# Bicycle Signals

Presented by

**Peter Koonce**

**Rock Miller**

**Dave Kirschner**

**Wednesday, April 25, 2018**

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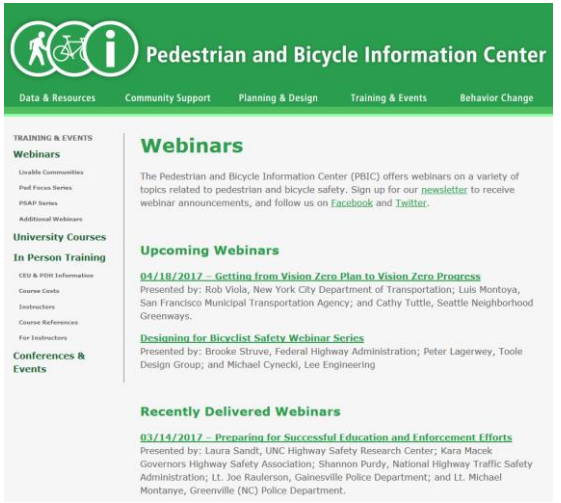


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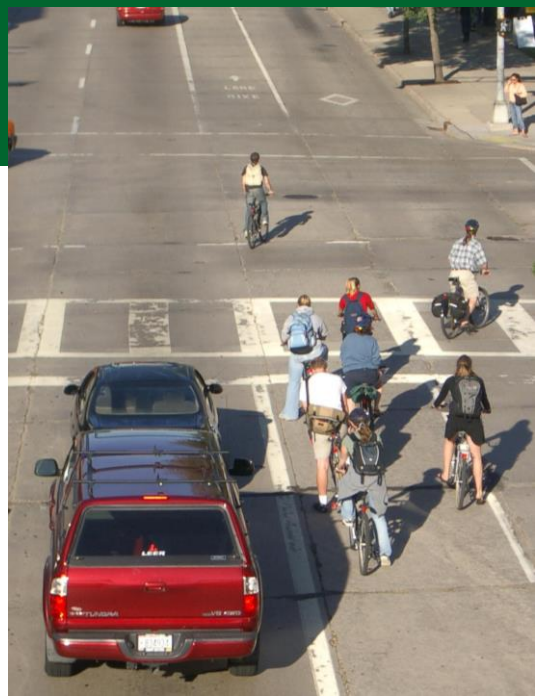
**April 30, 1:00 – 2:30 PM Eastern Time**



**Ilir Beijleri**
Univ of Florida

**Michael Sanders**
Arizona DOT

**Brent Crowther**
Kimley-Horn

**Michelle Beckley**
Lee Engineering

# Bicycle Signals

**April 25, 2018**

***Presented by:***

Peter Koonce, PE

# Webinar Outcomes

- **Identify uses of bicycle signals for making intersections safer for people.**
- **Understand elements of a bicycle signal.**
- **Explore issues and restrictions included in FHWA Interim Approval.**
- **Identify steps to implementation**

# Outline

**Background on Bicycle Signals**

**Recent Research**

**FHWA Interim Approval**

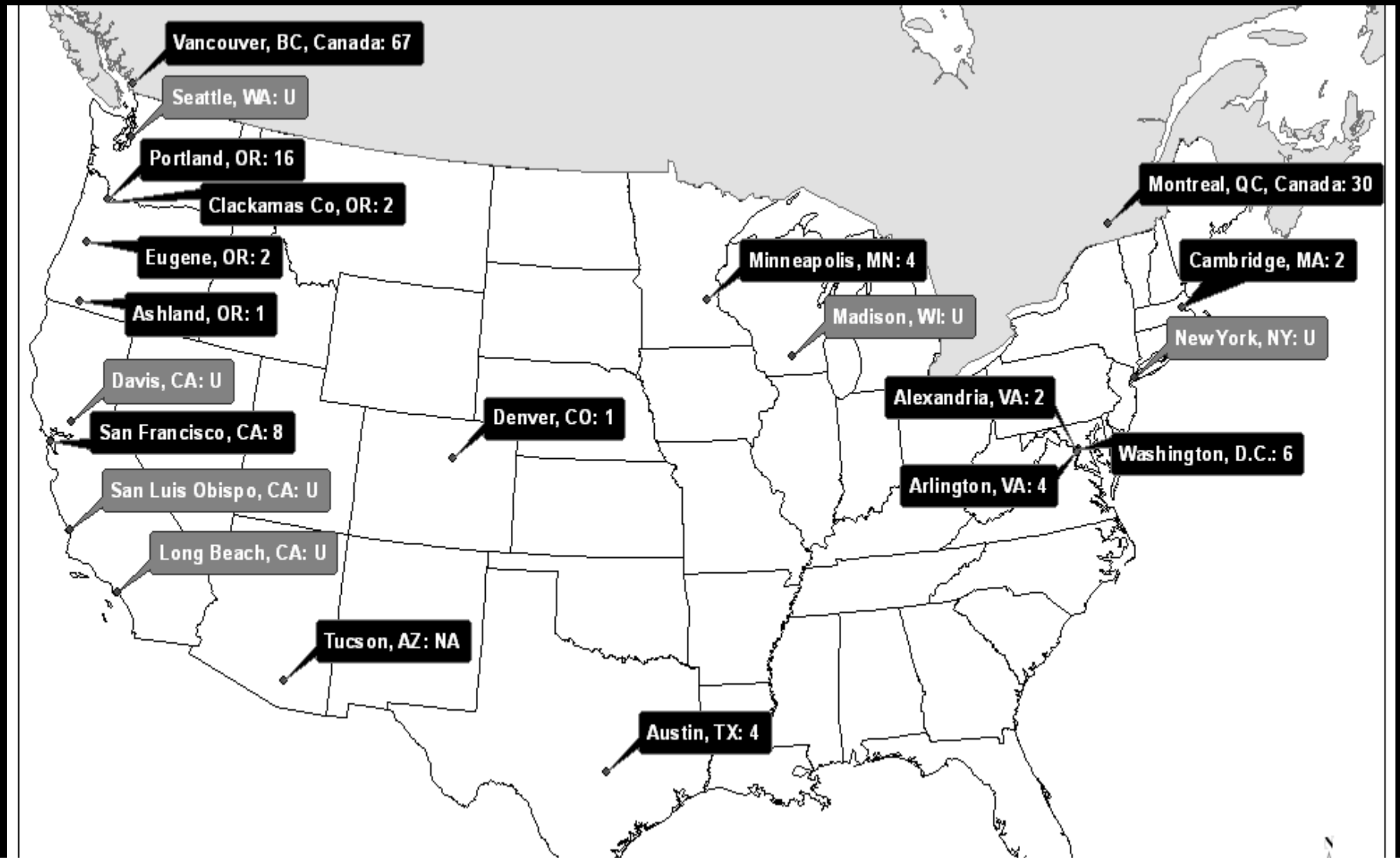
# Bicycle Signals

- **Common applications in Europe**
- **U.S. first bicycle signal in 2004**
- **FHWA Interim Approval December 2013**

# Bicycle-Specific Traffic Signals: State-of-the-Practice

- **review of relevant guidance documents**
- **survey of jurisdictions with known installations of bicycle-specific signals**

# Survey Distribution and Response



# Summary of Bicycle Signal PSU Survey (2013)

- **Total # of Municipalities: 21**
- **Total Intersections: 63**
- **Total Signal Heads: 149**

# Motivations for Use

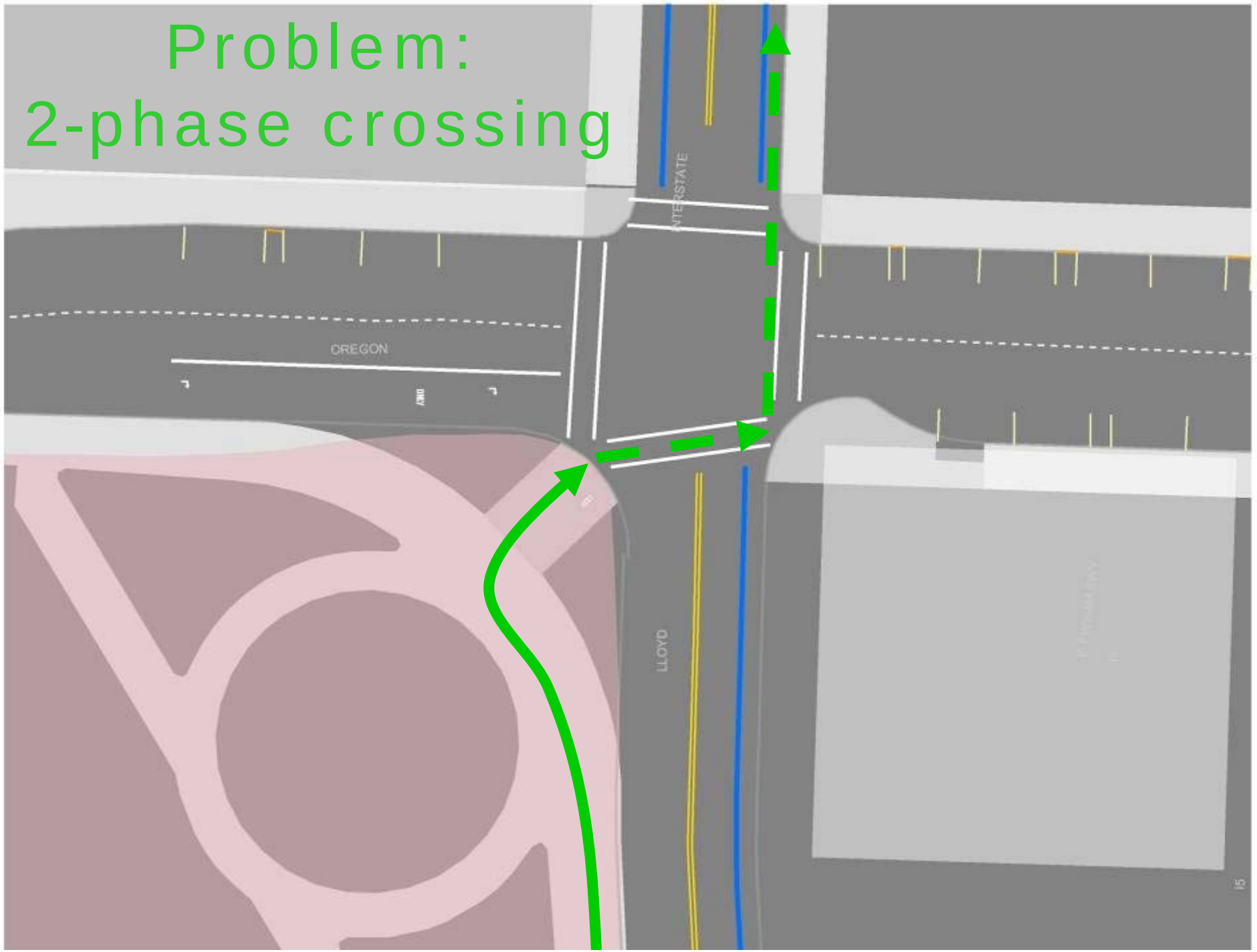
| Motivations | Number of Intersections | | | Percent of Sample | | |
|---|---|---|---|---|---|---|
| | US | CN | Total | US | CN | Total |
| Non-compliance | 3 | 0 | 3 | 8% | - | 3% |
| Contra-flow | 6 | 36 | 42 | 17% | 69% | 48% |
| Unique path | 13 | 3 | 16 | 36% | 6% | 18% |
| Safety | 9 | 12 | 21 | 25% | 23% | 24% |
| Other | 4 | 1 | 5 | 11% | 2% | 6% |

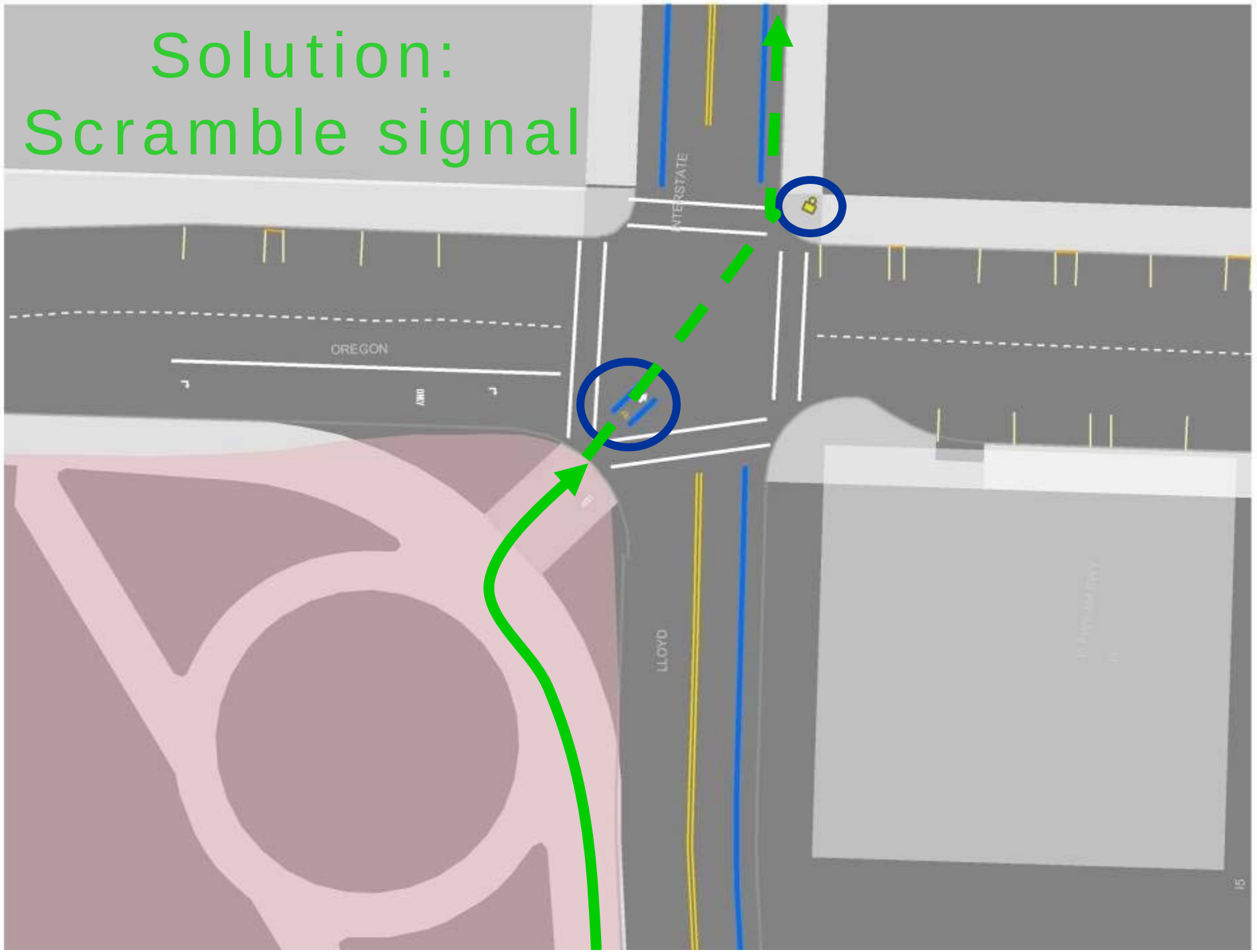
# Portland's First Bike Signal

# Scramble Phase Signal

## N Interstate Ave & Oregon St

- **Exclusive bike & pedestrian phase**
- **Bikes cross diagonally from southwest to northeast**
- **Movement controlled by a bike signal**


Problem:
2-phase crossing
OREGON
INTERSTATE
LLOYD


Solution:
Scramble signal
OREGON
INTERSTATE
LLOYD

# Scramble Phase Signal

## N Interstate Ave & Oregon St

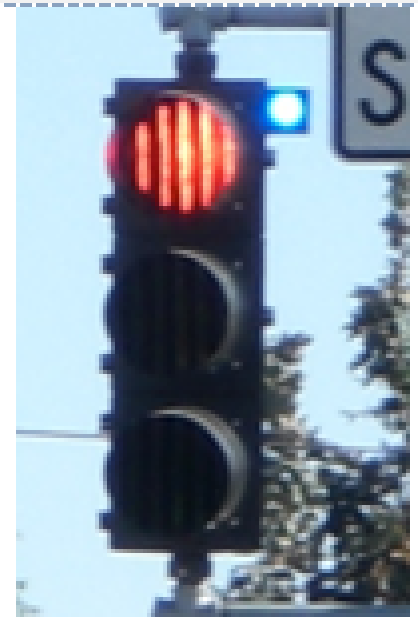
**Bicycle approach on the SW corner of the intersection**

Red bike signal phase

Green bike signal phase


**No right turn on red display during green bike signal phase**

# Signage

| | (e) Signage | | |
|---|---|---|---|
|  (Portland, OR) |  (Long Beach, CA) |  (Vancouver, BC)  (Eugene, OR) |  (Minneapolis, MN)  (Portland, OR) |
| Detection Light | On backplate | Black on white | |

# Mounting Location

(Austin, TX)

Separate pole


(Minneapolis, MN)

Same as vehicle


(Portland, OR)

Euro-style Near and Far

# Placement

| | | |
|---|---|---|
|  |  |  |
| (Vancouver, BC) | (Long Beach, CA) | (Portland, OR) |
| Near and Far | Far only | Far only – Diagonal |

# Design Elements

| Design Element | | Number of Intersections | | | Percent of Intersections | | |
|---|---|---|---|---|---|---|---|
| | | US | CN | Total | US | CN | Total |
| Detection Type | Loop | 7 | 0 | 7 | 26% | - | 11% |
| | Video | 2 | 0 | 2 | 7% | - | 3% |
| | Loop & Push-Button | 4 | 0 | 4 | 15% | - | 6% |
| | Push-button Only | 2 | 0 | 2 | 7% | - | 3% |
| | No Detection/ Recall | 12 | 36 | 48 | 44% | 100% | 76% |
| | Unknown | 0 | 0 | 0 | - | - | - |
| Phasing Type | Exclusive | 16 | 13 | 29 | 59% | 36% | 46% |
| | Concurrent | 7 | 23 | 30 | 26% | 64% | 48% |
| | Leading interval | 1 | 0 | 1 | 4% | - | 2% |
| | Unknown | 3 | 0 | 3 | 11% | - | 5% |
| Restricted Movements | Yes | 19 | 20 | 39 | 70% | 56% | 62% |
| | No | 6 | 16 | 22 | 22% | 44% | 35% |
| | Unknown | 2 | 0 | 2 | 7% | - | 3% |
| Accompanying Signage | Yes | 20 | 9 | 29 | 74% | 25% | 46% |
| | No | 6 | 27 | 33 | 22% | 75% | 52% |
| | Unknown | 1 | 0 | 1 | 4% | - | 2% |

# Lens Type & Detection

(c) Insignia

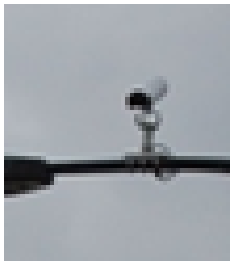
Faces right
(Washington, DC)

Faces left
(Denver, CO)

Abstract
(San Francisco, CA)

(d) Detection


Push button
(Portland, OR)



Video
(Portland, OR)


(Washington, DC)


(Clackamas Co, OR)

Loop

# Matching Housing & Backplate

(Minneapolis, MN)


(Long Beach, CA)

# Backplate (None)

(Denver, CO)

(Vancouver, BC)

# Mismatched Signal Housing

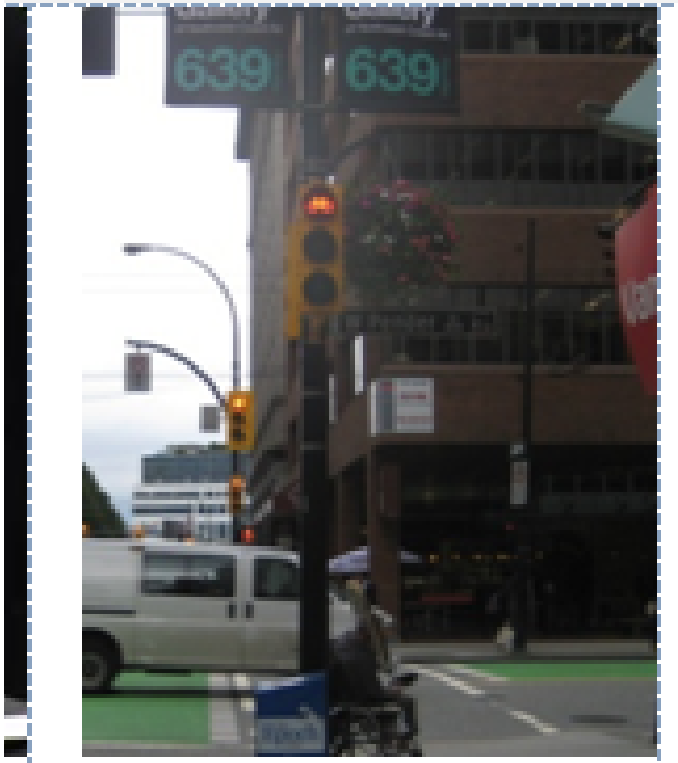
(Portland, OR)

(Clackamas Co., OR)

# Characteristics of Signals

| Characteristic | | Number of Signal Heads | | | Percent of Signal Heads | | |
|---|---|---|---|---|---|---|---|
| | | US | CN | Total | US | CN | Total |
| Backplate Color | Black | 18 | 0 | 18 | 35% | - | 12% |
| | Yellow | 10 | 0 | 10 | 19% | - | 7% |
| | No backplate | 24 | 97 | 121 | 46% | 100% | 81% |
| | Unknown | 0 | 0 | 0 | - | - | - |
| Housing Color | Black | 32 | 37 | 69 | 62% | 38% | 46% |
| | Yellow | 12 | 60 | 72 | 23% | 62% | 48% |
| | Other | 8 | 0 | 8 | 15% | - | 5% |
| | Unknown | 0 | 0 | 0 | - | - | - |
| Lens Size | 12" | 35 | 7 | 42 | 67% | 7% | 28% |
| | 10" | 0 | 0 | 0 | - | - | - |
| | 8" | 9 | 90 | 99 | 17% | 93% | 66% |
| | Other | 2 | 0 | 2 | 4% | - | 1% |
| | Unknown | 6 | 0 | 6 | 12% | - | 4% |
| Bicycle Insignia | Faces Left | 19 | 79 | 98 | 37% | 81% | 66% |
| | Faces Right | 20 | 0 | 20 | 38% | - | 13% |
| | No Insignia | 12 | 18 | 30 | 23% | 19% | 20% |
| | Unknown | 1 | 0 | 1 | 2% | - | 1% |
| Utilization of Louvers | Yes | 38 | 17 | 55 | 73% | 18% | 37% |
| | No | 13 | 80 | 93 | 25% | 82% | 62% |
| | Unknown | 1 | 0 | 1 | 2% | - | 1% |

## (b) Placement




(Vancouver, BC)

Near and Far

(Long Beach, CA)

Far only

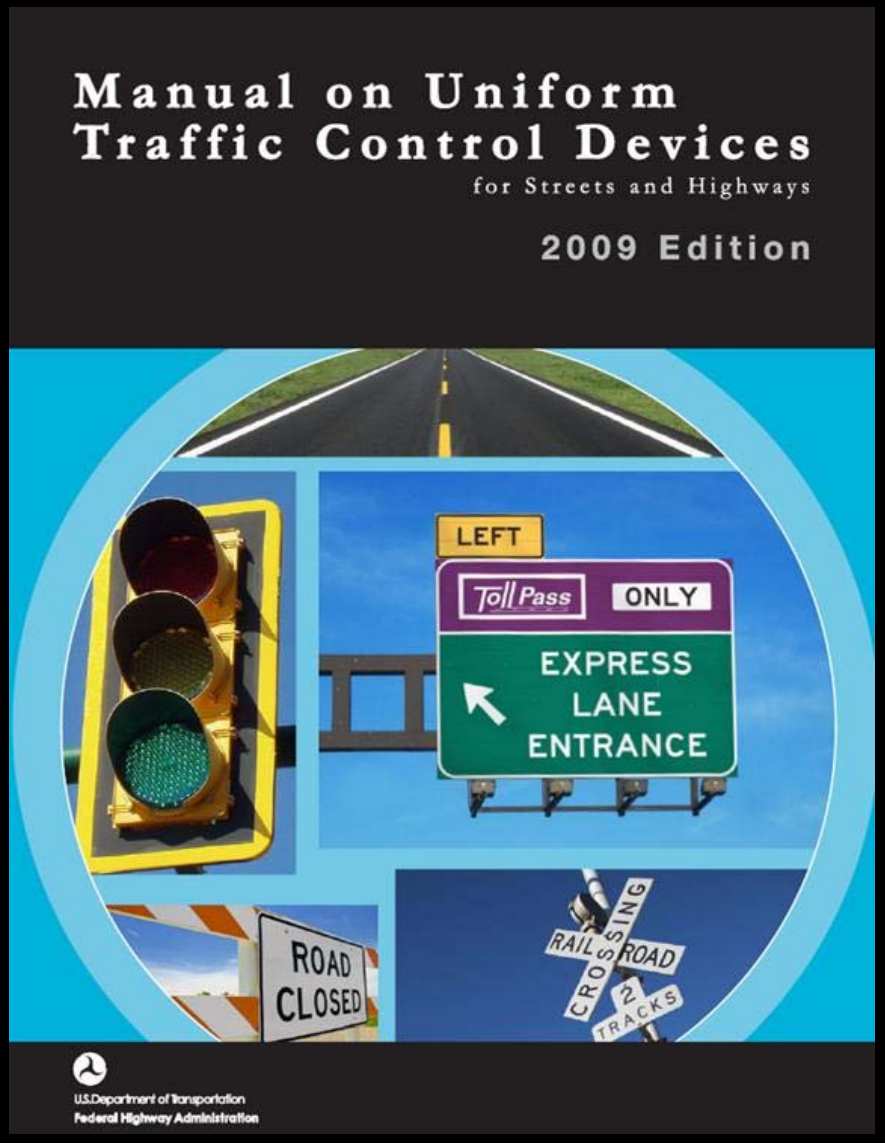
(Portland, OR)

Far only – Diagonal

## (e) Signage


# FHWA MUTCD Team

- **Request to Experiment process is well documented and several agencies have undertaken that effort**



| Request | Request Type | Requesting Agency | State | Date of Request | Topic | Status | Keywords |
|---|---|---|---|---|---|---|---|
| 9(09)-37 | Experiment | Oregon DOT | OR | 7/3/2012 | Bicycle Signal Displays | Active | Bikes\| Traffic Control Signals |
| 9(09)-35 | Experiment | City of Lakeland | FL | 8/24/2012 | Bicycle Boxes and Bicycle Signal Displays | Active | Bikes\| Colored Pavements\| Pavement Markings\| Traffic Co Signals |
| 9(09)-34 | Experimer | City of Chicago | IL | 7/24/2012 | Bicycle Signal Displays | Active | Bikes\| Traffic Control Signals |
| 9(09)-32 | Experiment | City of Sparks | NV | 4/17/2012 | Bicycle Signal Displays | Active | Bikes\| Traffic Control Signals |
| 9(09)-30 | Experiment | Minnesota DOT for Minneapolis | MN | 6/11/2012 | Bike Signal Indications for Leading Bike Phase | Active | Bikes\| Traffic Control Signals |
| 9(09)-28 | Experiment | City of Canton | OH | 12/8/2011 | Bike Signal Heads and Two-Stage Turn Queue Boxes | Active | Bikes\| Colored Pavements\| Pavement Markings\| Traffic Co Signals |
| 9(09)-25 | Experiment | City and County of Denver | CO | 10/25/2011 | Bike Signal Heads and Chevron Striping | Active | Bikes\| Pavement Markings\| Tra Control Signals |
| 9(09)-22 | Experime | Clackamas County | OR | 7/5/2011 | Bike Signal Heads and Diagonal Bike Pavement Markings | Active | Bikes\| Pavement Markings\| Tra Control Signals |
| 9(09)-16 | Experime | Oregon DOT for Ashland | OR | 3/10/2011 | Bike Signal Heads | Active | Bikes\| Traffic Control Signals |
| 9(09)-13 | Experiment | City of Madison | WI | 10/7/2010 | Bike Signal Heads | Active | Bikes\| Traffic Control Signals |
| 9(09)-9 | Experiment | Arlington County | VA | 8/19/2010 | Bike Signal Heads | Active | Bikes\| Traffic Control Signals |
| 9(09)-7 | Experiment | City of Alexandria | VA | 6/18/2010 | Bike Signal Heads | Active | Bikes\| Traffic Control Signals |
| 9(09)-6 | Experiment | Minnesota DOT for Minneapolis | MN | 5/11/2010 | Bike Pavement Markings and Bike Signal Heads | Active | Bikes\| Pavement Markings\| Tra Control Signals |
| 9-127 | Experiment | City of Washington | DC | 11/4/2009 | Bike Boxes and Bike Signal Heads | Active | Bikes\| Pavement Markings\| Tra Control Signals |
| 9-112 | Experiment | City of Long Beach | CA | 1/27/2009 | Green Markings and Bike Signal Heads | Active | Bikes\| Colored Pavements\| Pavement Markings\| Traffic Co Signals |
| 9-76 | Experiment | City and County of Denver | CO | 6/22/2004 | Bike Traffic Signal Heads [countdowns added in 2008] | Final Report Received | Bikes\| Traffic Control Signals |


NCUTCD
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# Interim Approval defines uses for Bicycle Signal Faces

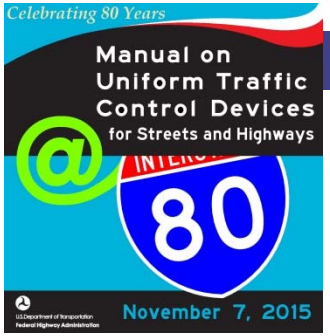
- Bicyclist non-compliance with the previous traffic control;
- Provide a leading or lagging bicycle interval;
- Continue the bicycle lane on the right-hand side of an exclusive turn lane (Section 9C.04);
- Augment the design of a segregated counter-flow bicycle facility; and
- Complex intersections, conflict areas, or signal control.

# MUTCD Interim Approval, Part 1

- Requires No Turn On Red without consideration of the intensity or volume of the conflict
- Bicycle Signal Indications identifies flashing Green as an option
- differences in interpretation what is “Protected Only”
- Requires 3 feet separation between signal heads

# MUTCD Interim Approval, Part 2

- Arrows shall be used as a part of the bicycle signal to accomplish “turn prohibitions”.
- Bicycle Signal sign “shall be installed immediately adjacent to every bicycle signal face”
- Restricts the use of a bicycle signal face with Pedestrian Hybrid Beacons
- “Scramble” Phases shall not be used (restricts diagonal bike movements)

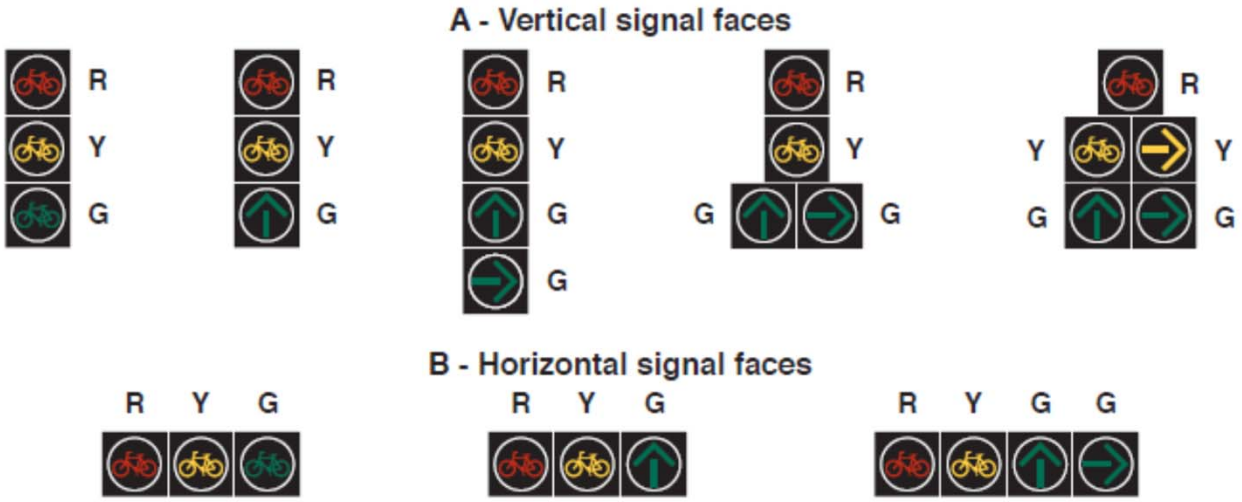



# Interim Approval under the MUTCD

- Optional use, jurisdictions are not required to use these devices
- Must apply for, and receive approval from FHWA
- Interim Approval 16
  - Adopted in 2013
  - Allows for bicycle signal faces

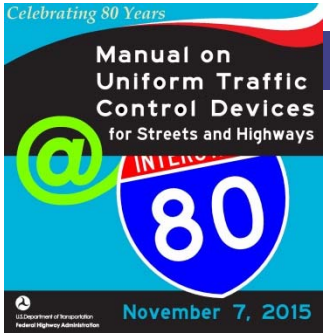
# Bicycle Devices Under Interim Approval

- Interim Approval 16 – Bicycle Signal Faces
  - Part 9 allows for the use of standard circular traffic signals to control bicycle facilities
  - IA-16 allows for the use of signal faces including bicycle symbols



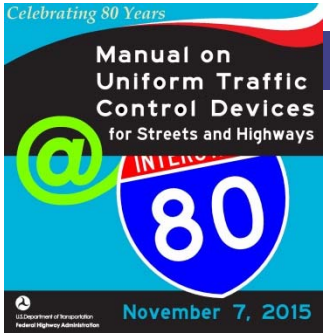
# Bicycle Devices Under Interim Approval

- Interim Approval 16 – Bicycle Signal Faces
  - IA-16 restricts the operation of bicycle signal faces where there are potentially conflicting motor vehicle movements
  - Permissive motor vehicle movements across bicycle signal face-controlled movements are non-compliant with IA-16
    - Experimentation is being conducted with this operation




# Bicycle TCDs Under Experimentation

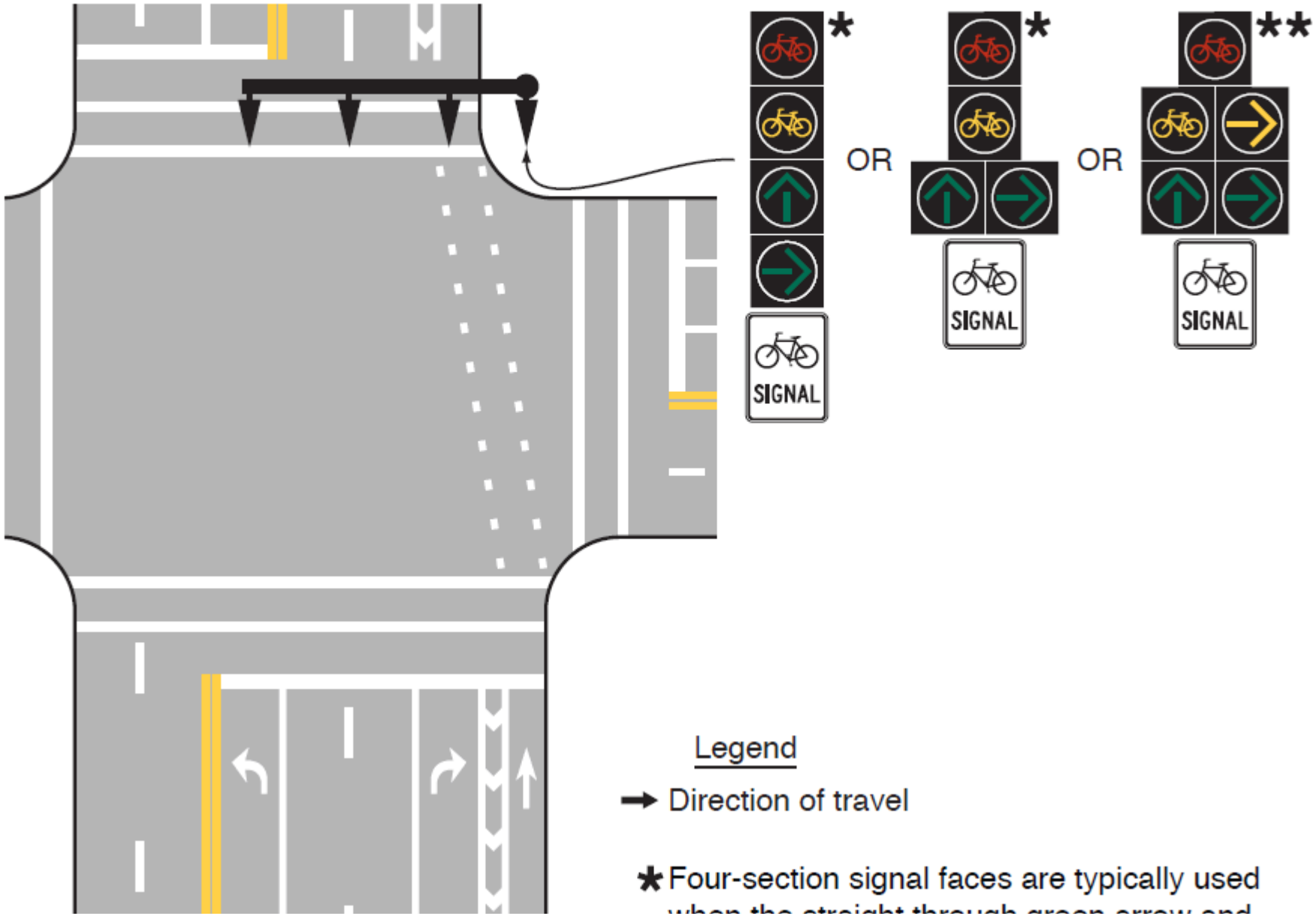
- Bicycle Signals allowing Conflicting Movements
  - IA-16 does not allow bicycle signal faces to be used where there are conflicting motor vehicle movements
  - FHWA has received many requests to relax this provision but no data or observations have been submitted
    - FHWA is aware that jurisdictions are operating bicycle signals in this manner but none that have collected operational or conflict data



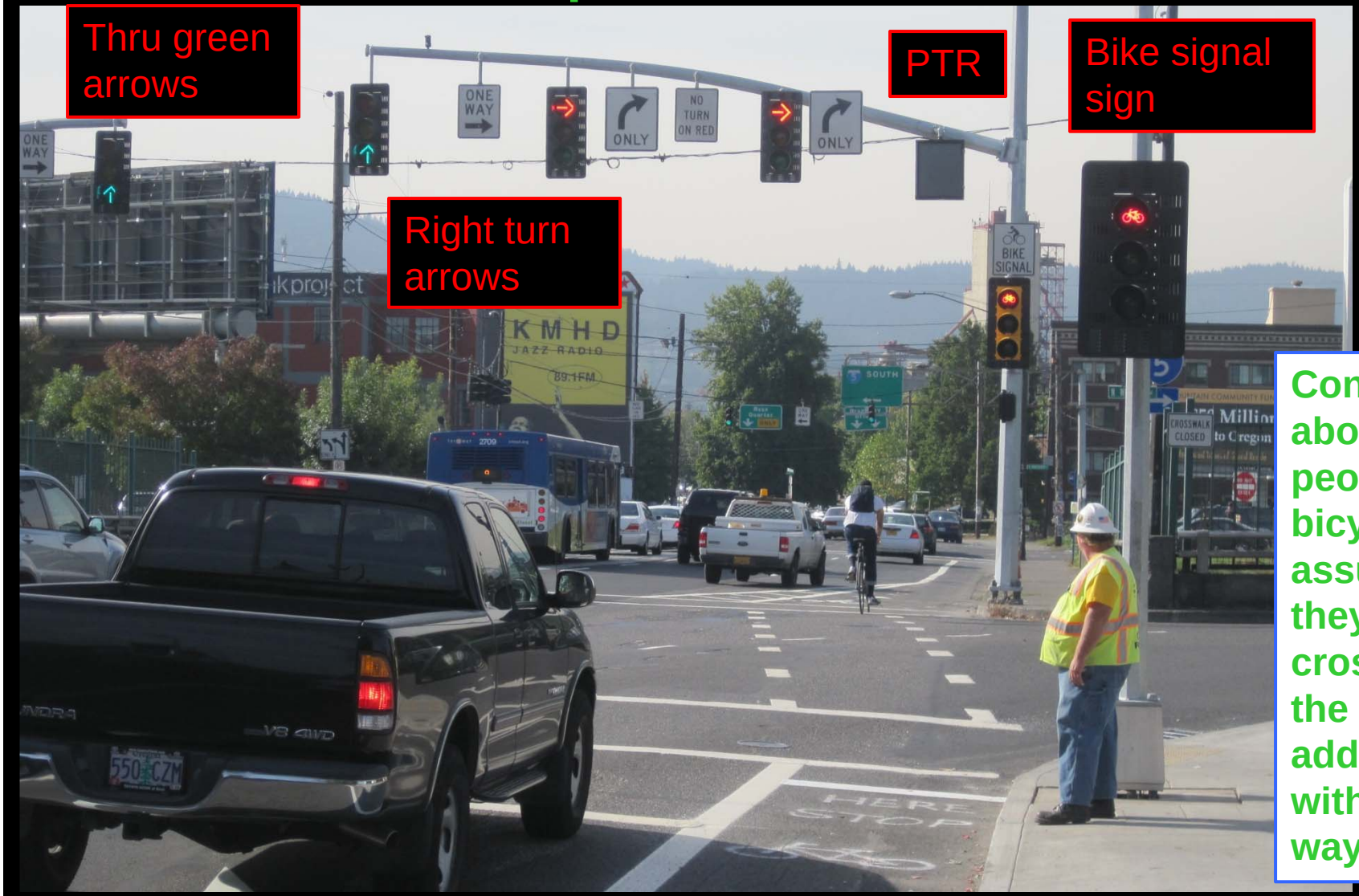

# Bicycle TCDs Under Experimentation

- Bicycle Signals allowing Conflicting Movements
  - Several experiments with this operation
    - Some show bicyclists a green bicycle indication, some show a flashing yellow bicycle indication
    - Critical observations – conflicts and interactions between motorists and bicyclists while conflicts are permitted
    - Do motorists and bicyclists understand the conflicts, rights, and responsibilities at these locations?
    - Flashing yellow arrows shown to turning motorists to indicate additional degree of conflict

# Attachment IA-16-2
# Example of How to Prohibit a Left-Turning Bike Movement



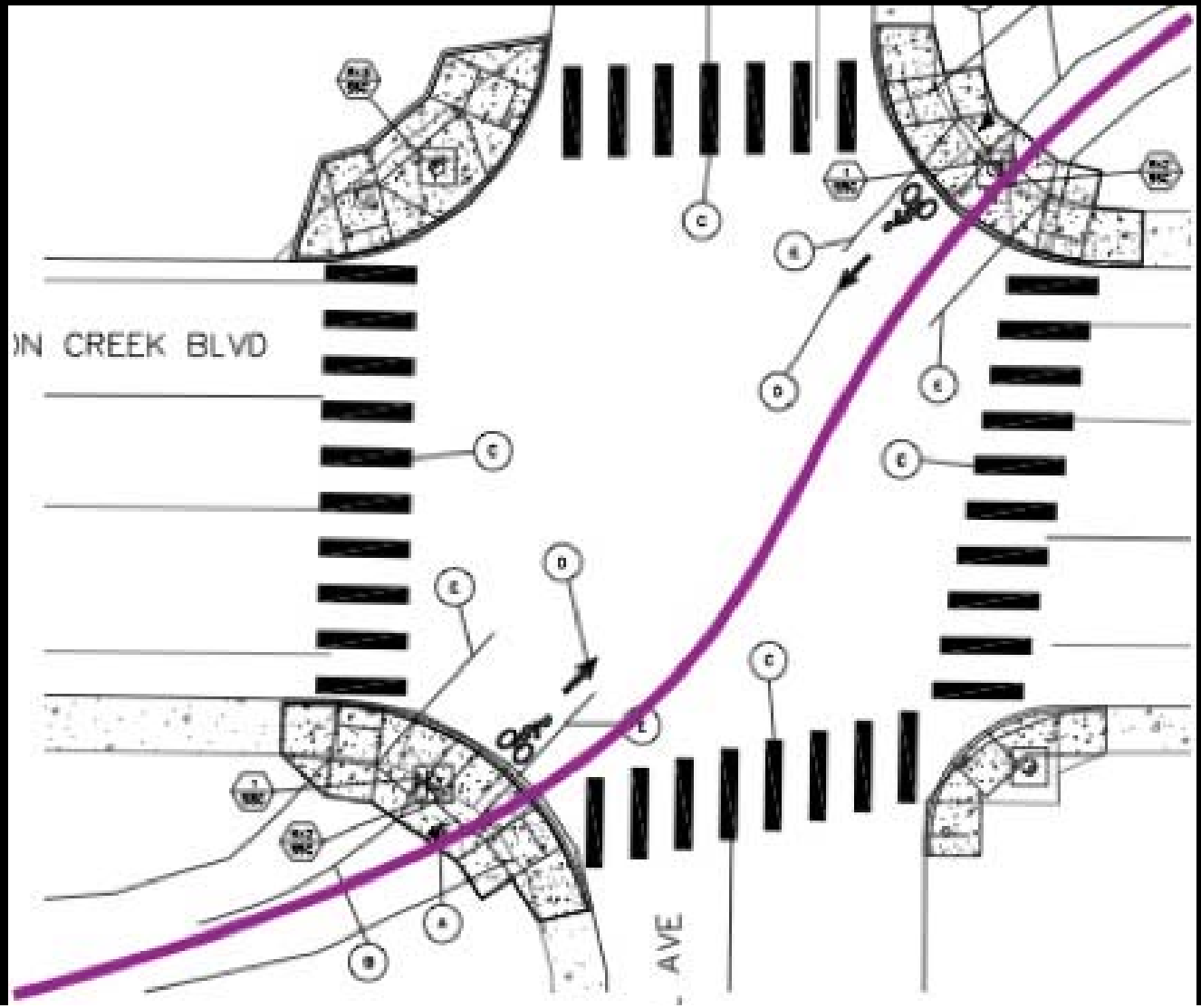
# N Broadway & Williams Improvements

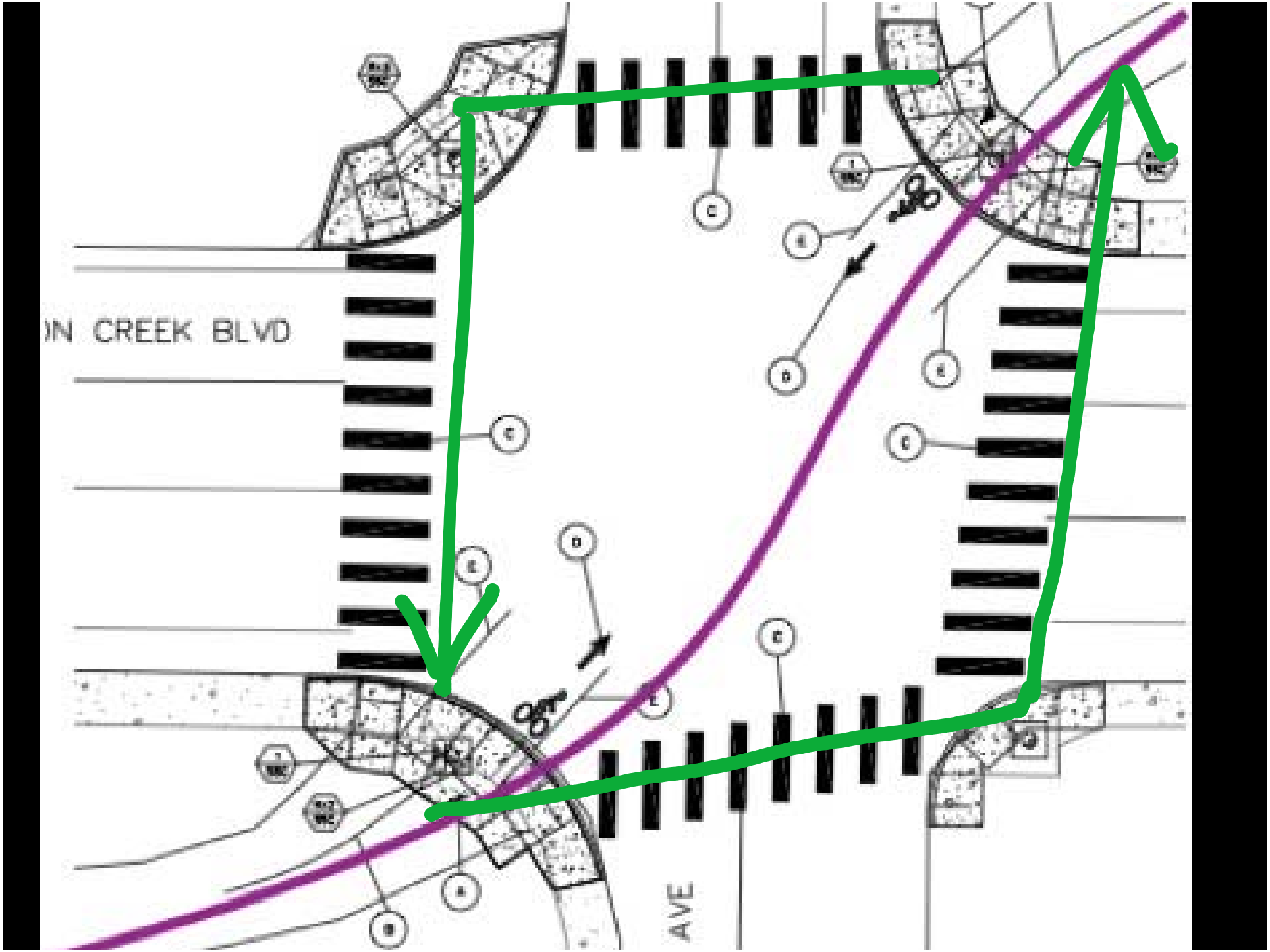



**Concern about people on bicycles assuming they can cross to the left addressed with one way**

# N Broadway & Williams Improvements

# Disallows some Diagonal Crossings without Peds




ON CREEK BLVD
AVE


SE BELL AV
Station
ARKET
OPEN
12 99


SE JOHNSON CRK BLVD
BIKE SIGNAL
CROSSPOINT


WAIT
HERE


SE JOHNSON CRK BLVD
BIKE
ONLY
BIKE
SIGNAL
6803
CROSSPOINT

# Contraflow King Street – Honolulu

# Using Bicycle Signal Faces

Emerging Practices

# Speaker Biography

- Rock Miller, PE (CA and HI), TE (CA), PTOE (ITE)
- President (2012) Institute of Transportation Engineers
- US National Committee on Uniform Traffic Control Devices
  - Bicycle Technical Committee
- TRB Bicycle Research Committee
- CA Traffic Control Devices Committee
  - 714-743-1415
  - RockMiller49@yahoo.com

Standard Copenhagen Bike Signal

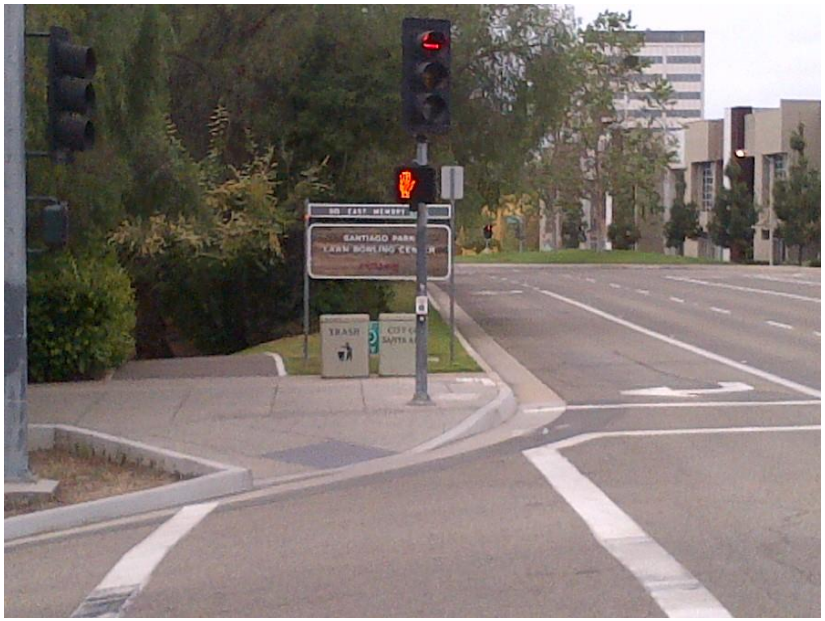
Thematic Danish Bike Signal

## Using Bicycle Signals

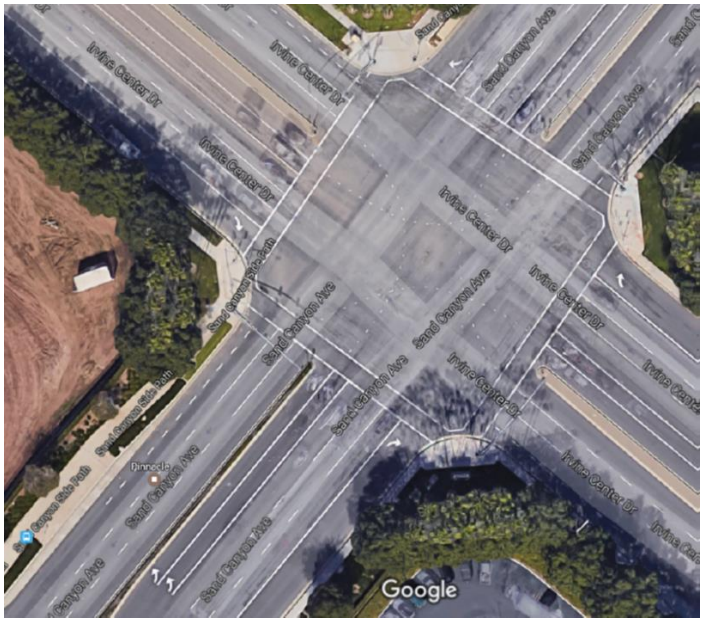

Danish Intersection with Bike Signals and Wayfinding

Rush Hour in Copenhagen with Bike Signal Control

# Why Use Bike Signals?



What direction is Green?




How long before turning left?

**Using Bicycle Signals**

# Two “T” Intersections… U.S. and Denmark



Using Bicycle Signals

# Montreal Traffic Control

No Room for Right Turn Lane.  Right Turn Vehicles must wait at onset of green (5-6 sec)

# Bike Signals and Users

- Over 100 known intersections in the US
- Another 100 in Canada
- List is Growing as Agencies Respond
  - Rmiller49@socal.rr.com

# One Way Street Examples


Long Beach, CA

- One or two way cycling
- Works well on downtown One Way Streets
- Left Side Avoids Transit
- Curbs, planters, parking, etc
- Must be able to sweep
- $30-40k per signalized intersection for poles and bike signals

# New York City


Using Bicycle Signals

# Other Treatments Examples

•Chicago


•Calgary AB

# Redondo Beach

- Two-Way Bikeway adjacent to 2-Way Traffic
- Heavy Recreational Use
  - All Ages!!
- Good Compliance with Bike Signals
- Three Signalized Intersections
  - Three Control Variations

# Using Bicycle Signals

# Intersection Turn Treatment

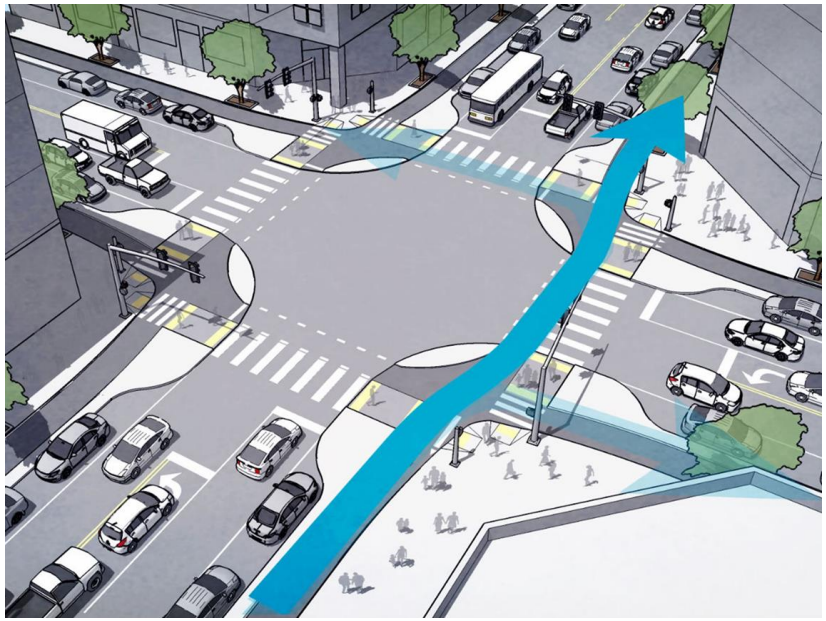

Using Bicycle Signals

# Other Phasing Strategies

- Leading vs Lagging Lefts
- Exclusive bike-only phase
- Vehicle right turn arrow with cross street left turn
- Green wave benefits

# Protected Intersection

- Needs a Lot of Room
- Existing Traffic Signals may need to be Rebuilt
- Need a Car Length for Right Turns (or RT Lane)
- European examples often include controlled right turn lanes plus bike signals



Using Bicycle Signals

# Conclusions

- Trade off
  - Construction cost vs reduction in conflicts
- Early Adopters are Trading Success Stories
- More Complete Guidance is Emerging
- Design Guides are Citing Knowledge Gaps
  - But are having trouble staying current
- MUTCD also following
  - Successful projects often are in front of MUTCD

# Discussion

- Send us your questions 
- Follow up with us:
  - Peter Koonce peter.koonce@gmail.com
  - Rock Miller rmiller49@socal.rr.com
  - Dave Kirschner david.kirschner@dot.gov
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