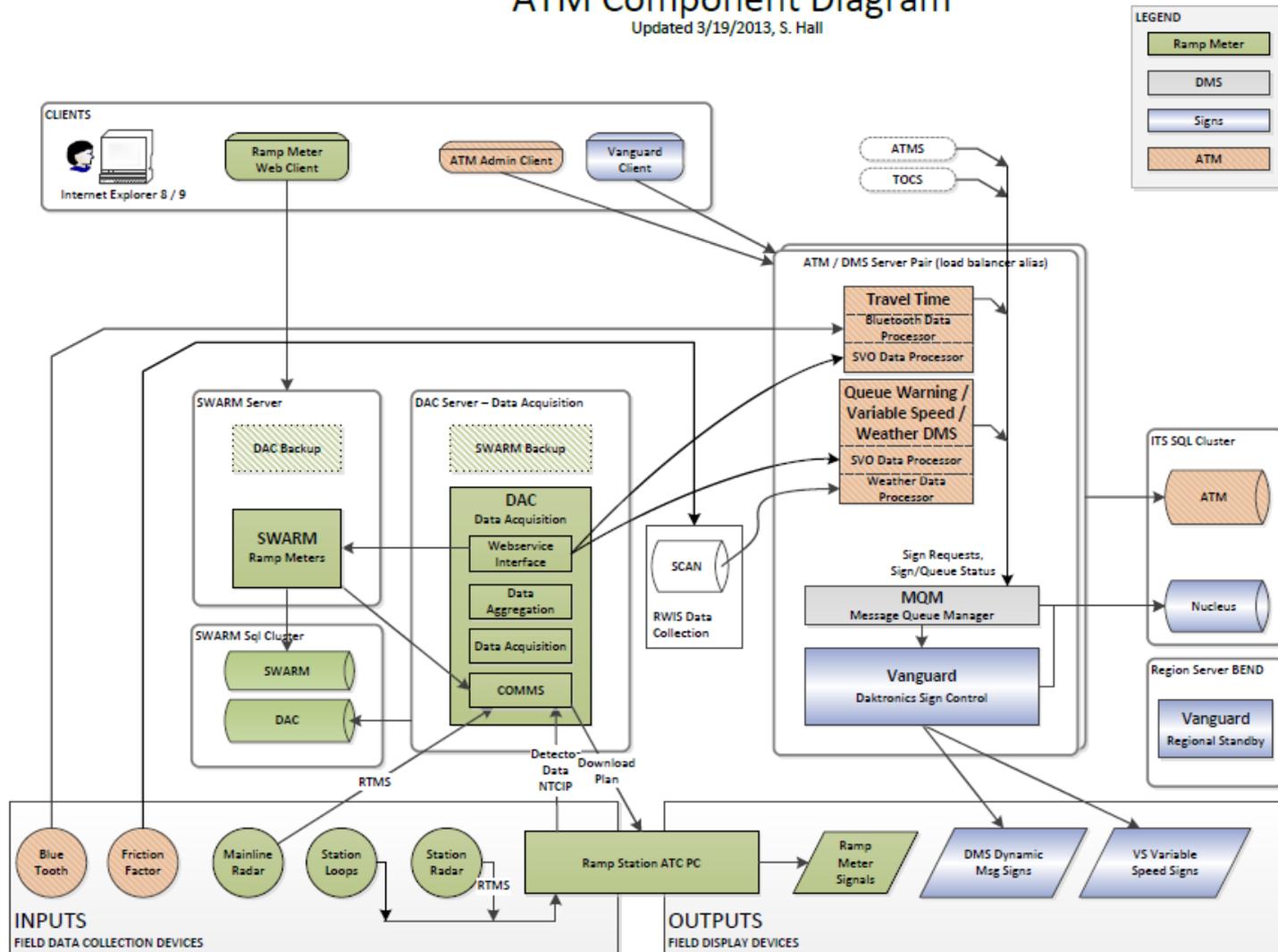
Planned ● In Operation ● In Design ●



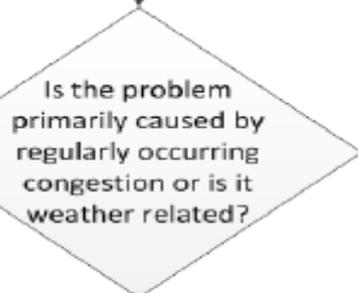
Software & Operations

ATM Component Diagram

Updated 3/19/2013, S. Hall



Once a variable speed system has been identified as a solution, start here to decide between a regulatory or advisory speed system



Regularly Occurring Congestion

Weather Related

Is the variable speed primarily for the safety of the driver*?

Will variable speeds be used in a corridor or at a specific location?

Yes

No

Corridor

Specific Location

Use Advisory Speeds

Use Regulatory Speeds

Use Regulatory Speeds

Use Advisory Speeds

Examples:
•OR217
•I-5/I-405 interchange

Examples:
•School zone
•Work zone
•Staley's Junction

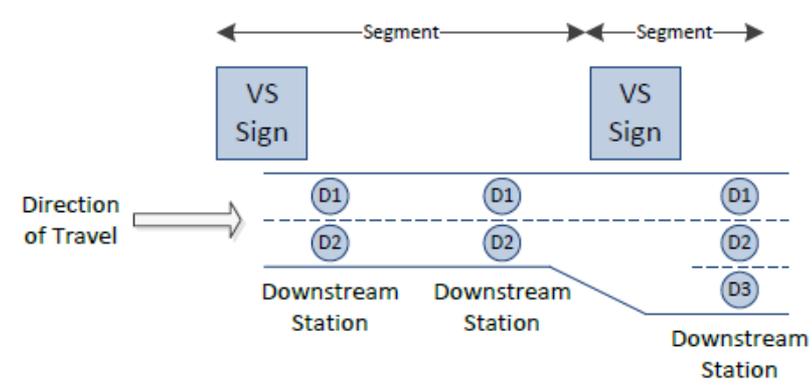
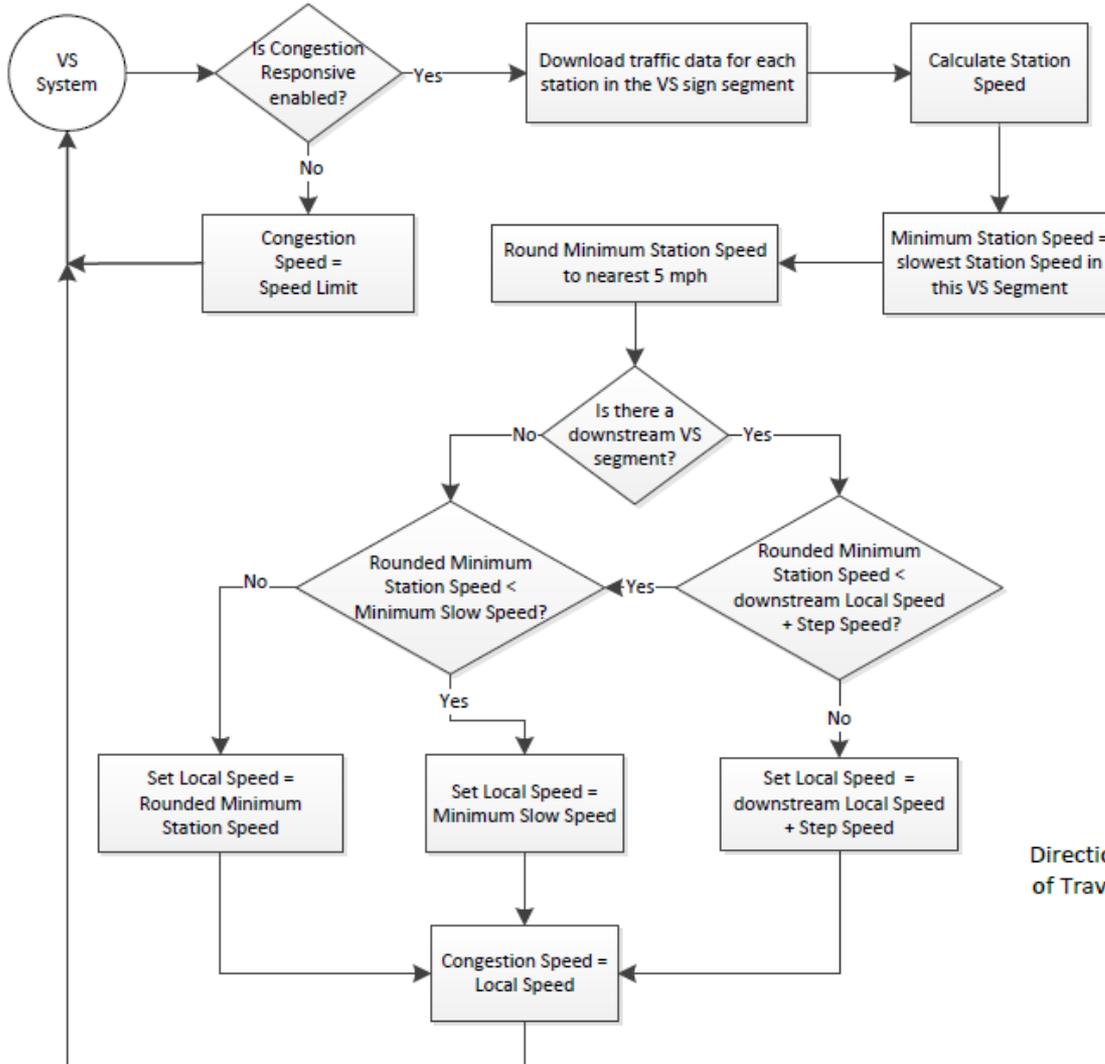
Examples:
•Rural freeway/
highway
•US97
•Siskiyou Pass

Examples:
•Segment < 2 miles
•Geometric feature

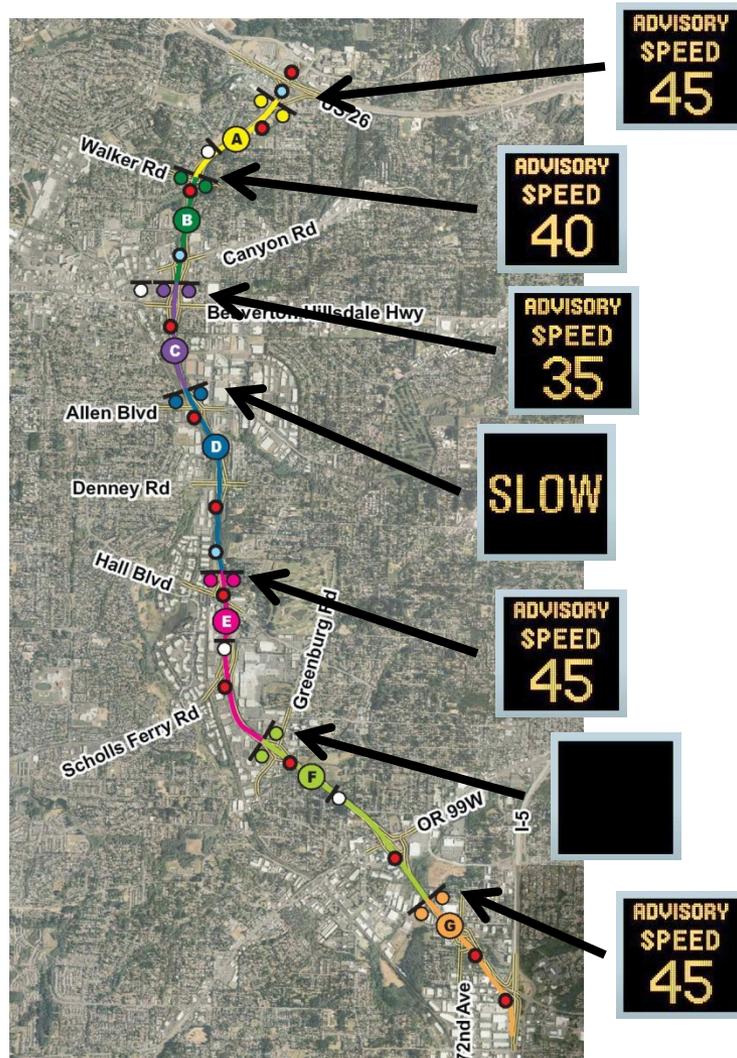
| | Regulatory Variable Speed | Advisory Variable Speed |
|---------------------------------|--|--|
| Compliance | <ul style="list-style-type: none"> Greater compliance is expected based on FHWA's guidelines. | |
| | <ul style="list-style-type: none"> Spot speed studies of static speed signing for I-5 mountain passes in southern Oregon show that: <ul style="list-style-type: none"> Up to 40% exceed posted speed | <ul style="list-style-type: none"> Over 75% exceed advisory speed |
| Enforcement | <ul style="list-style-type: none"> Posted speed is enforceable. Use of regulatory would support existing or planned active enforcement efforts. | <ul style="list-style-type: none"> Enforcement limited to basic rule for the regulatory speed zone. Consider advisory if there is limited shoulder width for active enforcement. |
| Crash Rate | <ul style="list-style-type: none"> May have more safety benefits in segments with crash rates higher than statewide average. The I-80 system in Wyoming reduced crashes by 55% the first year in operation. | <ul style="list-style-type: none"> Limited crash analysis is available. |
| Roadway Conditions | <ul style="list-style-type: none"> Use for segments longer than two miles per FHWA guidelines. | <ul style="list-style-type: none"> Consider advisory if the variable speed is limited to a single geometric feature such as horizontal or vertical curvature similar to the application of static advisory speeds. |
| Public Perception | <ul style="list-style-type: none"> The public perceives that regulatory speed enforcement is tied to revenue generation. Larger responsibility to display speeds based on accurate real-time data that is credible to drivers. | <ul style="list-style-type: none"> The public is more accepting of advisory speeds because there are no financial implications. |
| System Power and Communications | <ul style="list-style-type: none"> Hardwire power service and communications recommended to maintain regulatory system. | <ul style="list-style-type: none"> Consider advisory if solar power or cellular communications are most viable options. |
| Oregon Legal Requirements | <ul style="list-style-type: none"> Requirements include: <ul style="list-style-type: none"> Engineering study Speed zone order | <ul style="list-style-type: none"> None (although an engineering study is still recommended) |
| National Practice | <ul style="list-style-type: none"> The majority of variable speed systems active in the U.S. are regulatory. Generally, FHWA prefers a regulatory system over an advisory one. | <ul style="list-style-type: none"> Minnesota uses advisory because they were able to deploy it quickly without changing state statutes. Missouri uses advisory because their regulatory system was unresponsive to changing conditions, which led to a lack of compliance. |



Congestion Responsive Variable Speed Subsystem



Congestion Responsive Variable Speed Subsystem



- Each subzone's speed determined by the lower of:
 - Local 85th percentile speed
 - Downstream speed + step (5-10 mph)
- Speeds measured by dual loops and radar
- Speeds < 30 mph display "SLOW"

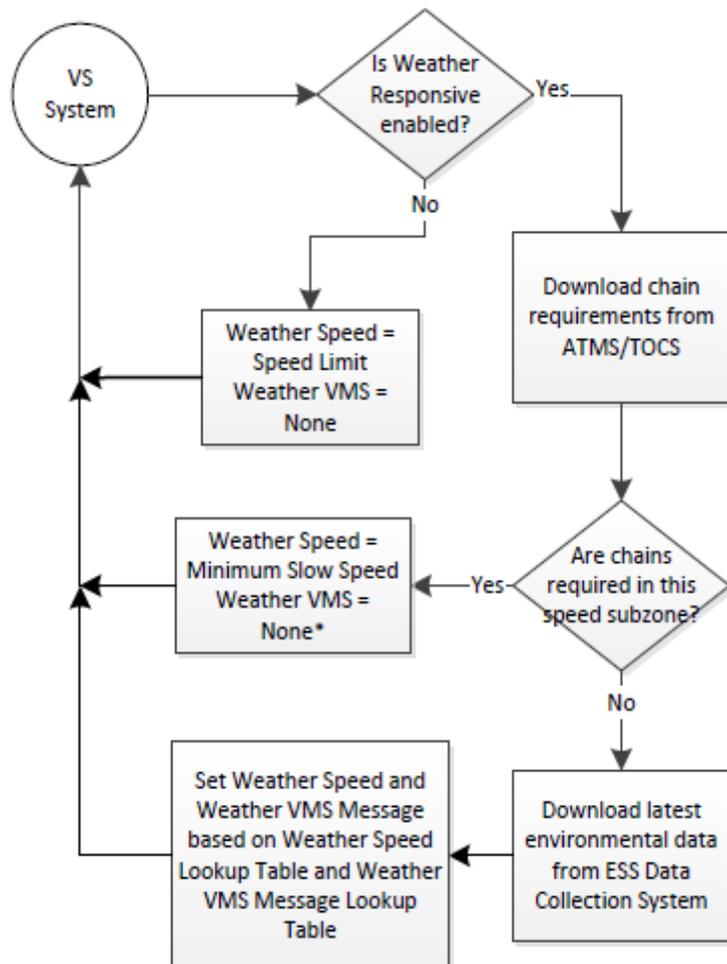


Weather Responsive Variable Speed Subsystem

- Goal is to notify drivers of adverse weather conditions by:
 - Providing advised speeds for different adverse weather events (including visibility)
 - Using applicable messages on VMS during adverse weather events
- RWIS grip factor sensors installed in corridor



Weather Responsive Variable Speed Subsystem



Weather Speed Lookup Table

| Visibility \ Grip Factor | > 0.70 | < 0.70 | Chain Requirement |
|--------------------------|-------------|--------|--------------------|
| > 500' | Speed Limit | 45 | Minimum Slow Speed |
| < 500' | 45 | 35 | Minimum Slow Speed |

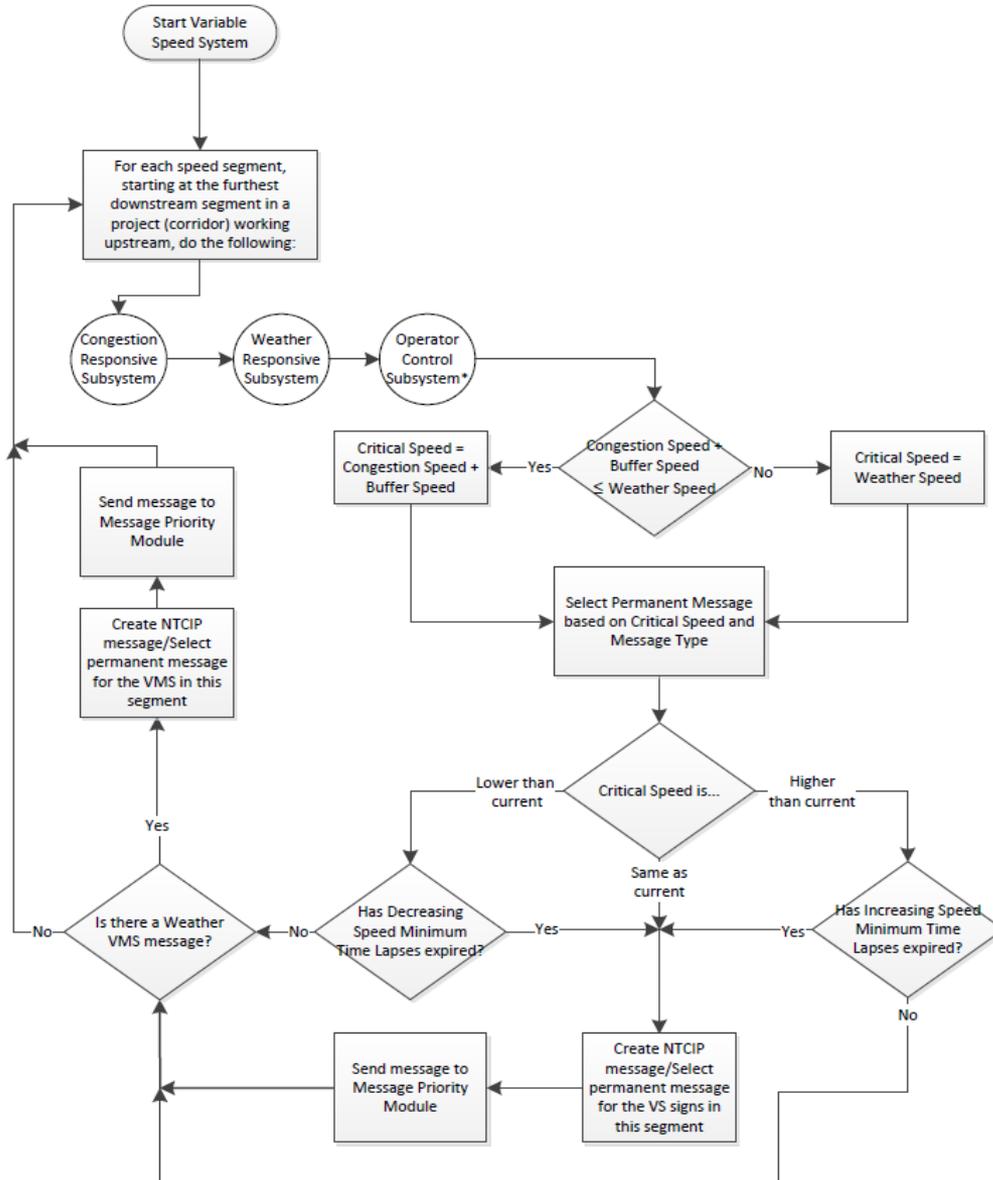
Weather VMS Message Lookup Table

| Visibility | Classification | Grip Factor | > 0.70 | < 0.70 | Chain Requirement |
|------------|-------------------------------|-------------|----------------------------|---|-------------------|
| > 500' | Moist or Wet | | (None) |  USE CAUTION | (None)* |
| | Frosty, Snowy, Icy, or Slushy | | N/A |  USE CAUTION | (None)* |
| < 500' | Moist or Wet | | LOW VISIBILITY USE CAUTION |  USE CAUTION | (None)* |
| | Frosty, Snowy, Icy, or Slushy | | LOW VISIBILITY USE CAUTION |  USE CAUTION | (None)* |

*Snow zone chain requirement messages for VMS will come from ATMS/TOCS

| Condition Code | Visibility | Grip Factor | Surface Condition Classification | Condition Speed | Weather Message | Actual Sign Message |
|----------------|-------------------------|--------------------------|----------------------------------|------------------------|--|---|
| A | < Visibility Threshold | >= Grip Factor Threshold | Moist, Wet | Maximum Speed – 10 MPH | “LOW VISIBILITY” |  |
| B | < Visibility Threshold | < Grip Factor Threshold | Moist, Wet | Minimum Speed | Slippery when wet sign + “USE CAUTION” |  USE CAUTION |
| C | >= Visibility Threshold | >= Grip Factor Threshold | Moist, Wet | Maximum Speed | None | |
| D | >= Visibility Threshold | < Grip Factor Threshold | Moist, Wet | Maximum Speed – 20 MPH | Slippery when wet sign + “USE CAUTION” |  USE CAUTION |
| E | < Visibility Threshold | >= Grip Factor Threshold | Frosty, Snowy, Icy, Slushy | Maximum Speed – 10 MPH | “LOW VISIBILITY” |  |
| F | < Visibility Threshold | < Grip Factor Threshold | Frosty, Snowy, Icy, Slushy | Minimum Speed | ICE sign + “USE CAUTION” |  USE CAUTION |
| G | >= Visibility Threshold | >= Grip Factor Threshold | Frosty, Snowy, Icy, Slushy | Maximum Speed | None | |
| H | >= Visibility Threshold | < Grip Factor Threshold | Frosty, Snowy, Icy, Slushy | Maximum Speed – 20 MPH | ICE sign + “USE CAUTION” |  USE CAUTION |
| I | < Visibility Threshold | >= Grip Factor Threshold | Dry | Maximum Speed | “LOW VISIBILITY” |  |
| J | < Visibility Threshold | < Grip Factor Threshold | Dry | Maximum Speed | None | |
| K | >= Visibility Threshold | >= Grip Factor Threshold | Dry | Maximum Speed | None | |
| L | >= Visibility Threshold | < Grip Factor Threshold | Dry | Maximum Speed | None | |

Variable Speed System



Speed Lookup Table

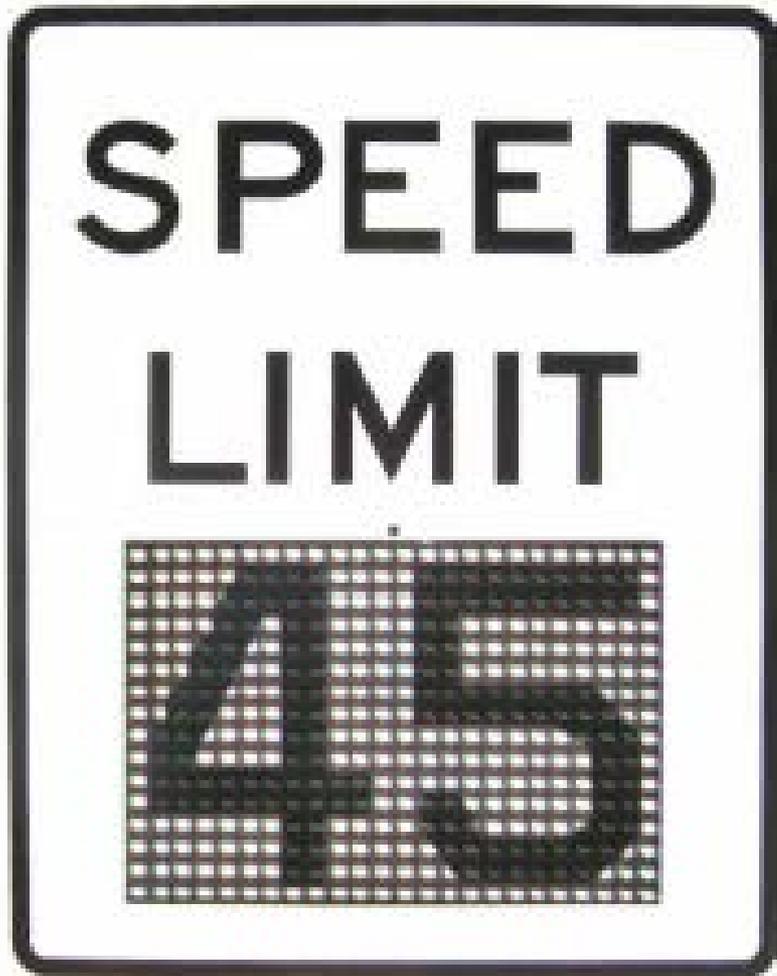
| Critical Speed | Variable Speed Limit (VSL) Perm. Message | Variable Advisory Speed (VAS) Perm. Message |
|----------------|--|---|
| 0 | "Speed Limit 30" | "SLOW" |
| 5 | "Speed Limit 30" | "SLOW" |
| 10 | "Speed Limit 30" | "SLOW" |
| 15 | "Speed Limit 30" | "SLOW" |
| 20 | "Speed Limit 30" | "SLOW" |
| 25 | "Speed Limit 30" | "SLOW" |
| 30 | "Speed Limit 30" | "Advisory Speed 30" |
| 35 | "Speed Limit 35" | "Advisory Speed 35" |
| 40 | "Speed Limit 40" | "Advisory Speed 40" |
| 45 | "Speed Limit 45" | "Advisory Speed 45" |
| 50 | "Speed Limit 50" | "Advisory Speed 50" |
| 55 | "Speed Limit 55" | "Advisory Speed 55" |
| 60 | "Speed Limit 60" | "Advisory Speed 60" |
| > 60 | "Speed Limit 65" | blank |

Variable Speed Signing

- Static signs with LED inserts
- Small full color graphic VMS
- Larger VMS can do combinations



Static signs with LED inserts

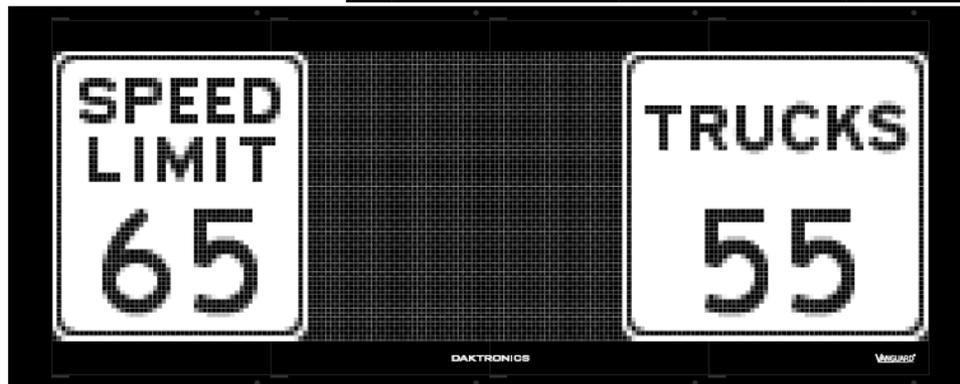
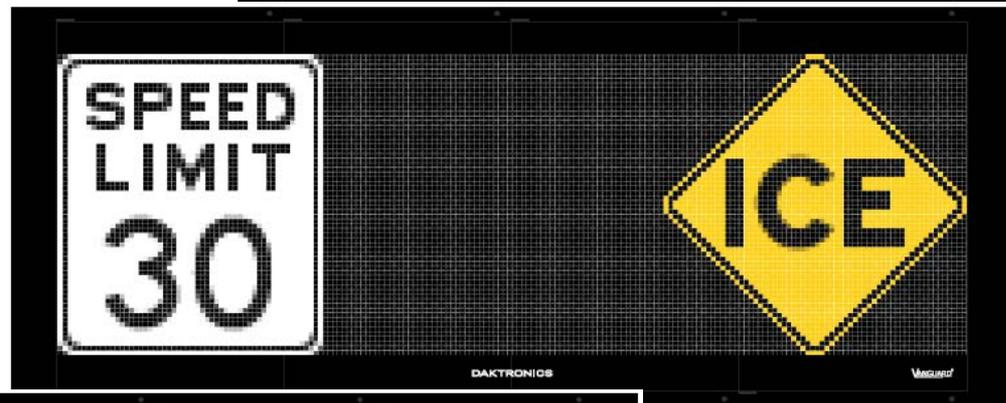


Full color graphic VMS

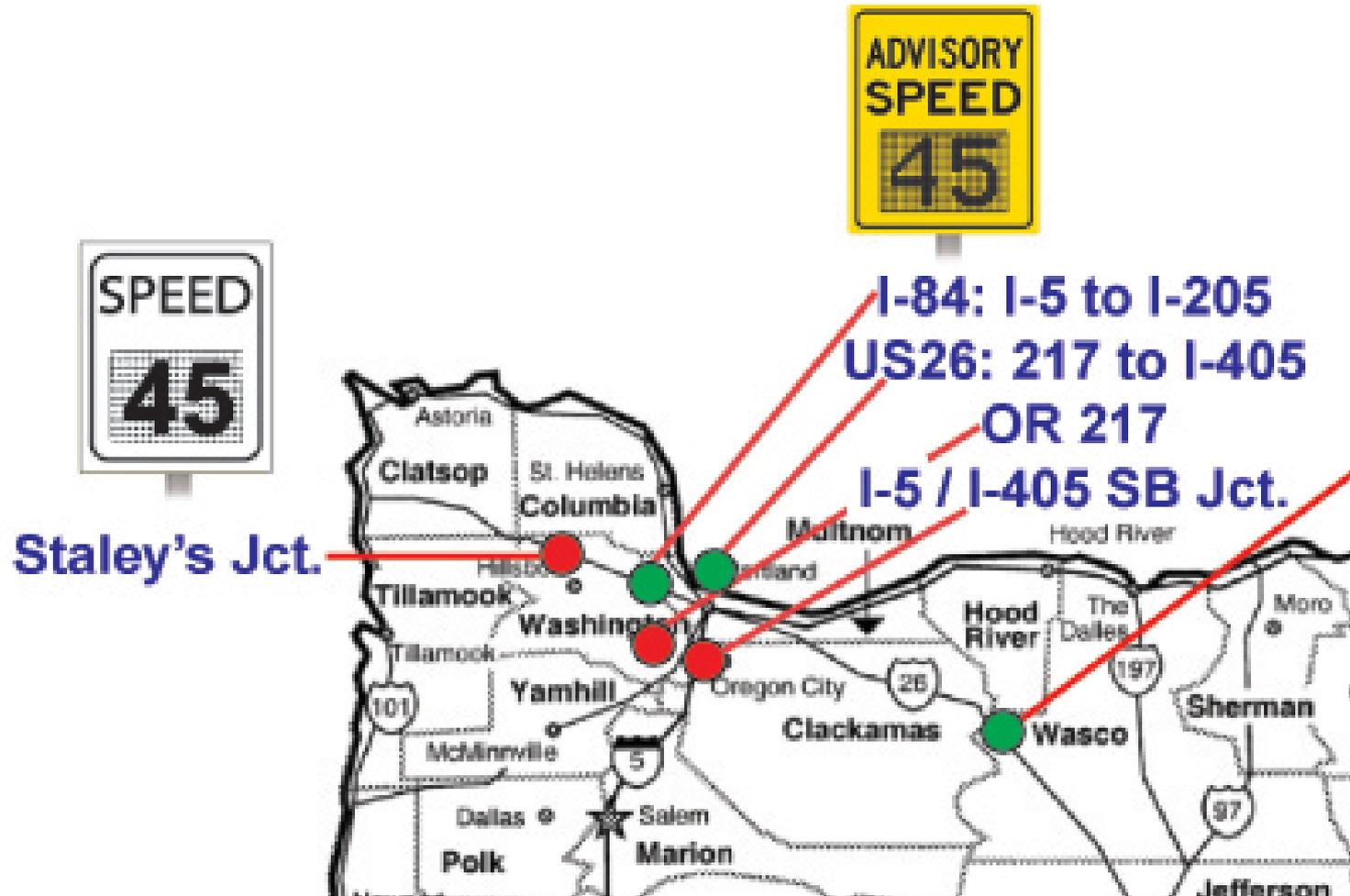


Larger VMS

- Speed and text or graphics
- Dual speed



In Operation



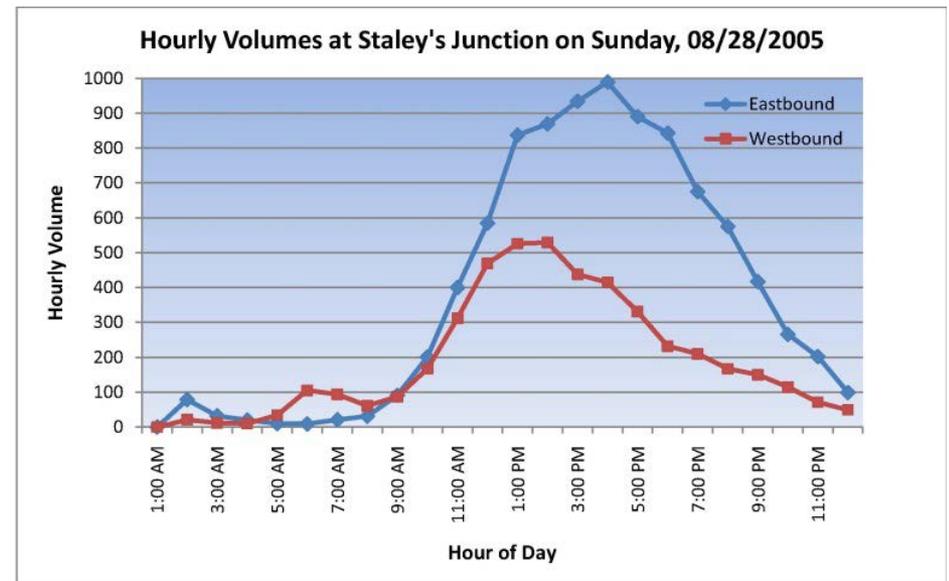
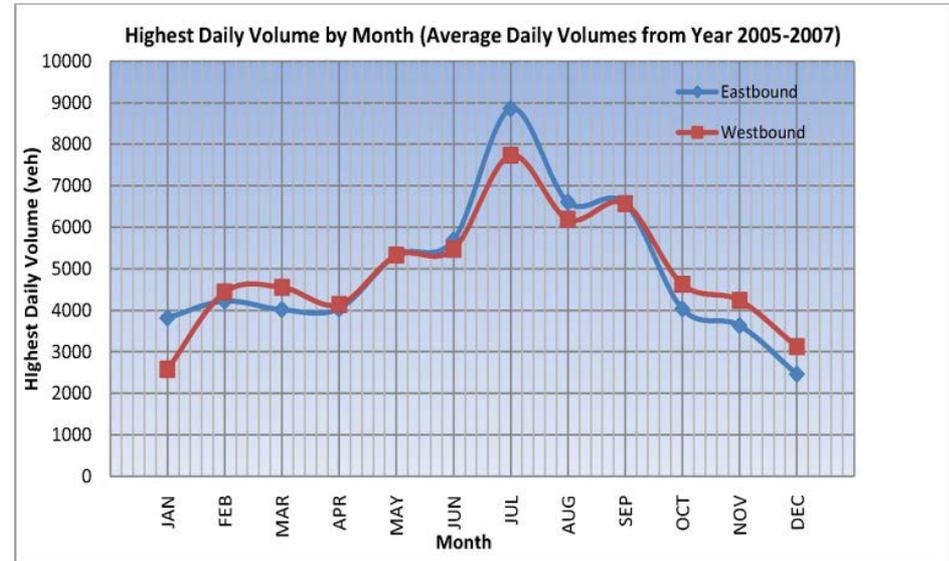
Staley's Junction

- Variable Speed Limit
- Rural non-freeway
- Interim Project



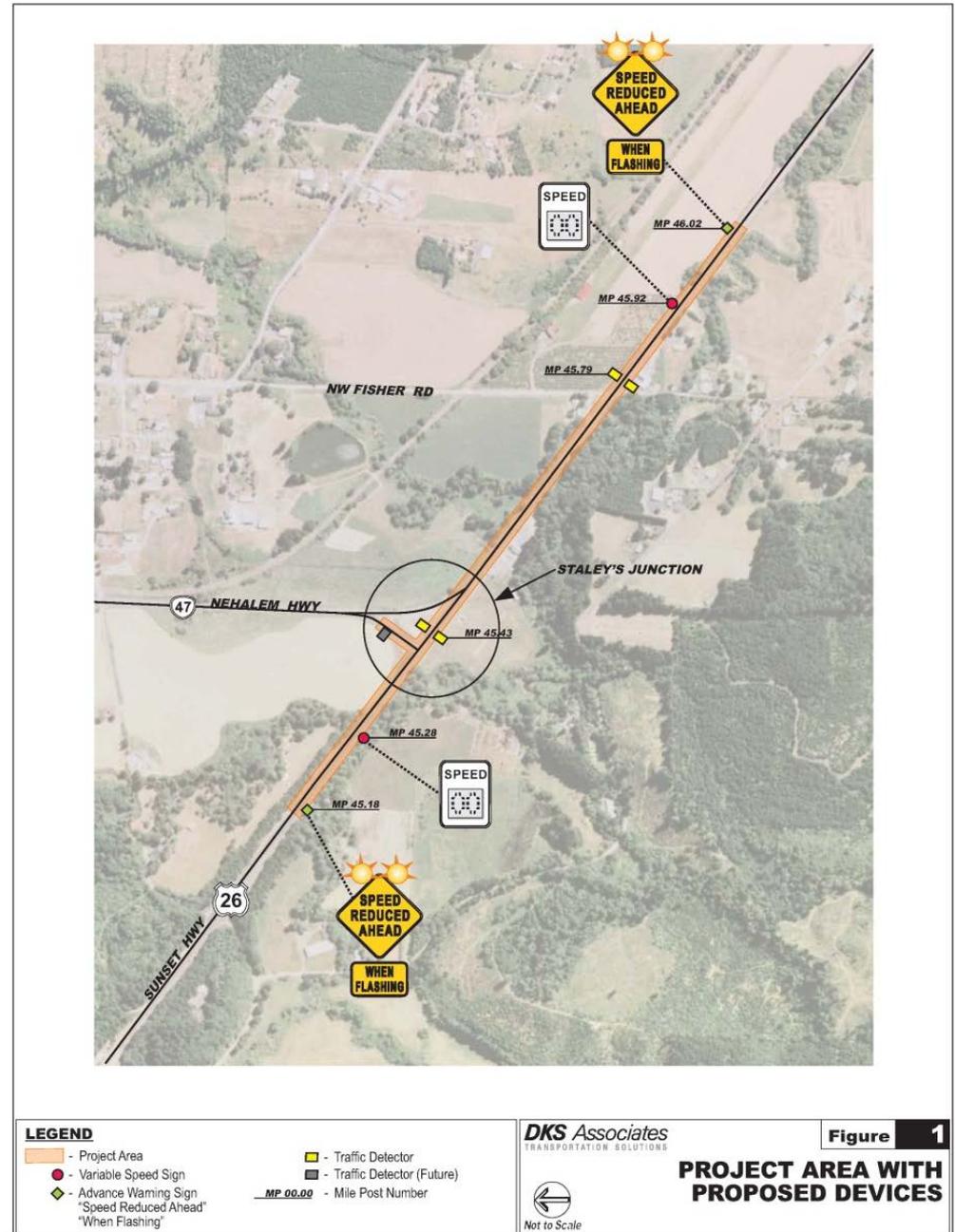
Staley's Junction

- Two lane, two-way rural location through intersection
- Safety and delay for left turns from side street
- Long delays from recreation traffic



Staley's

- Variable Speed Signs
- Warning Signs
- Detection



System Performance

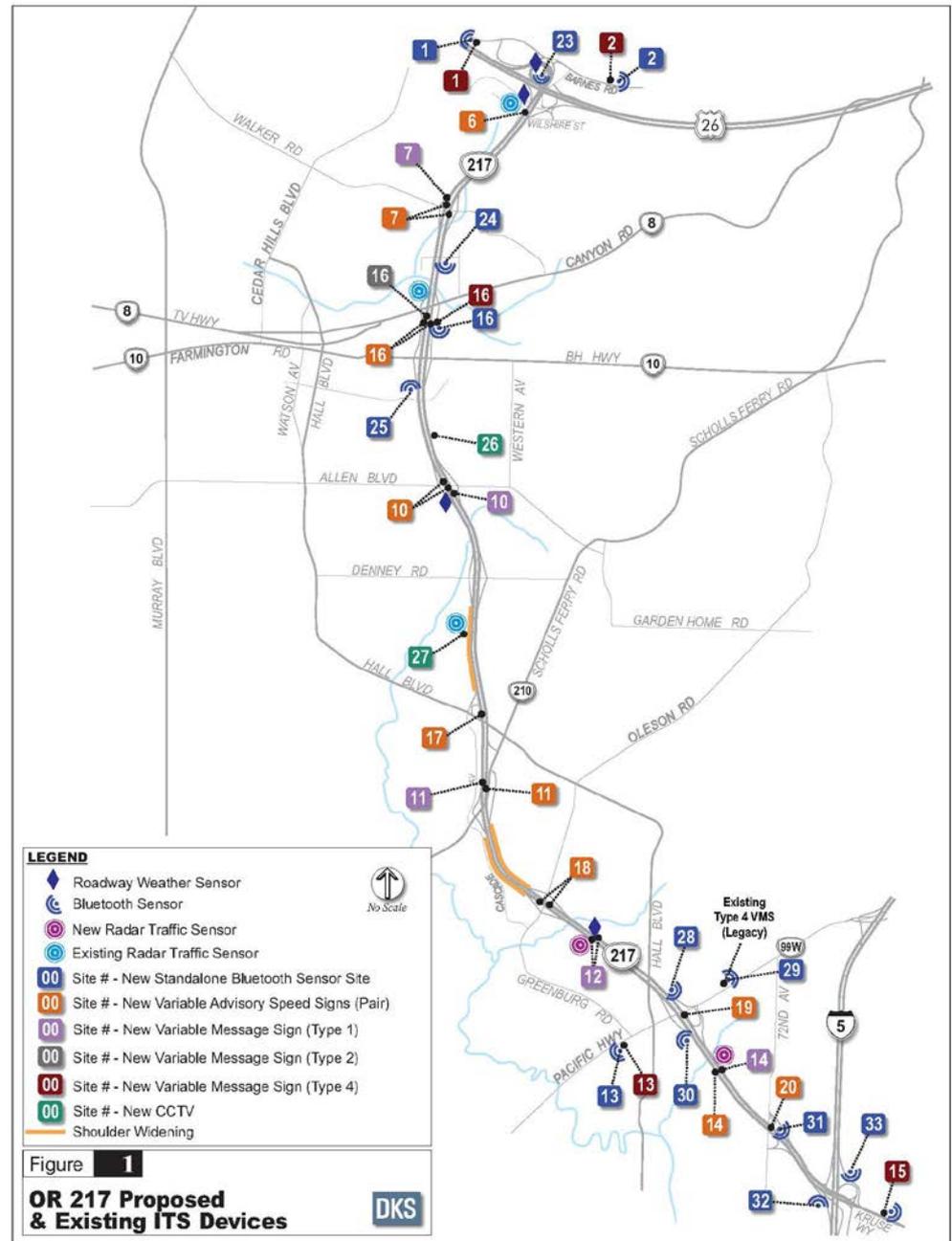
- Lower speeds both average and 85th %
- Less side street delay & shorter queues
- No complaints

| TABLE 7 | | | | | | | | |
|--|----------|--------------|---------------|-----------|-------------------|-------------|-----------------|---------------|
| STALEY'S JCT. VSL ANALYSIS BY POSTED SPEED SUMMARY | | | | | | | | |
| June 12 & July 24, 2011 | | | | | | | | |
| | Vehicles | Posted Speed | Average Speed | 85% Speed | Percent Exceeding | Pace Limits | Percent In Pace | Maximum Speed |
| AVERAGES | 231 | 50 MPH | 47 | 52 | >50=23% | 43-53 | 82% | 58 |
| AVERAGES | 217 | 45 MPH | 44 | 48 | >45=45% | 39-49 | 81% | 56 |
| AVERAGES | 282 | 40 MPH | 35 | 41 | >40=27% | 32-42 | 75% | 50 |
| AVERAGES | 278 | 35 MPH | 31 | 37 | >35=31% | 26-36 | 68% | 46 |
| AVERAGES | 316 | 30 MPH | 23 | 29 | >30=10% | 20-30 | 66% | 38 |



OR217

- 28 variable advisory speed signs
- Seven segments in each direction
- Four RWIS grip factor sensors



Variable Advisory Speed



Early Results

9%

Reduction in travel times during morning and evening peaks

8% to 18%

Reduction in midday travel times

50%

Reduction in travel time variability

Speeds

Increased during peak periods

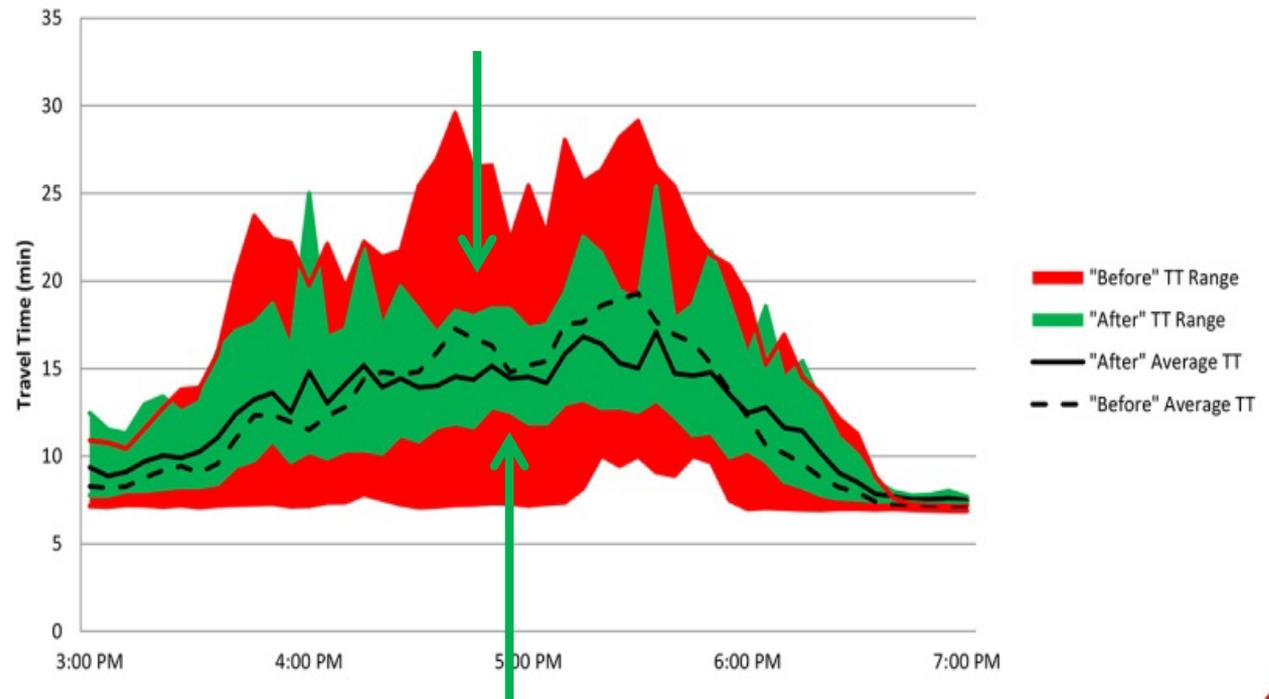
25%

Reduction in crash-related incidents in November 2014

Travel Time Reliability Improvement



Before and After Travel Time Reliability, OR-217 NB Left Lane



- Average Buffer Index before VAS = 48.8%
- Average Buffer Index after VAS = 27.64%
- Before = July 2012 midweek days
- After = Midweek days from the past three weeks



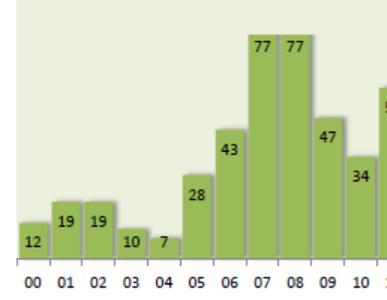
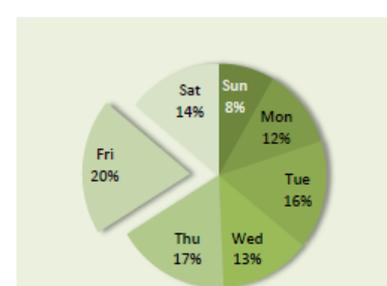
Highway 217 Motor Vehicle Incident



Total

| Month | Jan | Feb | Mar | Apr | May |
|-----------------|------|------|------|------|------|
| % of Total | 9.3% | 8.1% | 5.9% | 8.6% | 8.6% |
| October - March | 53% | | | | |

Incident Counts by Time of Day and Day of W



Highest Time of Day / Day of Week combinat

| | Sun | Mon | Tue | Wed | Thu |
|------|-----|-----|-----|-----|-----|
| Hr14 | 10 | 11 | 14 | 12 | 18 |
| Hr15 | 5 | 7 | 22 | 15 | 24 |
| Hr16 | 9 | 13 | 14 | 17 | 24 |
| Hr17 | 15 | 20 | 22 | 17 | 34 |

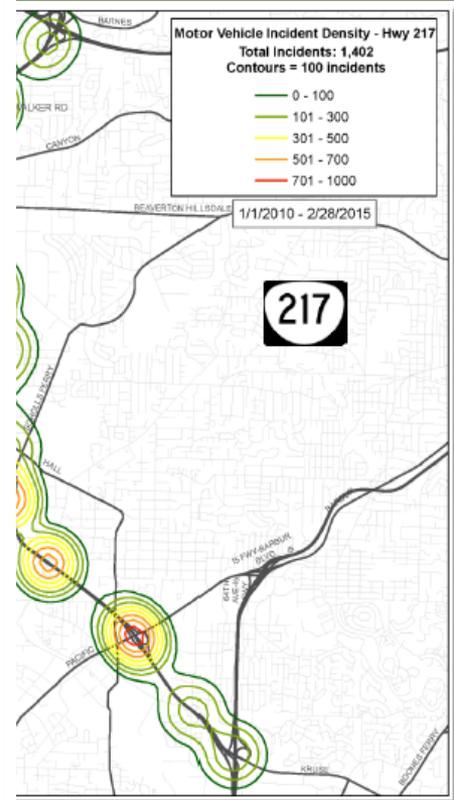
7/1/13 - 12/31/13

| | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|-------|-----|-----|-----|-----|-----|-----|-------|
| Sun | | | 4 | 3 | 3 | 3 | 13 |
| Mon | 2 | 1 | 4 | 4 | 6 | 8 | 25 |
| Tue | 10 | 5 | | 11 | 4 | 2 | 32 |
| Wed | 5 | 2 | 3 | 1 | 4 | 3 | 18 |
| Thu | 4 | 4 | 5 | 4 | 3 | 6 | 26 |
| Fri | 2 | 6 | 4 | 5 | 5 | 5 | 27 |
| Sat | 2 | 5 | 4 | 2 | 5 | 4 | 22 |
| Total | 25 | 23 | 24 | 30 | 30 | 31 | 163 |

7/1/14 - 12/31/14

| | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|--------|-----|------|-----|------|------|------|-------|
| Sun | 2 | 3 | 1 | | 2 | 4 | 12 |
| Mon | 3 | 3 | 2 | 4 | 3 | 3 | 18 |
| Tue | 10 | 2 | 3 | 3 | 2 | 5 | 25 |
| Wed | 3 | 2 | 4 | 4 | 4 | 2 | 19 |
| Thu | 6 | 4 | 5 | 8 | 2 | 3 | 28 |
| Fri | 7 | 5 | 6 | 7 | 5 | 3 | 33 |
| Sat | 1 | 1 | 1 | 1 | 5 | 7 | 16 |
| Total | 32 | 20 | 22 | 27 | 23 | 27 | 151 |
| % Chng | 28% | -13% | -8% | -10% | -23% | -13% | -7% |

1/1/2010 - 2/28/2015



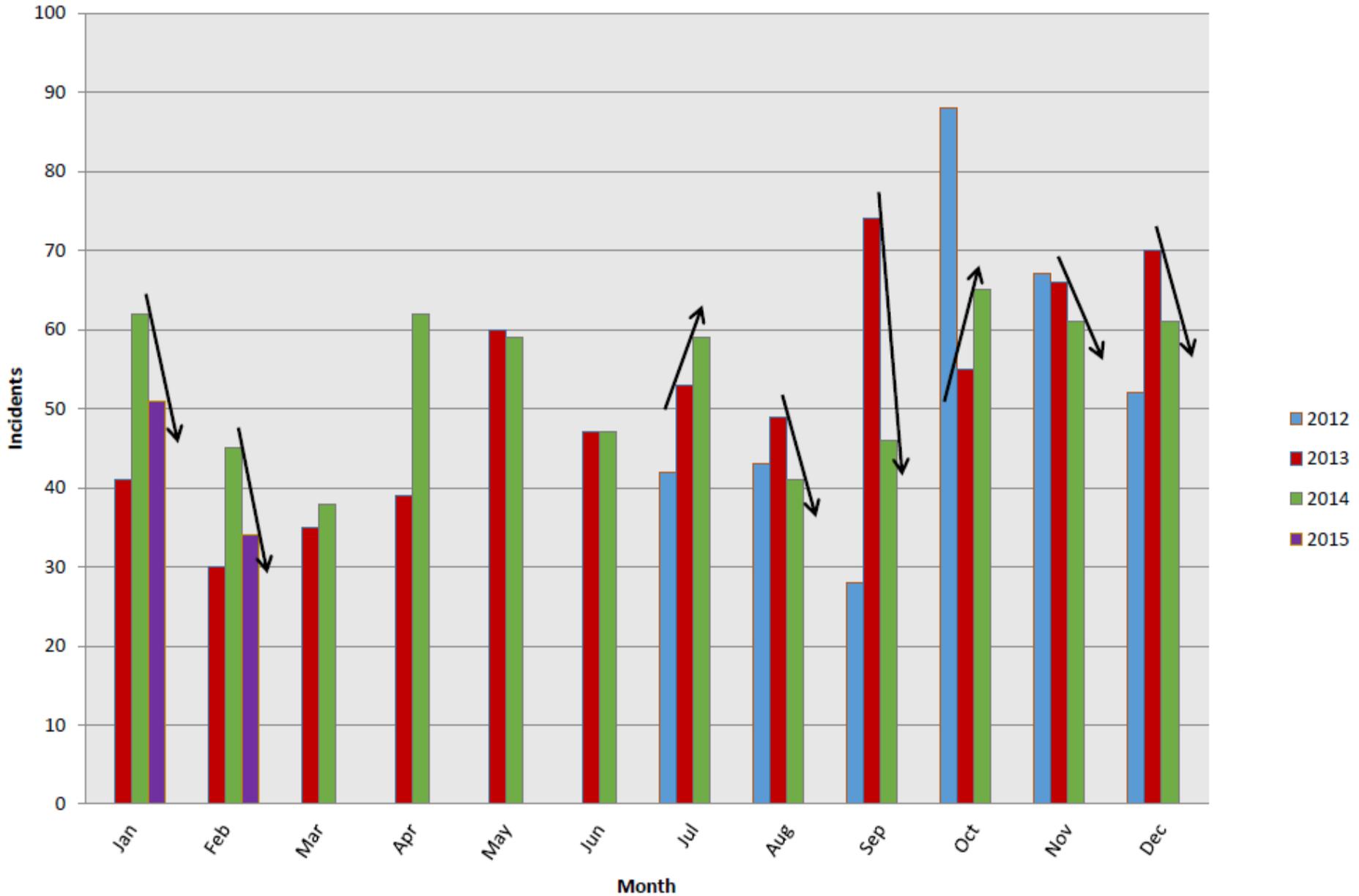
| | Highest Hour |
|-----------------|--------------|
| WALKER | 101 Hr17 |
| ANYON | 83 Hr17 |
| LLEN BLVD | 74 Hr16 |
| CHOLLS FERRY | 70 Hr16 |
| PACIFIC HW | 69 Hr16 |
| GREENBURG | 68 Hr15 |
| JEARY HSLDL HWY | 63 Hr16 |
| ALLEN BLVD | 53 Hr17 |
| PACIFIC HW | 48 Hr17 |
| ANYON | 43 Hr17 |

Data filters: emergency dispatch incidents gathered spa

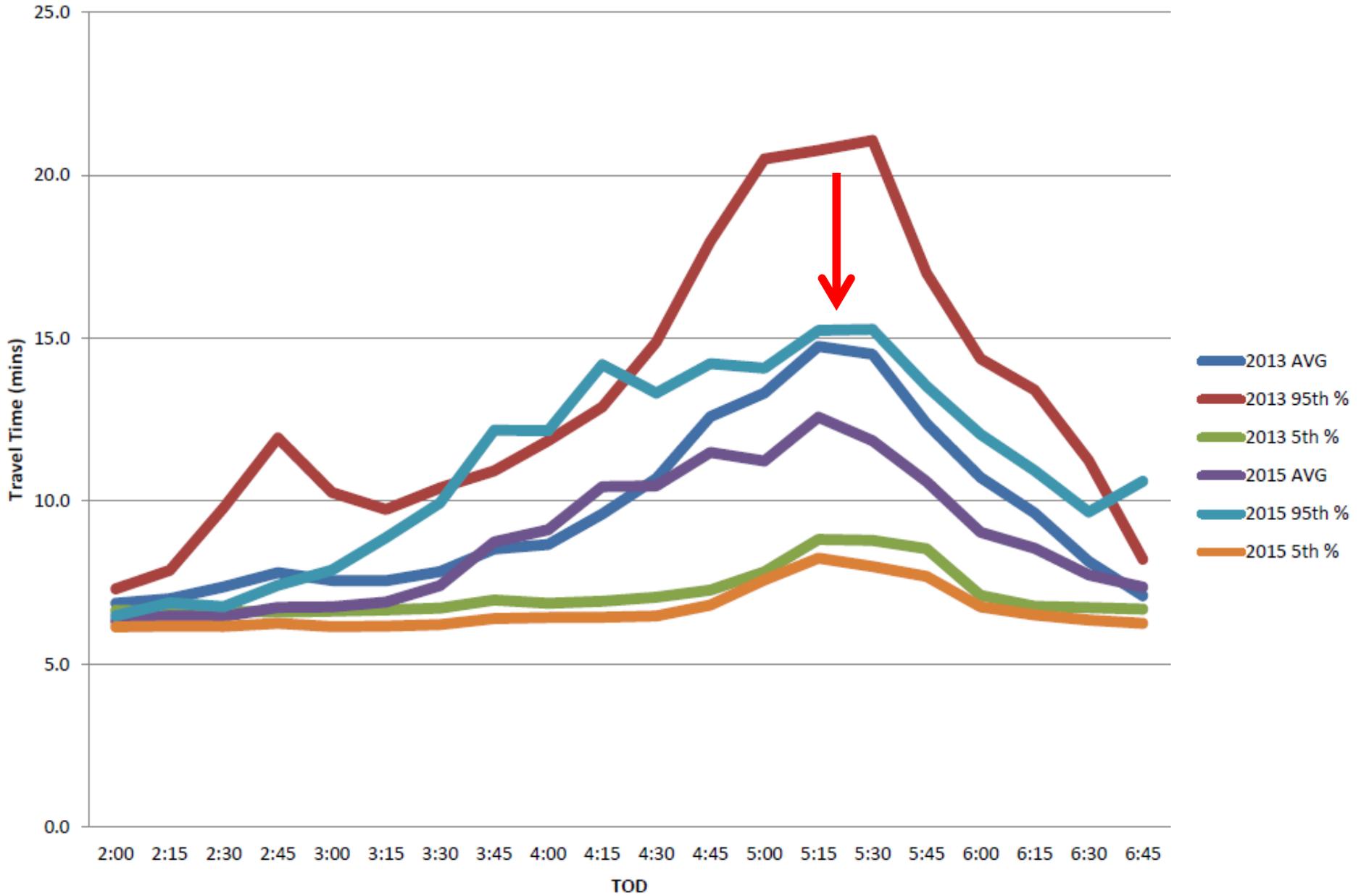
Note: though data are gathered spatially, some inciden

Dispatch Types: motor vehicle crash, spill, trauma | Situation Found: motor vehicle crash, obstruction, accident clean up

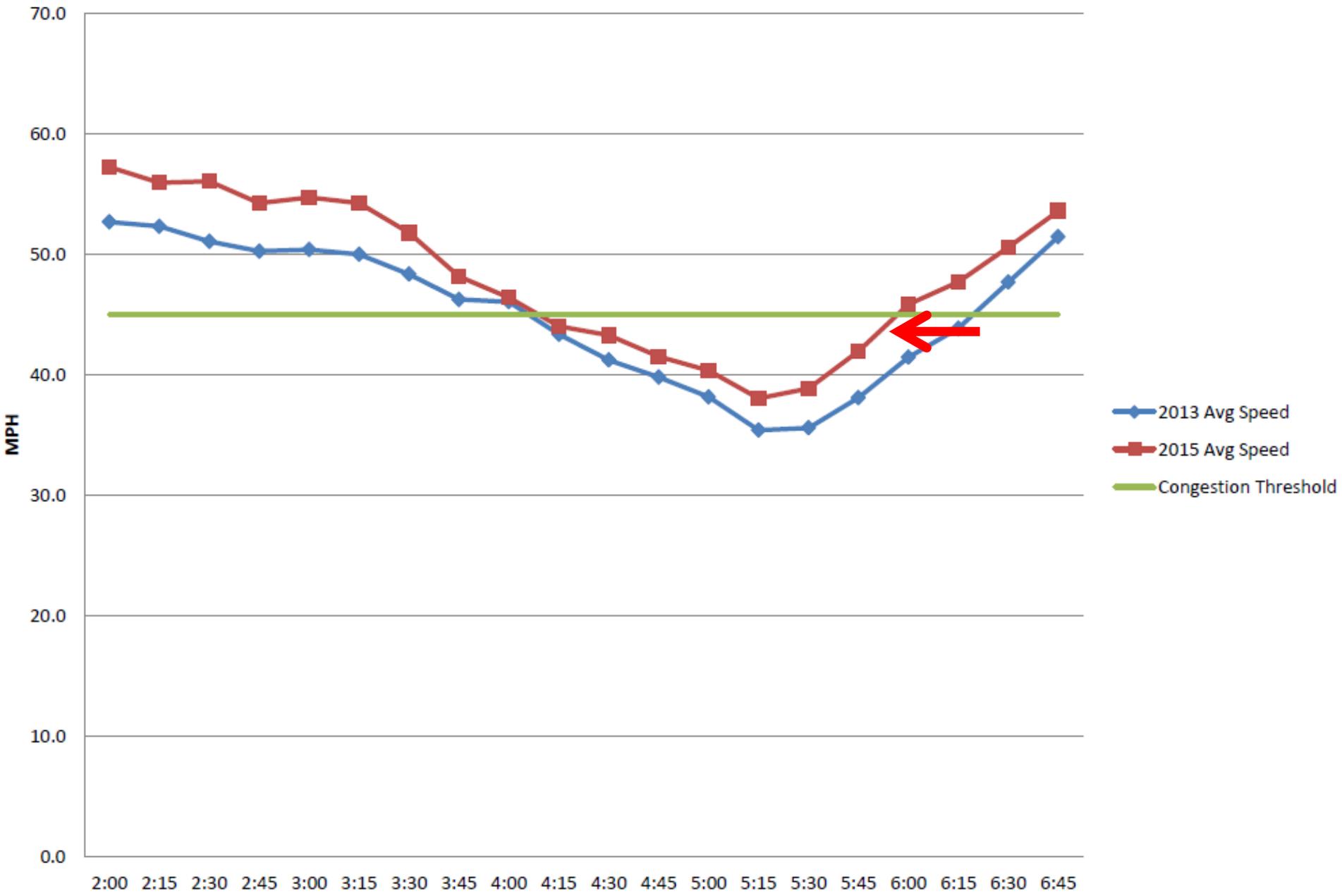
OR217 NB/SB Incident Data (WCCCA)



OR217 SB PM PEAK (January)



OR217 SB PM Peak (January)



I-5 / I-405 SB

- Originally designed as regulatory



I-5 / I-405

- Multiple zones

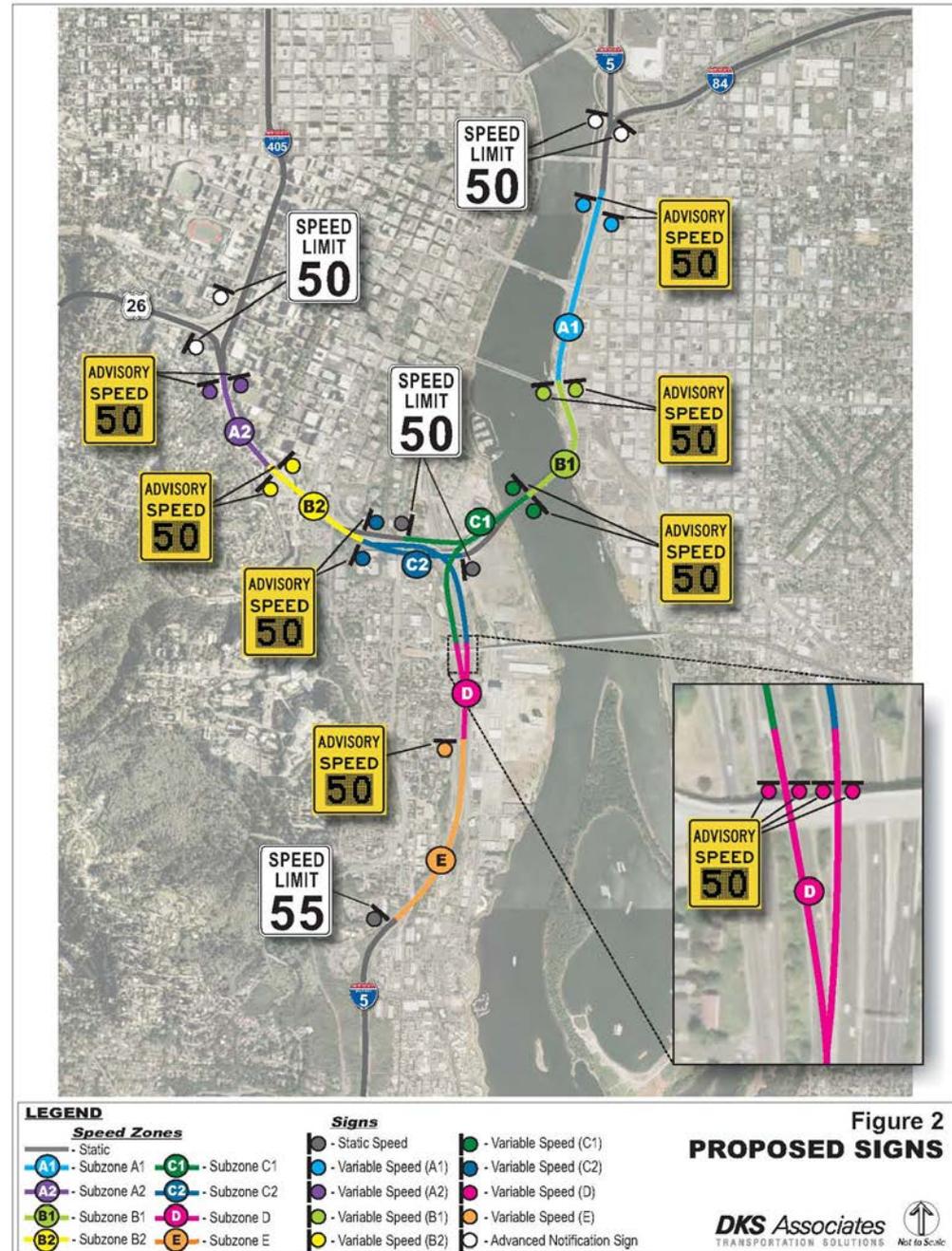


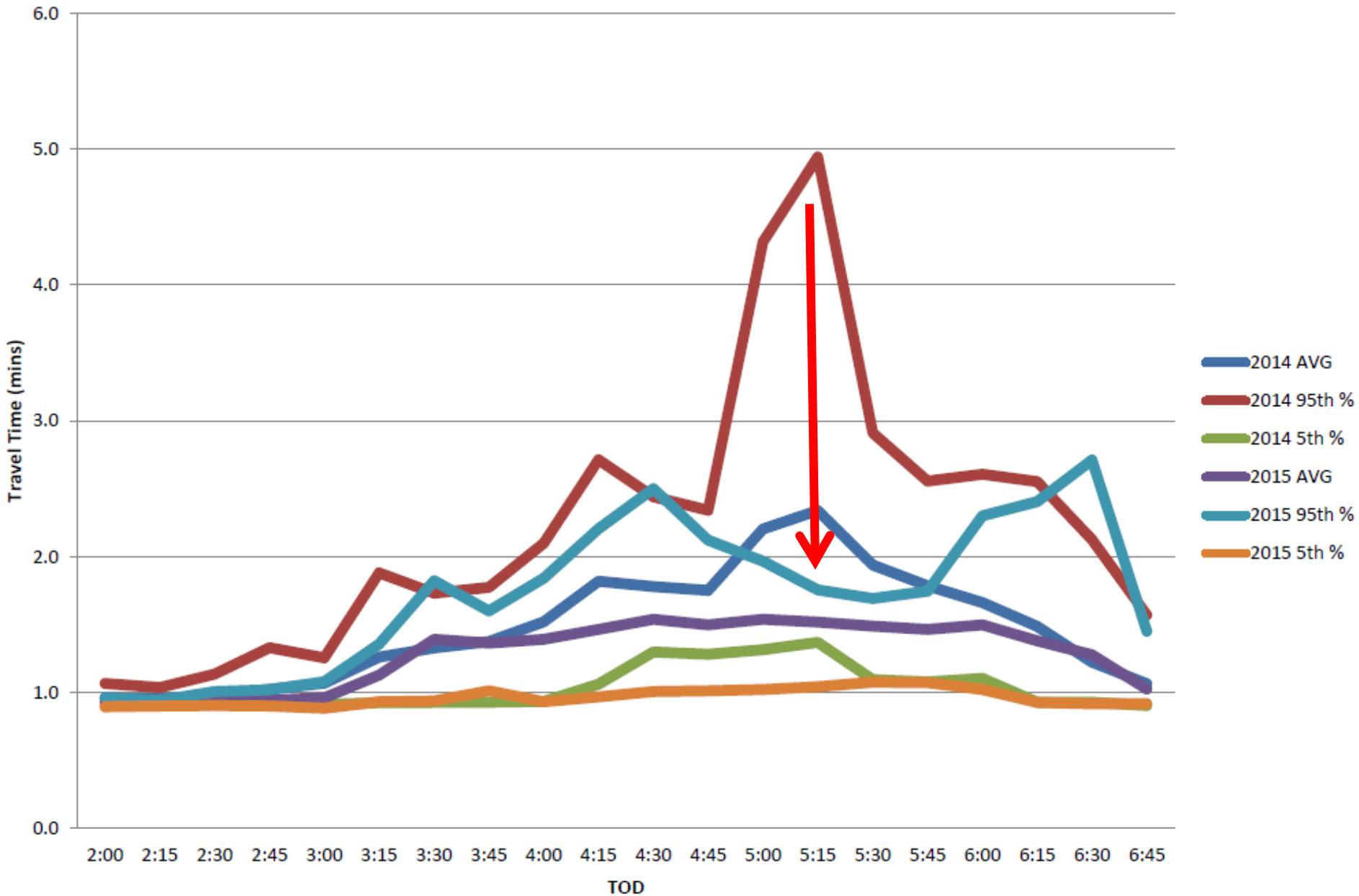
Figure 2
PROPOSED SIGNS



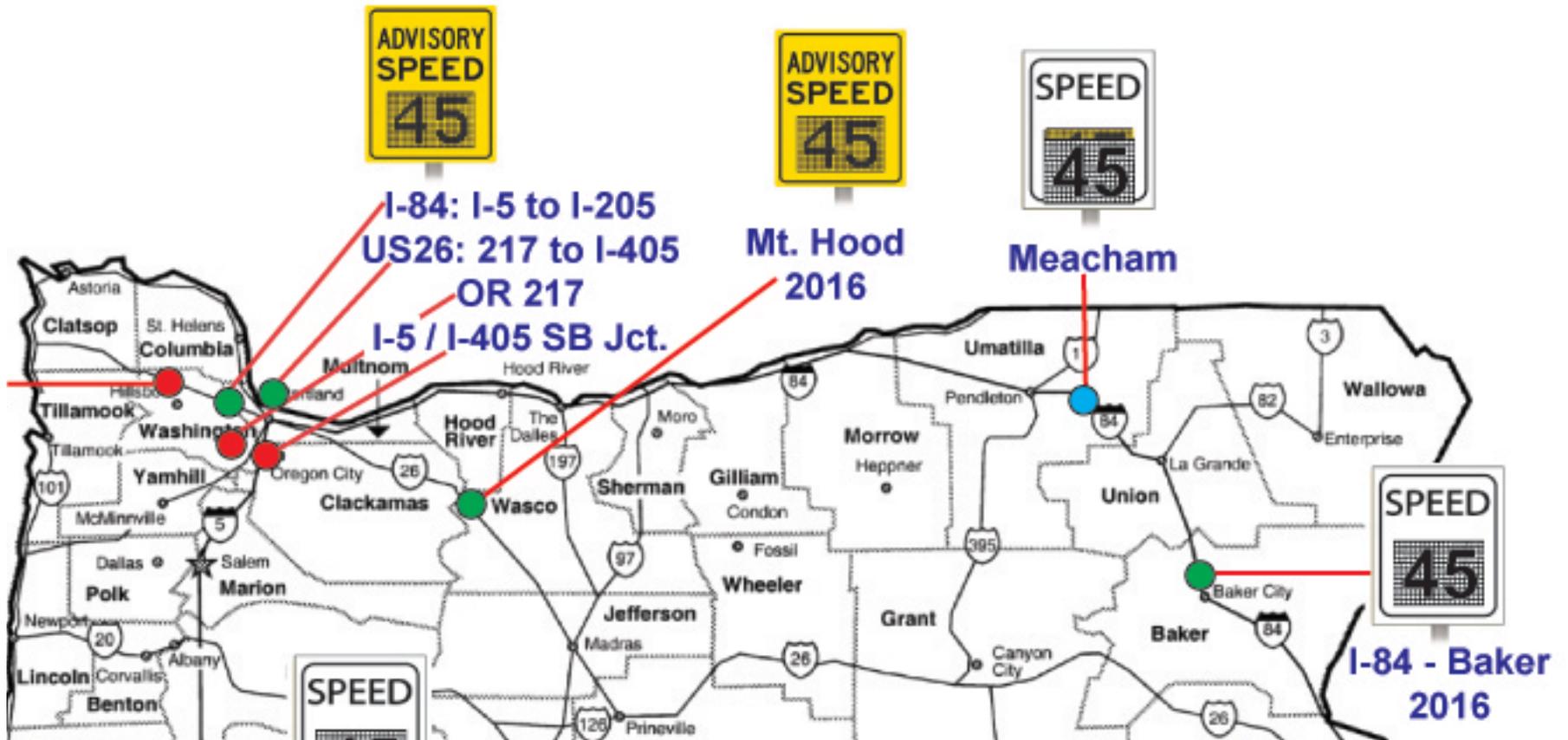
I-405 at Broadway



I-5 SB PM PEAK (January)



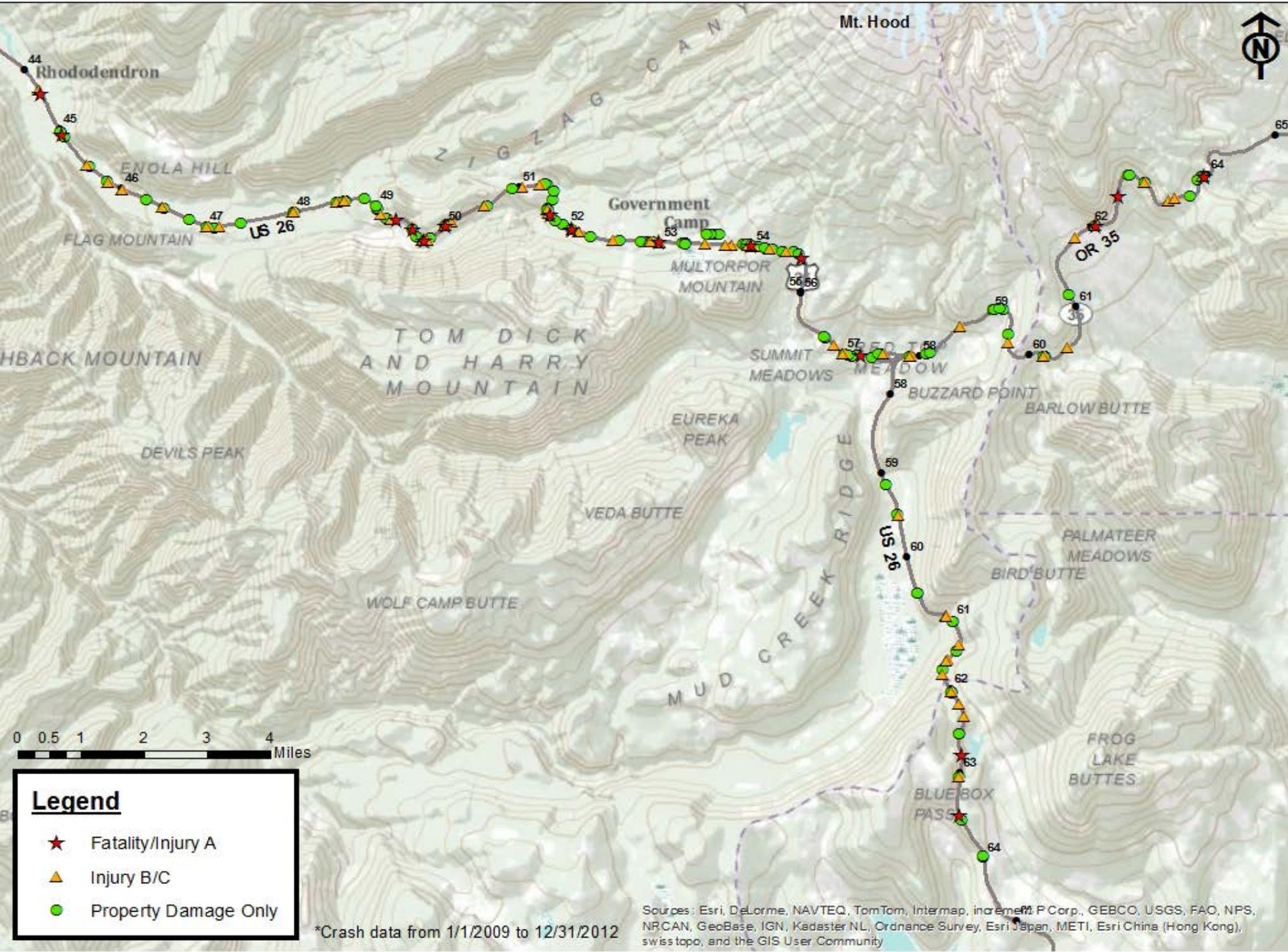
In Design



Mt Hood ATM

- US26 & ORE35
Variable Advisory
Speed
- Federal Grant
- Recreational route
 - Through traffic in
summer to
central Oregon
 - Skiing on Mt.
Hood in winter



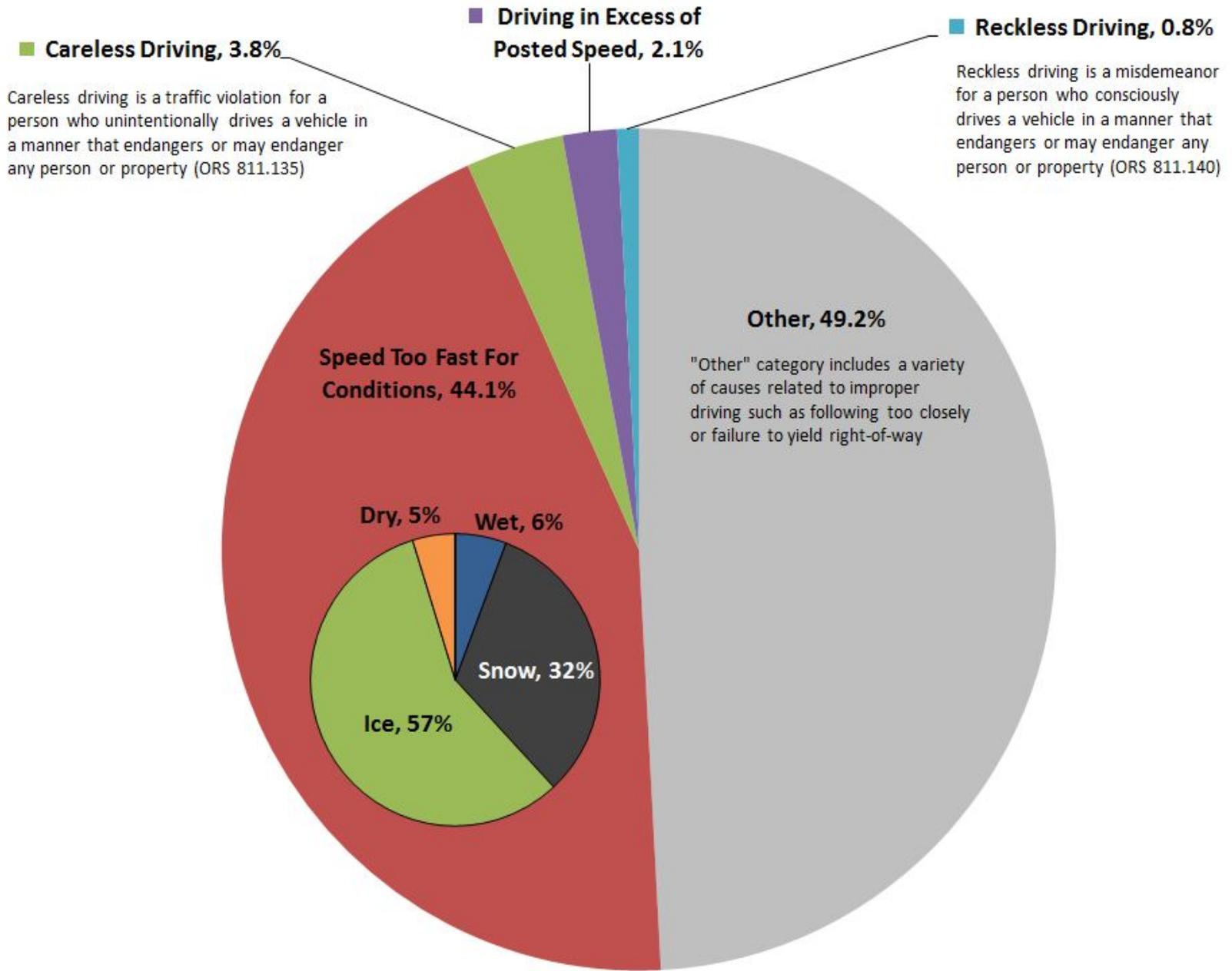


Legend

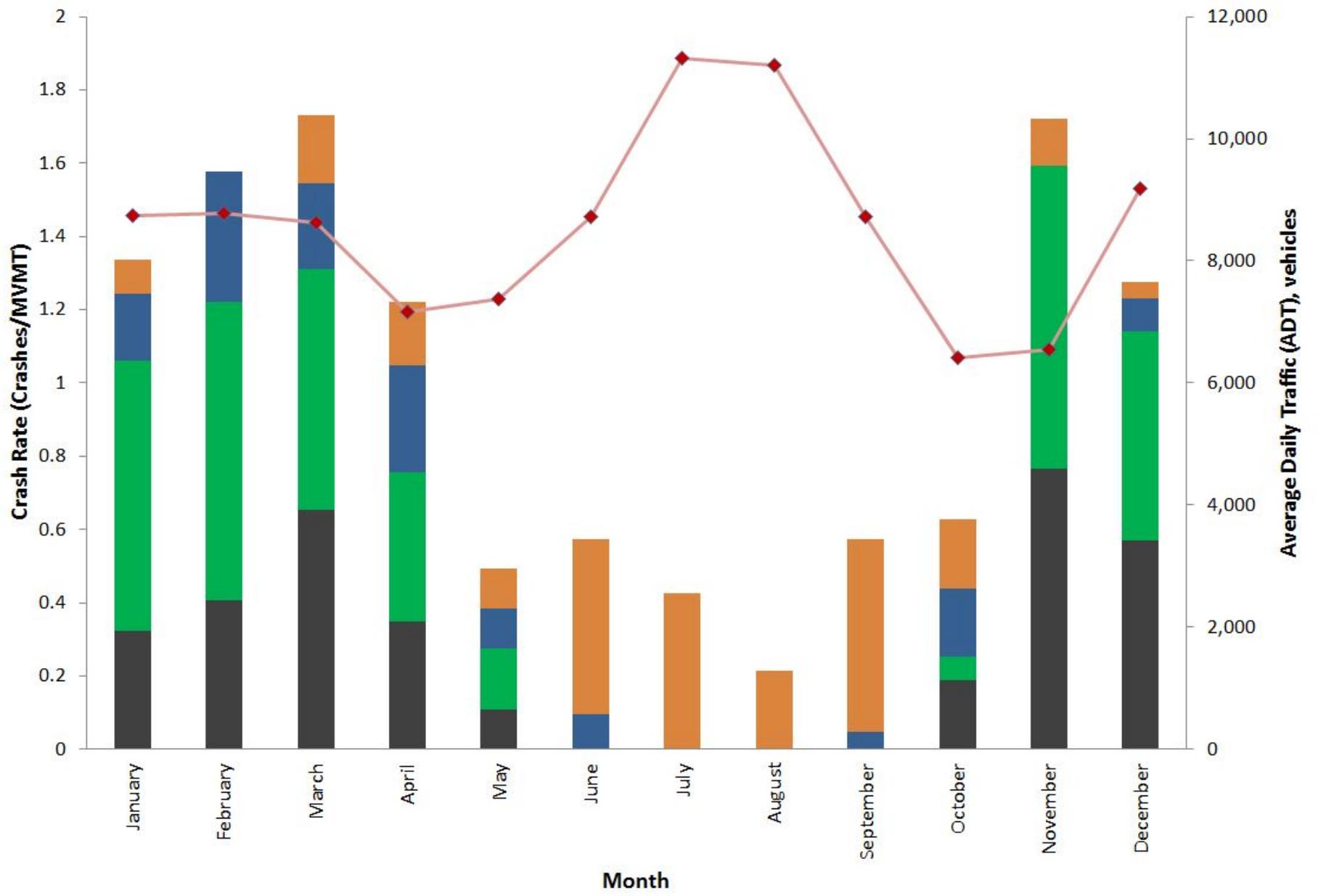
- ★ Fatality/Injury A
- ▲ Injury B/C
- Property Damage Only

*Crash data from 1/1/2009 to 12/31/2012

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swiss topo, and the GIS User Community



SNOW
 ICE
 WET
 DRY
 ADT (2009-2012)



Variable Advisory Speed

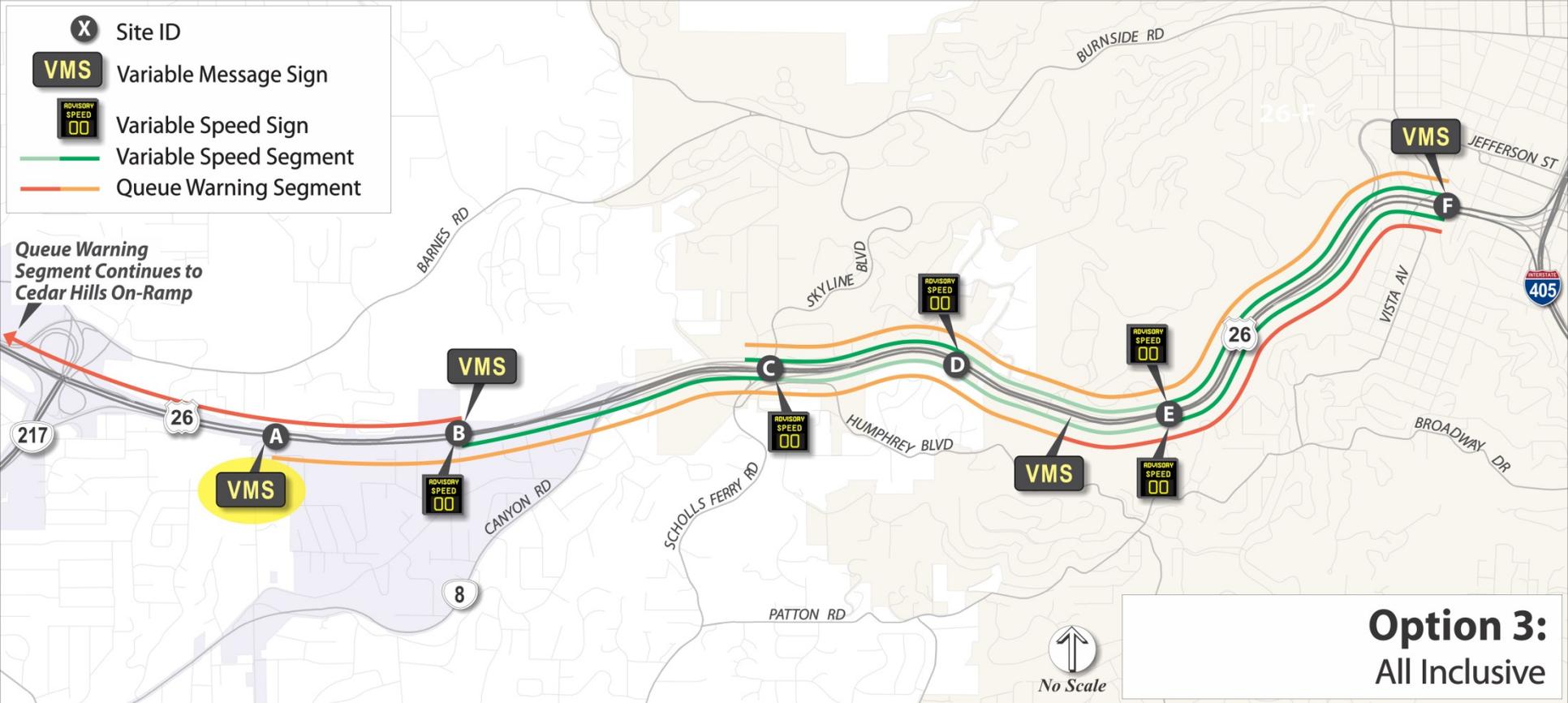


TIGER Grant

- US26
 - OR217 to I-405
- I-84
 - I-5 to I-205
- Variable Advisory Speed



US26



Oregon Department of
Transportation



I-84



**Option 3:
All Inclusive**

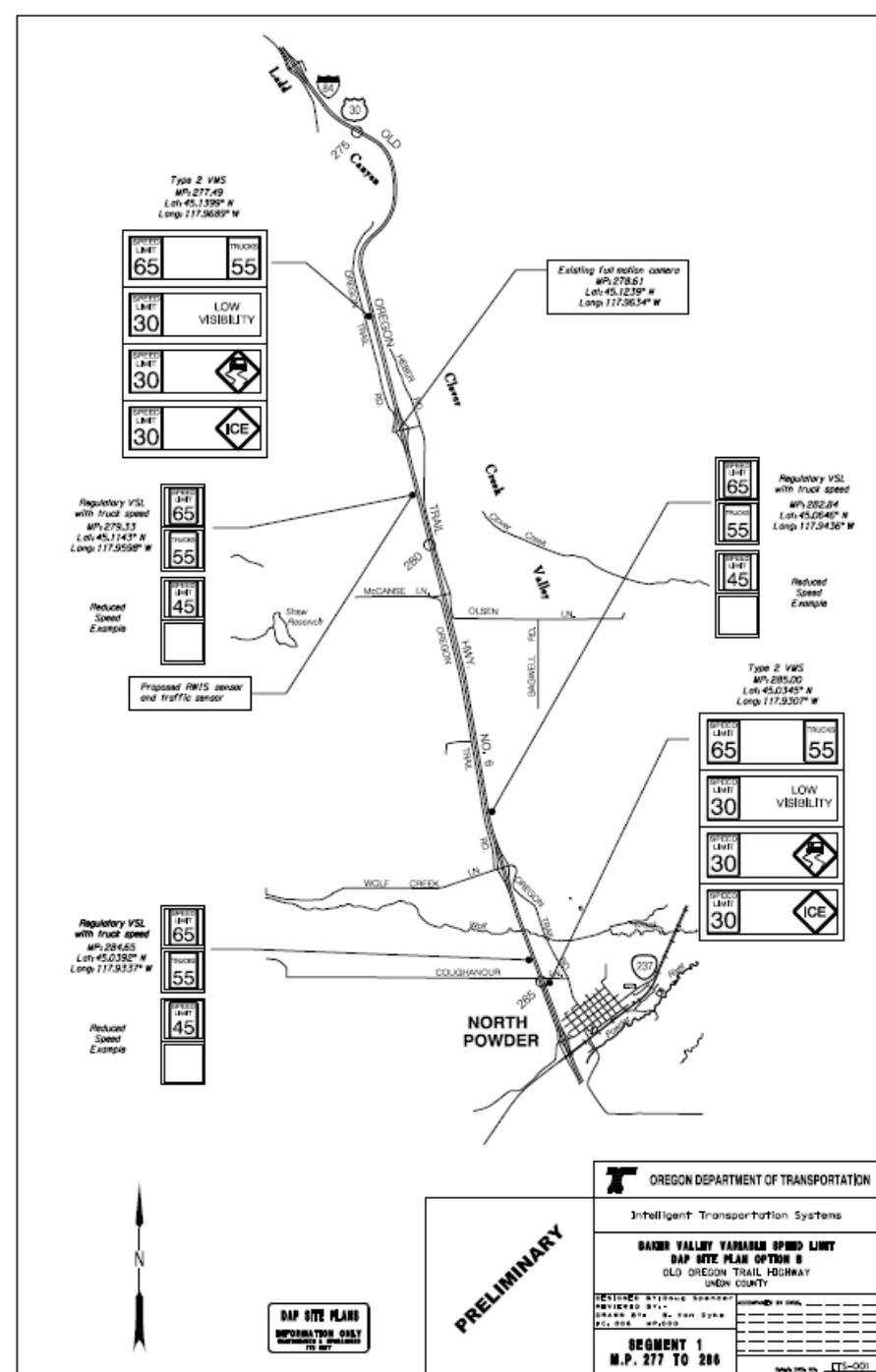


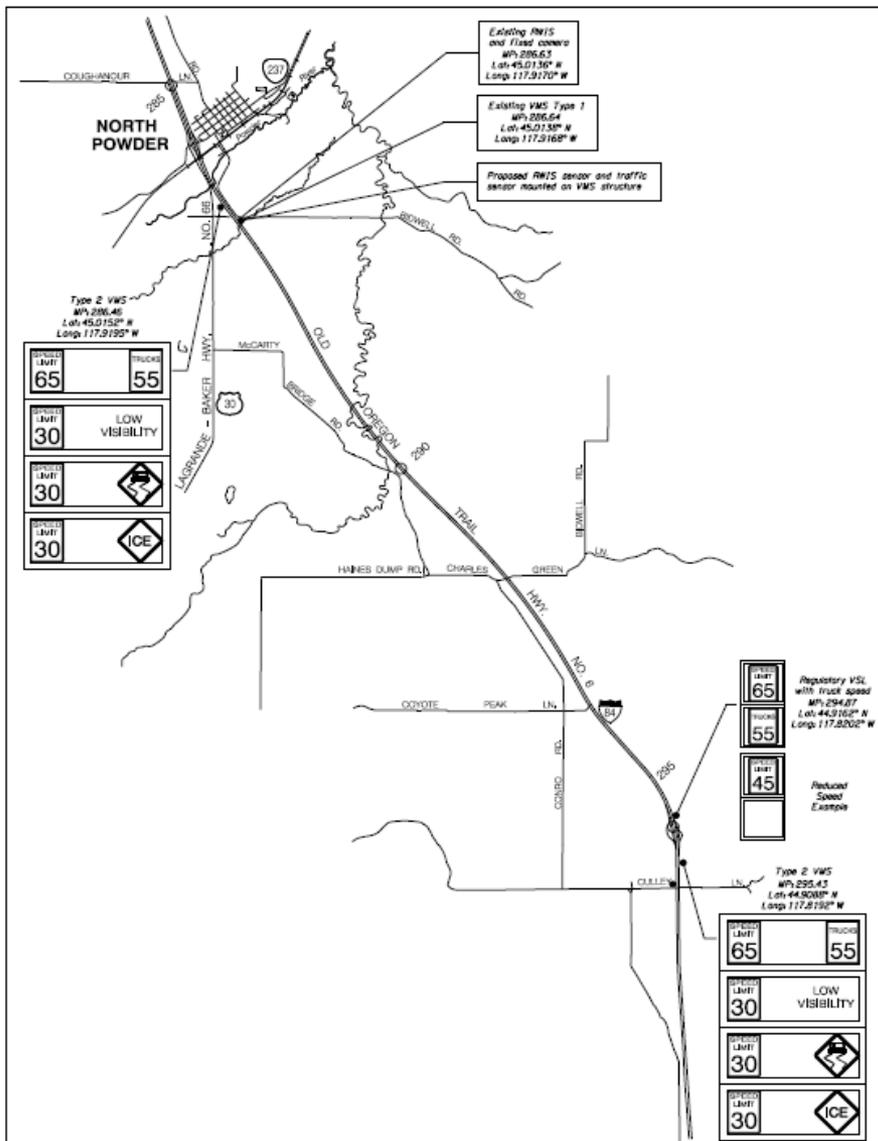
**Oregon Department of
Transportation**



I-84 Baker Valley

- Weather Responsive Regulatory VSL
- 30 mile project area segmented into three 10 mile corridors
- 6 Type 2 VMS
- 20 Lane Control Signs
- 3 Traffic Sensors
- 3 Pavement Sensors





| | | |
|----|----------------|----|
| 65 | TRUCKS | 55 |
| 30 | LOW VISIBILITY | |
| 30 | | |
| 30 | | |

| | | |
|----|----------------|----|
| 65 | TRUCKS | 55 |
| 30 | LOW VISIBILITY | |
| 30 | | |
| 30 | | |

| | | |
|----|----------------|----|
| 65 | TRUCKS | 55 |
| 30 | LOW VISIBILITY | |
| 30 | | |
| 30 | | |



DAP SITE PLAN
INFORMATION ONLY
DO NOT SCALE

PRELIMINARY

OREGON DEPARTMENT OF TRANSPORTATION

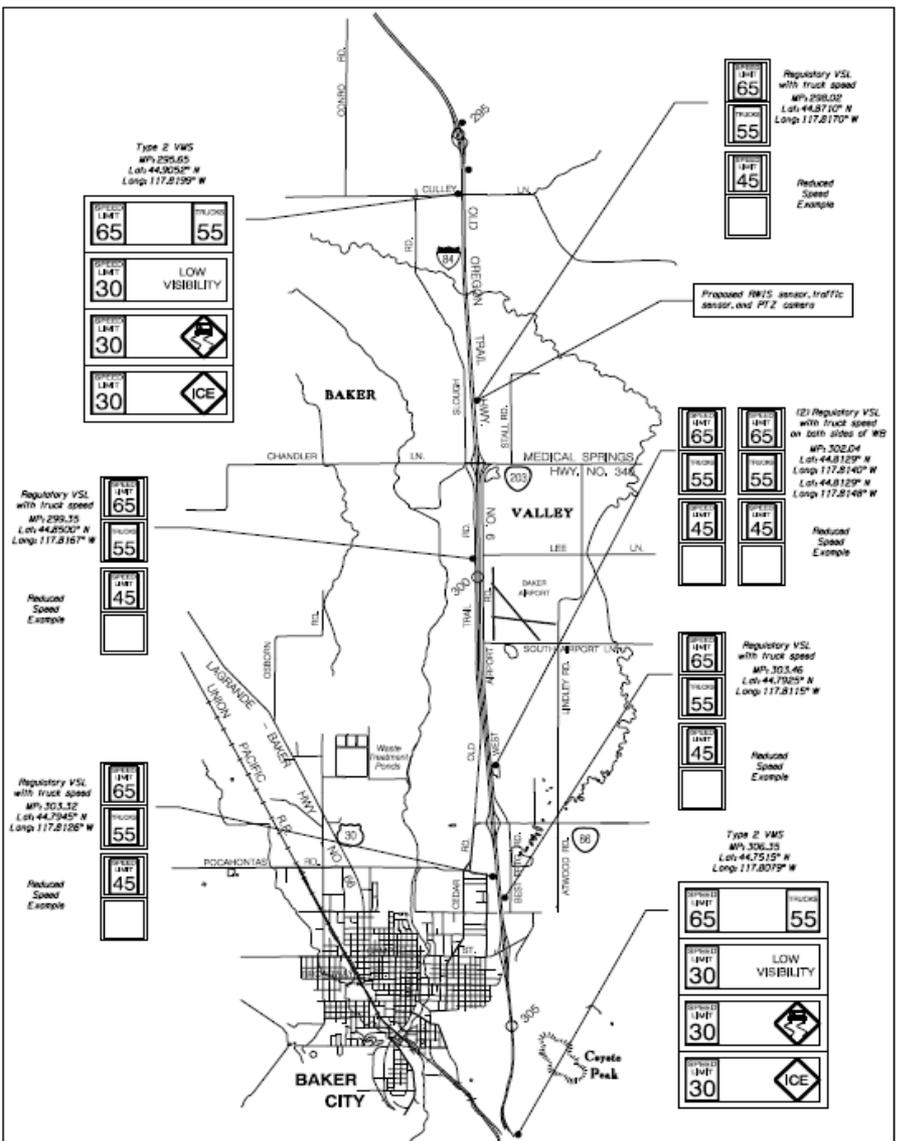
Intelligent Transportation Systems

BAKER VALLEY VARIABLE SPEED LIMIT
DAP SITE PLAN OPTION B
OLD OREGON TRAIL HIGHWAY
BAKER COUNTY

REVISIONS: REVISION NUMBER, DATE, BY, FOR

SEGMENT 2
M.P. 286 TO 285

Scale: 1" = 1/4" CT-302



| | | |
|----|----------------|----|
| 65 | TRUCKS | 55 |
| 30 | LOW VISIBILITY | |
| 30 | | |
| 30 | | |

| | | |
|----|--------|----|
| 65 | TRUCKS | 55 |
| 45 | | |

| | | |
|----|--------|----|
| 65 | TRUCKS | 55 |
| 45 | | |

| | | |
|----|--------|----|
| 65 | TRUCKS | 55 |
| 45 | | |

| | | |
|----|--------|----|
| 65 | TRUCKS | 55 |
| 45 | | |

| | | |
|----|--------|----|
| 65 | TRUCKS | 55 |
| 45 | | |

| | | |
|----|----------------|----|
| 65 | TRUCKS | 55 |
| 30 | LOW VISIBILITY | |
| 30 | | |
| 30 | | |



DAP SITE PLAN
INFORMATION ONLY
DO NOT SCALE

PRELIMINARY

OREGON DEPARTMENT OF TRANSPORTATION

Intelligent Transportation Systems

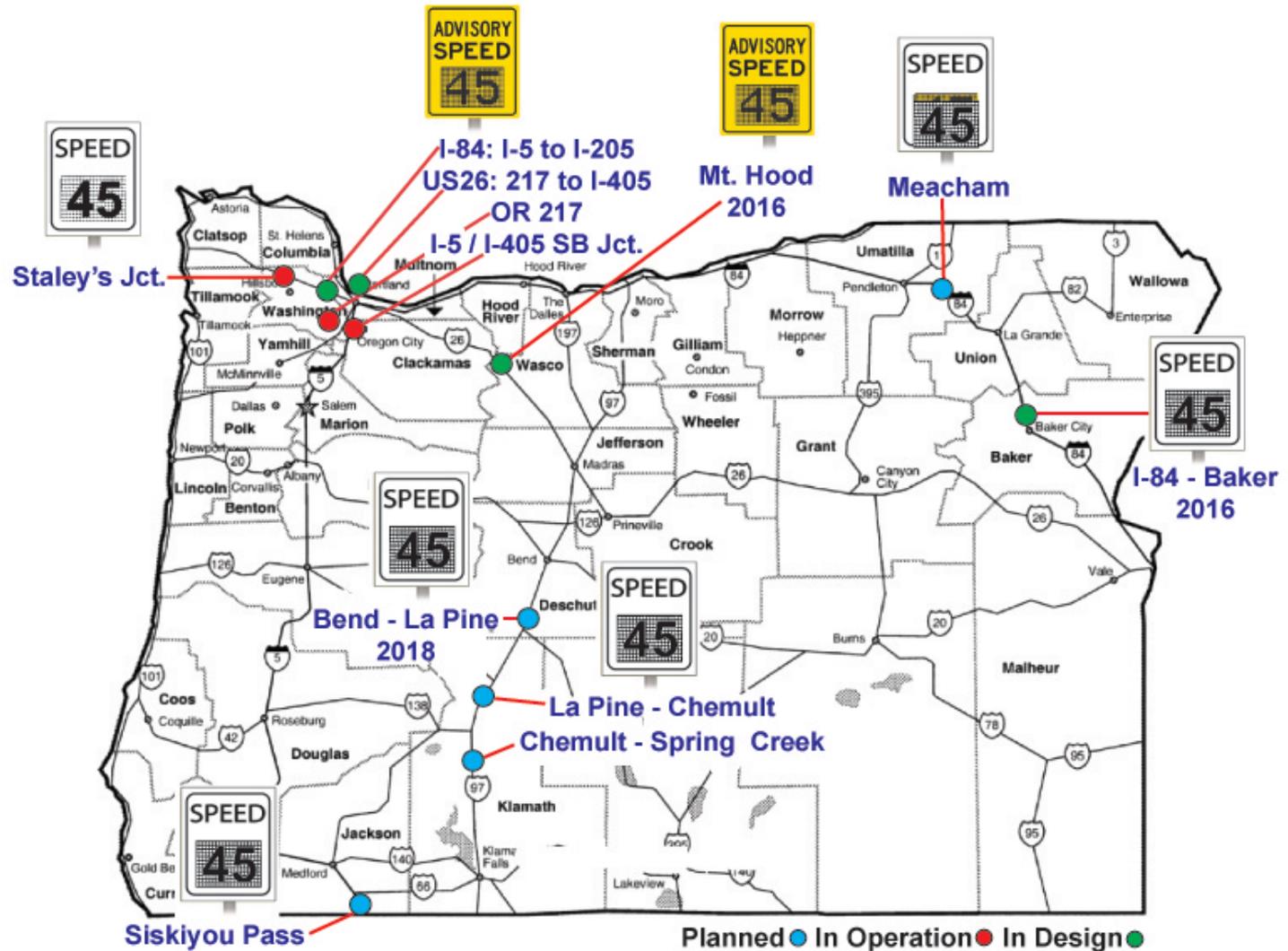
BAKER VALLEY VARIABLE SPEED LIMIT
DAP SITE PLAN OPTION B
OLD OREGON TRAIL HIGHWAY
BAKER COUNTY

REVISIONS: REVISION NUMBER, DATE, BY, FOR

SEGMENT 3
M.P. 285 TO 304

Scale: 1" = 1/4" CT-302

Planned



Planned

- I-5 Siskiyou Pass
- US97 Bend – La Pine
- US97 La Pine – Chemult
- US97 Chemult – Spring Creek
- I-84 Meacham



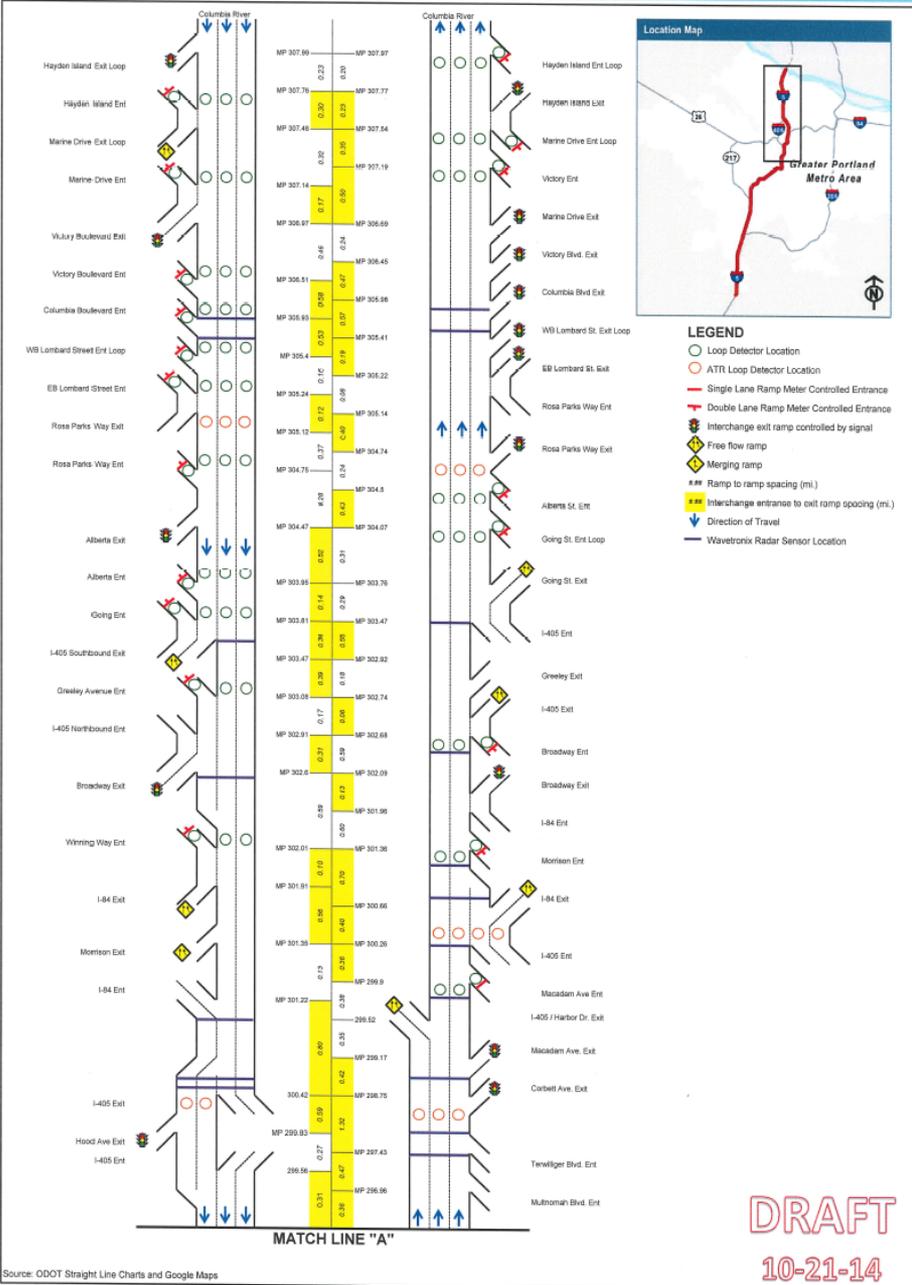
Study Phase

- Portland Area Active Traffic Management (ATM) Strategy
 - Variable Speed is a component of ATM
 - Data
 - Constraints
 - Visualization
 - System to system interaction



I-5: Pacific Highway Corridor

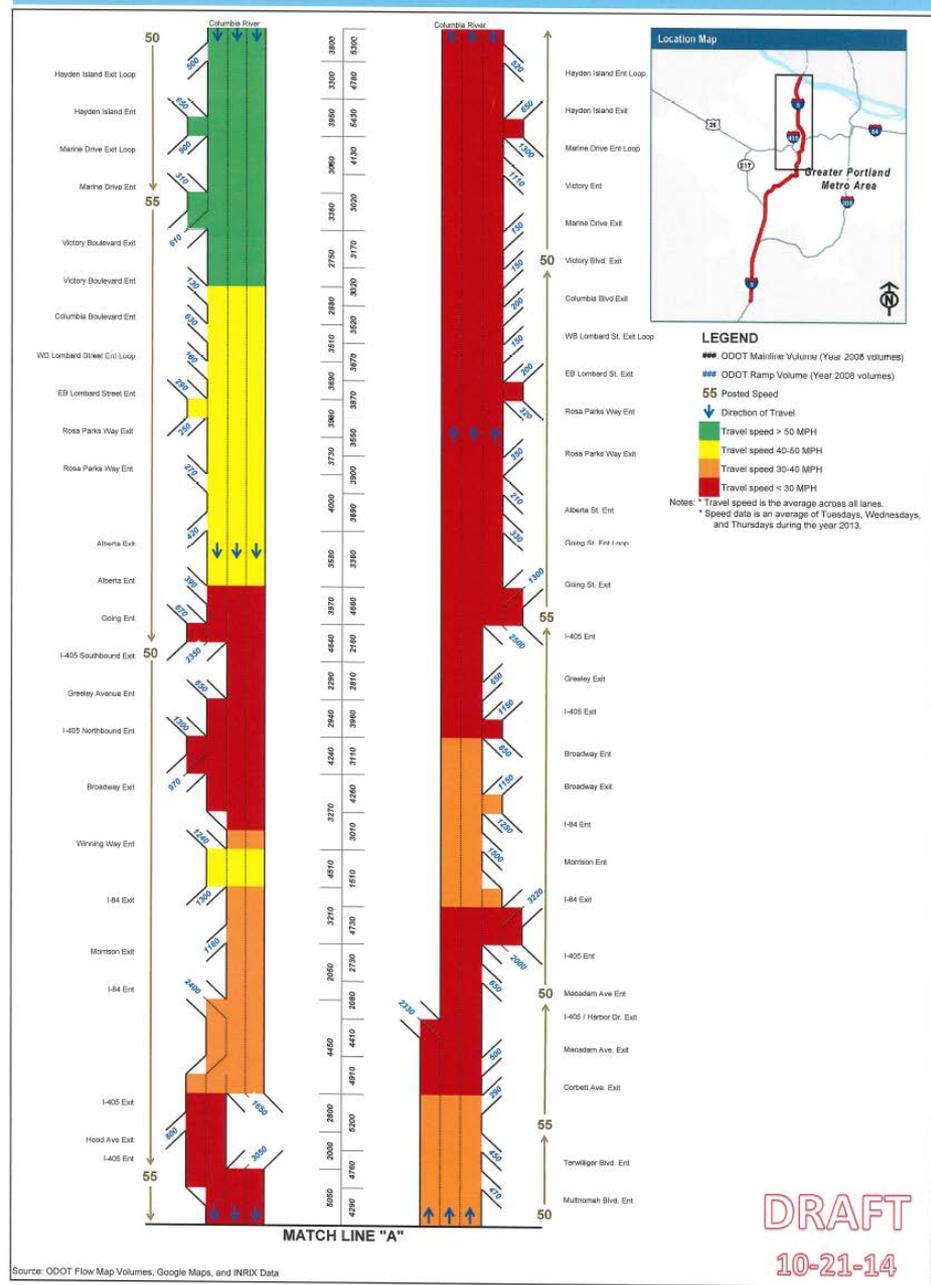
Exhibit 2a: Lane and Ramp Configurations, Spacing, and Signals



DRAFT
10-21-14

I-5: Pacific Highway Corridor

Exhibit 6a: P.M. Peak Hour (5:00 PM) Volumes and Speeds



DRAFT
10-21-14



I-5: Pacific Highway Corridor

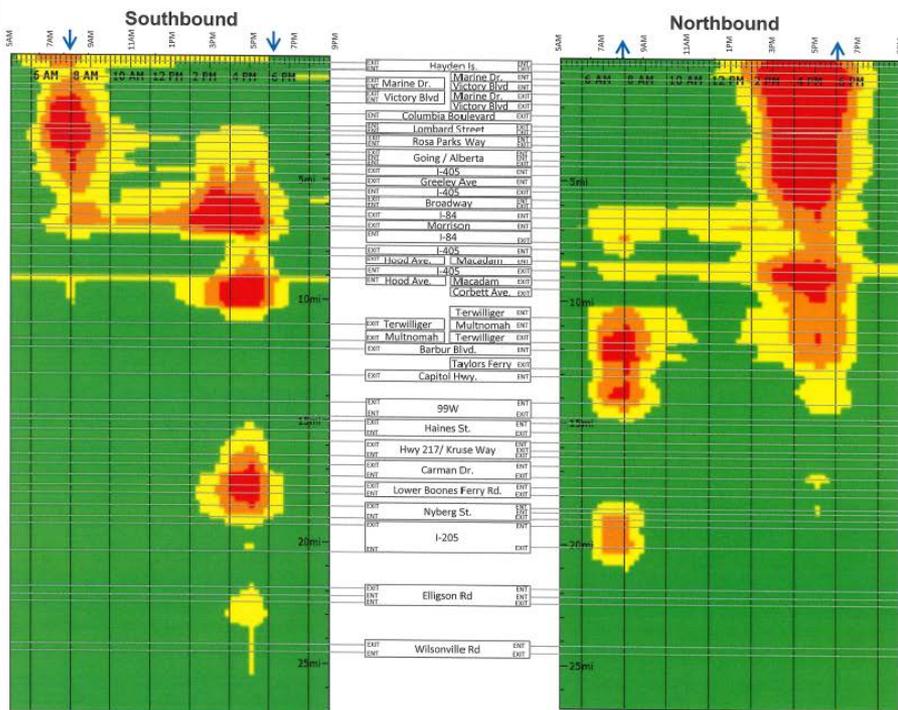
Exhibit 7: Corridor Speed Summary



Measured speed across all lanes as a percentage of the free flow speed.



Averaged by 1 hour increment for 2013 (Every Tuesday, Wednesday, and Thursday)



- Exit 1: Haystack Is. (Exit)
- Exit 2: Marine Dr. (Exit)
- Exit 3: Victory Blvd. (Exit)
- Exit 4: Columbia Boulevard (Exit)
- Exit 5: Lombard Street (Exit)
- Exit 6: Rosa Parks Way (Exit)
- Exit 7: Going / Alberta (Exit)
- Exit 8: I-405 (Exit)
- Exit 9: Greeley Ave. (Exit)
- Exit 10: Broadway (Exit)
- Exit 11: I-84 (Exit)
- Exit 12: Morrison (Exit)
- Exit 13: I-84 (Exit)
- Exit 14: Hood Ave. / Macadam (Exit)
- Exit 15: Hood Ave. / Macadam (Exit)
- Exit 16: Corbett Ave. (Exit)
- Exit 17: Terwilliger (Exit)
- Exit 18: Multnomah (Exit)
- Exit 19: Terwilliger (Exit)
- Exit 20: Multnomah (Exit)
- Exit 21: Barbur Blvd. (Exit)
- Exit 22: Taylor's Ferry (Exit)
- Exit 23: Capitol Hwy. (Exit)
- Exit 24: 99W (Exit)
- Exit 25: Haines St. (Exit)
- Exit 26: Hwy 217/ Kruse Way (Exit)
- Exit 27: Carman Dr. (Exit)
- Exit 28: Lower Boones Ferry Rd. (Exit)
- Exit 29: Nyberg St. (Exit)
- Exit 30: I-205 (Exit)
- Exit 31: Elligson Rd. (Exit)
- Exit 32: Wilsonville Rd. (Exit)

| | | |
|------------------------------|----------------------------------|---------------------------------|
| 25.2 | Length of Corridor (mi) | 25.2 |
| 7.1 7.9 4.6 3.6 8.1 16.6 2.9 | Length of Corridor < 50 mph (mi) | 10.2 6.9 3.0 3.2 12.4 15.2 12.6 |
| 3.8 5.4 0.3 0.7 4.3 8.4 0.0 | Length of Corridor < 40 mph (mi) | 5.3 1.0 0.0 0.1 7.8 12.7 2.3 |
| 2.1 1.1 0.0 0.0 1.7 4.3 0.0 | Length of Corridor < 30 mph (mi) | 1.2 0.0 0.0 0.0 5.8 8.9 0.0 |

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I-5: Pacific Freeway Corridor

Exhibit 8a: 5-Year Crash Data (2008 to 2012) in 0.1 Mile Segments and 2013 SPIS Sites



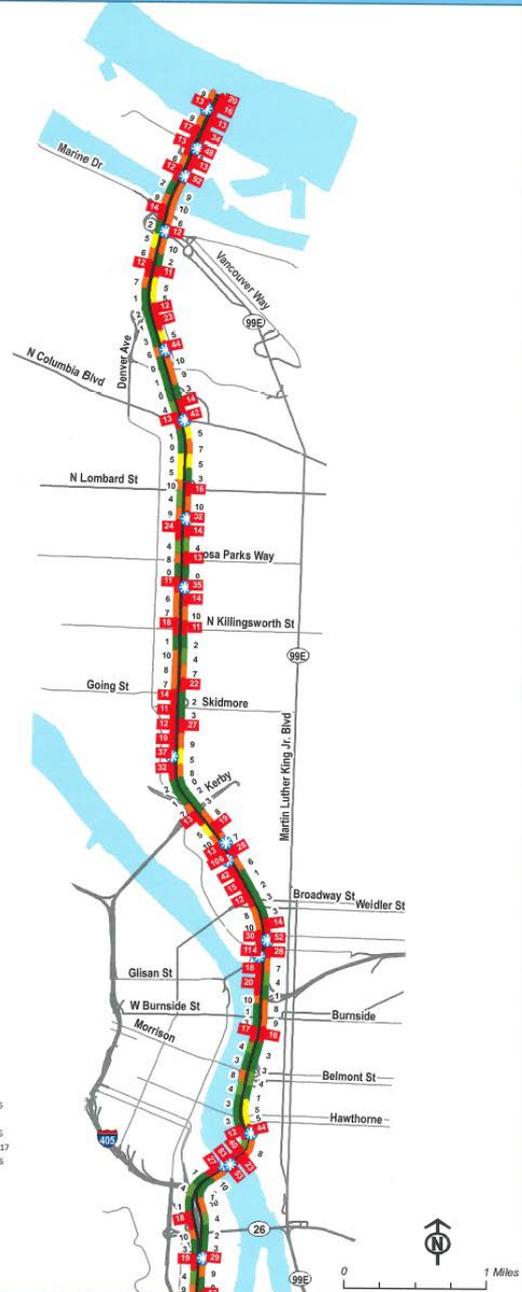
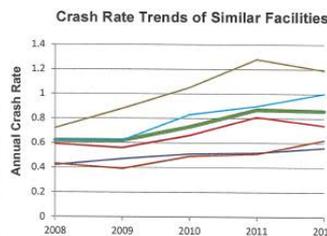
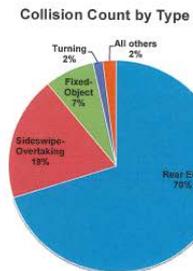
Collision Frequency by 0.1 of a Mile (annual average crashes)

- < 0.00 Crashes/Year
- 0.61 to 0.80 Crashes/Year
- 0.81 to 1.00 Crashes/Year
- 1.1 to 2.0 Crashes/Year
- > 2.0 Crashes/Year

2013 Top 10% Safety Priority Index System (SPIS) Sites

Collision Count by 0.1 of a Mile

- 5 Year Crash Count (less than 10 crashes)
- 5 Year Crash Count (greater than 10 crashes)

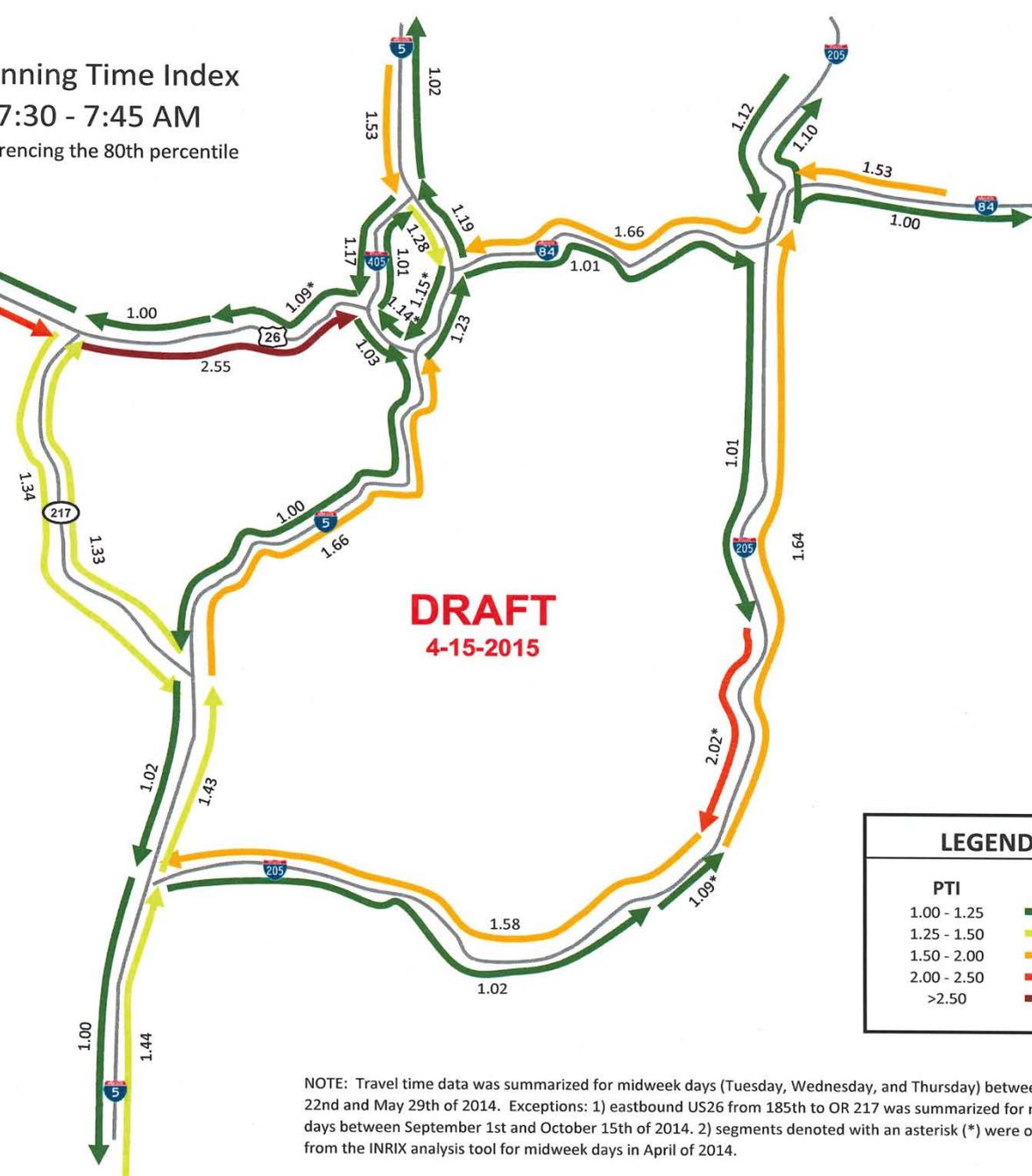


Planning Time Index

7:30 - 7:45 AM

Referencing the 80th percentile

| Rank | Freeway Section | PTI |
|------|--------------------------------|-------|
| 1 | US 26 EB 217 to I-405 | 2.55 |
| 2 | US 26 EB 185th to 217 | 2.45 |
| 3 | I-205 SB Sunnyside to 213 | 2.02* |
| 4 | I-5 NB 217 to I-405 (S) | 1.66 |
| 5 | I-84 WB I-205 to I-5 | 1.66 |
| 6 | I-205 NB 213 to I-84 | 1.64 |
| 7 | I-205 SB 213 to I-5 | 1.58 |
| 8 | I-5 SB Columbia R to I-405 (N) | 1.53 |
| 9 | I-84 WB 181st to I-205 | 1.53 |
| 10 | I-5 NB Wilsonville to I-205 | 1.44 |
| 11 | I-5 NB I-205 to 217 | 1.43 |
| 12 | 217 SB | 1.34 |
| 13 | 217 NB | 1.33 |
| 14 | I-5 SB I-405 (N) to I-84 | 1.28 |
| 15 | I-5 NB I-405 (S) to I-84 | 1.23* |
| 16 | I-5 NB I-84 to I-405 (N) | 1.19 |
| 17 | I-405 SB I-5 to US26 | 1.17 |
| 18 | I-5 SB I-84 to I-405 (S) | 1.15* |
| 19 | I-405 NB I-5 to US26 | 1.14* |
| 20 | I-205 SB Airport Way to I-84 | 1.12 |
| 21 | I-205 NB I-84 to Airport Way | 1.10 |
| 22 | US 26 WB I-405 to Sylvan | 1.09* |
| 23 | I-205 NB 99 to 213 | 1.09* |
| 24 | I-405 SB US26 to I-5 | 1.03 |
| 25 | I-5 NB I-405 to Columbia R | 1.02 |
| 26 | I-5 SB 217 to I-205 | 1.02 |
| 27 | I-205 NB I-5 to 99 | 1.02 |
| 28 | I-405 NB US26 to I-5 | 1.01 |
| 29 | I-84 EB I-5 to I-205 | 1.01 |
| 30 | I-205 SB I-84 to Sunnyside | 1.01 |
| 31 | I-5 SB I-405 (S) to 217 | 1.00 |
| 32 | I-5 SB I-205 to Wilsonville | 1.00 |
| 33 | US 26 WB Sylvan to 217 | 1.00 |
| 34 | US 26 WB 217 to 185th | 1.00 |
| 35 | I-84 EB I-205 to 181st | 1.00 |



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4-15-2015

| LEGEND | |
|-------------|--------------------|
| PTI | |
| 1.00 - 1.25 | Green Arrow |
| 1.25 - 1.50 | Yellow-Green Arrow |
| 1.50 - 2.00 | Yellow Arrow |
| 2.00 - 2.50 | Orange Arrow |
| >2.50 | Red Arrow |

NOTE: Travel time data was summarized for midweek days (Tuesday, Wednesday, and Thursday) between April 22nd and May 29th of 2014. Exceptions: 1) eastbound US26 from 185th to OR 217 was summarized for midweek days between September 1st and October 15th of 2014. 2) segments denoted with an asterisk (*) were obtained from the INRIX analysis tool for midweek days in April of 2014.

Planning Time Index

5:00 - 5:15 PM

Referencing the 80th percentile

| Rank | Freeway Section | PTI |
|------|--------------------------------|-------|
| 1 | I-5 NB I-405 to Columbia R | 4.29 |
| 2 | I-5 SB I-405 (N) to I-84 | 4.25 |
| 3 | I-5 NB I-405 (S) to I-84 | 4.13* |
| 4 | I-405 SB US26 to I-5 | 3.86 |
| 5 | I-5 NB I-84 to I-405 (N) | 3.82 |
| 6 | I-405 NB US26 to I-5 | 3.31 |
| 7 | US 26 EB 217 to I-405 | 2.97 |
| 8 | I-205 NB I-5 to 99 | 2.64 |
| 9 | I-205 NB I-84 to Airport Way | 2.55 |
| 10 | I-5 NB 217 to I-405 (S) | 2.44 |
| 11 | I-84 EB I-5 to I-205 | 2.36 |
| 12 | I-405 SB I-5 to US26 | 2.21 |
| 13 | I-5 SB I-84 to I-405 (S) | 2.04* |
| 14 | I-205 SB Sunnyside to 213 | 1.96* |
| 15 | I-205 NB 213 to I-84 | 1.93 |
| 16 | I-405 NB I-5 to US26 | 1.86* |
| 17 | I-205 SB I-84 to Sunnyside | 1.77 |
| 18 | I-205 SB Airport Way to I-84 | 1.76 |
| 19 | I-5 SB Columbia R to I-405 (N) | 1.64 |
| 20 | 217 SB | 1.64 |
| 21 | I-5 SB I-205 to Wilsonville | 1.49 |
| 22 | I-5 SB I-405 (S) to 217 | 1.48 |
| 23 | 217 NB | 1.41 |
| 24 | I-84 WB 181st to I-205 | 1.40 |
| 25 | I-84 WB I-205 to I-5 | 1.27 |
| 26 | US 26 WB I-405 to Sylvan | 1.16* |
| 27 | I-205 NB 99 to 213 | 1.11* |
| 28 | I-5 SB 217 to I-205 | 1.09 |
| 29 | I-205 SB 213 to I-5 | 1.09 |
| 30 | US 26 EB 185th to 217 | 1.07 |
| 31 | I-84 EB I-205 to 181st | 1.05 |
| 32 | I-5 NB Wilsonville to I-205 | 1.03 |
| 33 | I-5 NB I-205 to 217 | 1.03 |
| 34 | US 26 WB Sylvan to 217 | 1.00 |
| 35 | US 26 WB 217 to 185th | 1.00 |



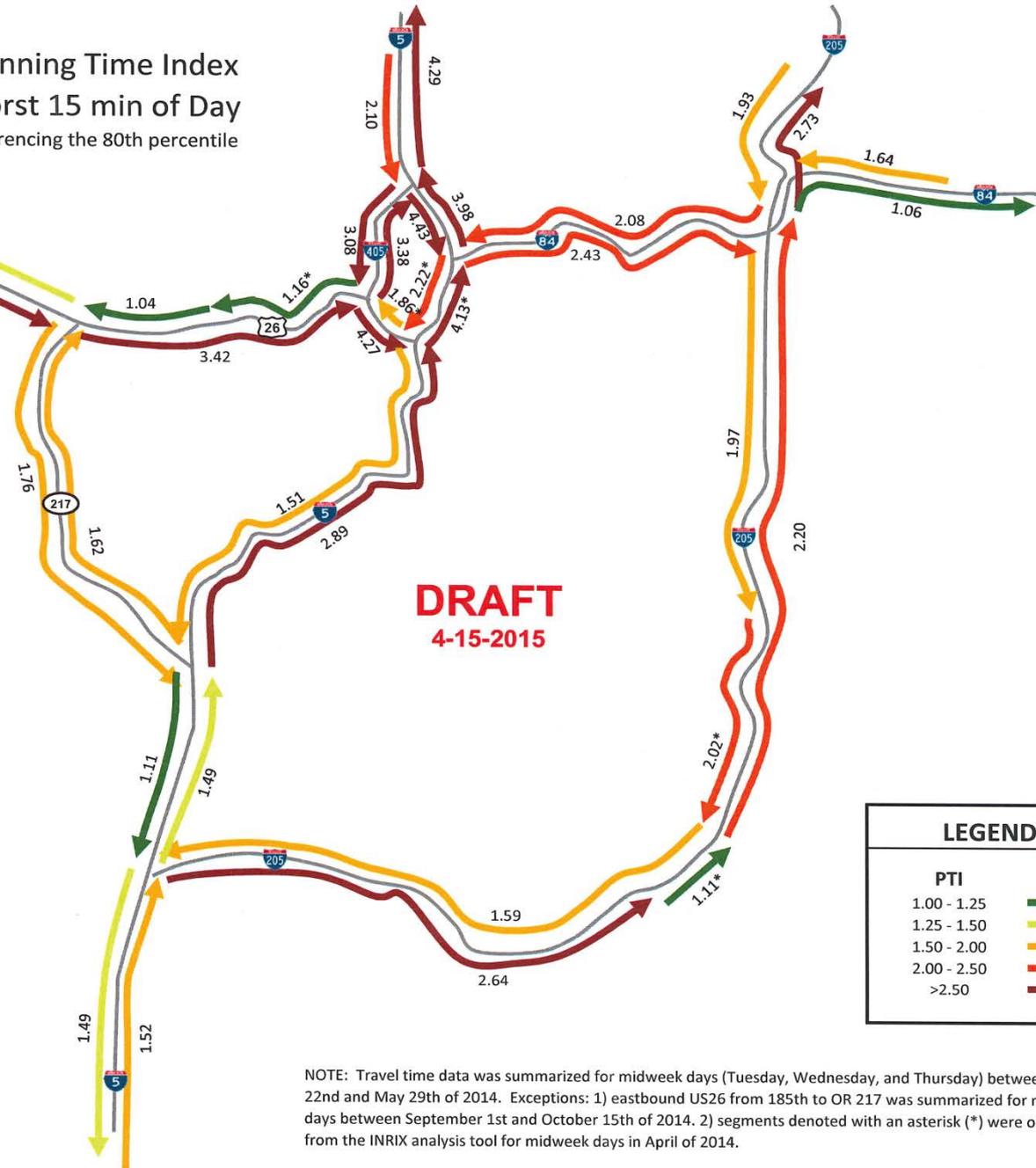
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| LEGEND | |
|-------------|-------------------|
| PTI | |
| 1.00 - 1.25 | Green Arrow |
| 1.25 - 1.50 | Light Green Arrow |
| 1.50 - 2.00 | Yellow Arrow |
| 2.00 - 2.50 | Orange Arrow |
| >2.50 | Red Arrow |

NOTE: Travel time data was summarized for midweek days (Tuesday, Wednesday, and Thursday) between April 22nd and May 29th of 2014. Exceptions: 1) eastbound US26 from 185th to OR 217 was summarized for midweek days between September 1st and October 15th of 2014. 2) segments denoted with an asterisk (*) were obtained from the INRIX analysis tool for midweek days in April of 2014.

Planning Time Index Worst 15 min of Day Referencing the 80th percentile

| Rank | Freeway Section | PTI |
|------|--------------------------------|-------|
| 1 | I-5 SB I-405 (N) to I-84 | 4.43 |
| 2 | I-5 NB I-405 to Columbia R | 4.29 |
| 3 | I-405 SB US26 to I-5 | 4.27 |
| 4 | I-5 SB I-84 to I-405 (S) | 4.13* |
| 5 | I-5 NB I-84 to I-405 (N) | 3.98 |
| 6 | US 26 EB 217 to I-405 | 3.42 |
| 7 | I-405 NB US26 to I-5 | 3.38 |
| 8 | I-405 SB I-5 to US26 | 3.08 |
| 9 | I-5 NB 217 to I-405 (S) | 2.89 |
| 10 | US 26 EB 185th to 217 | 2.74 |
| 11 | I-205 NB I-84 to Airport Way | 2.73 |
| 12 | I-205 NB I-5 to 99 | 2.64 |
| 13 | I-84 EB I-5 to I-205 | 2.43 |
| 14 | I-5 NB I-405 (S) to I-84 | 2.22* |
| 15 | I-205 NB 213 to I-84 | 2.20 |
| 16 | I-5 SB Columbia R to I-405 (N) | 2.10 |
| 17 | I-84 WB I-205 to I-5 | 2.08 |
| 18 | I-205 SB Sunnyside to 213 | 2.02* |
| 19 | I-205 SB I-84 to Sunnyside | 1.97 |
| 20 | I-205 SB Airport Way to I-84 | 1.93 |
| 21 | I-405 NB I-5 to US26 | 1.86* |
| 22 | 217 SB | 1.76 |
| 23 | I-84 WB 181st to I-205 | 1.64 |
| 24 | 217 NB | 1.62 |
| 25 | I-205 SB 213 to I-5 | 1.59 |
| 26 | I-5 NB Wilsonville to I-205 | 1.52 |
| 27 | I-5 SB I-405 (S) to 217 | 1.51 |
| 28 | I-5 NB I-205 to 217 | 1.49 |
| 29 | I-5 SB I-205 to Wilsonville | 1.49 |
| 30 | US 26 WB 217 to 185th | 1.31 |
| 31 | US 26 WB I-405 to Sylvan | 1.16* |
| 32 | I-5 SB 217 to I-205 | 1.11 |
| 33 | I-205 NB 99 to 213 | 1.11* |
| 34 | I-84 EB I-205 to 181st | 1.06 |
| 35 | US 26 WB Sylvan to 217 | 1.04 |



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| LEGEND | |
|-------------|--------------------|
| PTI | |
| 1.00 - 1.25 | Green Arrow |
| 1.25 - 1.50 | Yellow-Green Arrow |
| 1.50 - 2.00 | Yellow Arrow |
| 2.00 - 2.50 | Orange Arrow |
| >2.50 | Red Arrow |

NOTE: Travel time data was summarized for midweek days (Tuesday, Wednesday, and Thursday) between April 22nd and May 29th of 2014. Exceptions: 1) eastbound US26 from 185th to OR 217 was summarized for midweek days between September 1st and October 15th of 2014. 2) segments denoted with an asterisk (*) were obtained from the INRIX analysis tool for midweek days in April of 2014.

Crashes Per Mile 2008 - 2012

| Rank | Freeway Section | Rate |
|------|--------------------------------|------|
| 1 | I-5 SB I-405 (N) to I-84 | 277 |
| 2 | US 26 EB 217 to I-405 | 254 |
| 3 | I-405 NB I-5 to US26 | 146 |
| 4 | I-5 NB I-405 to Columbia R | 140 |
| 5 | I-5 SB I-84 to I-405 (S) | 137 |
| 6 | US 26 WB I-405 to Sylvan | 132 |
| 7 | I-5 NB I-405 (S) to I-84 | 123 |
| 8 | I-5 NB I-84 to I-405 (N) | 122 |
| 9 | I-405 NB US26 to I-5 | 104 |
| 10 | I-5 SB 217 to I-205 | 103 |
| 11 | I-84 WB I-205 to I-5 | 98 |
| 12 | I-405 SB I-5 to US26 | 89 |
| 13 | I-5 SB Columbia R to I-405 (N) | 83 |
| 14 | I-405 SB US26 to I-5 | 78 |
| 15 | I-84 EB I-5 to I-205 | 75 |
| 16 | I-5 NB I-205 to 217 | 73 |
| 17 | I-205 NB I-84 to Airport Way | 72 |
| 18 | I-5 NB 217 to I-405 (S) | 70 |
| 19 | I-205 NB 213 to I-84 | 68 |
| 20 | 217 SB | 66 |
| 21 | 217 NB | 66 |
| 22 | I-205 SB I-84 to Sunnyside | 63 |
| 23 | US 26 WB 217 to 185th | 62 |
| 24 | I-205 SB Sunnyside to 213 | 55 |
| 25 | I-5 SB I-405 (S) to 217 | 53 |
| 26 | I-5 NB Wilsonville to I-205 | 49 |
| 27 | I-5 SB I-205 to Wilsonville | 44 |
| 28 | I-205 SB Airport Way to I-84 | 36 |
| 29 | I-205 SB 213 to I-5 | 35 |
| 30 | I-205 NB I-5 to 99 | 33 |
| 31 | US 26 EB 185th to 217 | 31 |
| 32 | I-84 WB 181st to I-205 | 27 |
| 33 | I-205 NB 99 to 213 | 24 |
| 34 | I-84 EB I-205 to 181st | 19 |
| 35 | US 26 WB Sylvan to 217 | 15 |



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4-15-2015

LEGEND

Crashes per Mi.

- < 35
- 35 - 70
- 70 - 105
- 105 - 140
- > 140

NOTE: Crash data is based on ODOT reports for the 5-year period from January 1st of 2008 to December 31st of 2012.

ATM Region Strategy

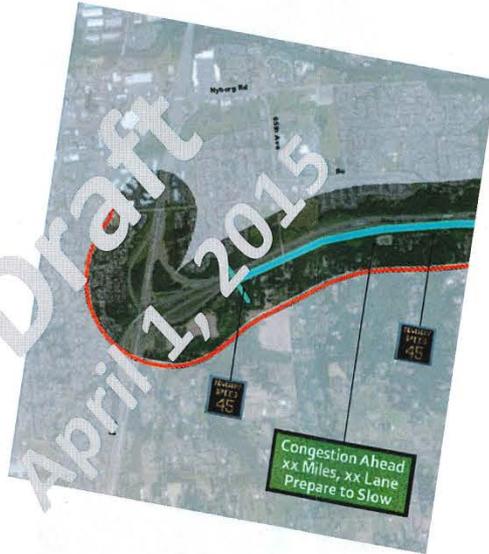
System to System Congestion at Interchanges



System to System connection at I-5 and I-205

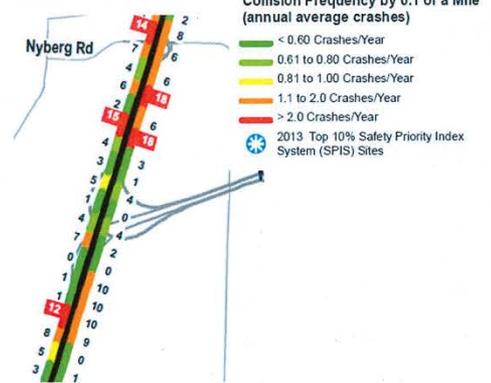


Draft I-5 ATM Corridor Design



Draft I-205 ATM Corridor Design

5-year Crash Data



5-year Crash Data



Questions?



Presentation

