



WRONG WAY PILOT PROJECTS FOR
PREVENTION OF WRONG WAY
COLLISIONS ON FREEWAYS



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The research reported herein was performed by the researcher listed as author

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EXECUTIVE SUMMARY

As part of a renewed effort to address wrong way collisions, Caltrans San Diego and Sacramento regions developed pilot projects to test new and emerging technologies, as well as review current wrong way countermeasures. The Pilot Projects were initiated in 2016 with various phases of implementation. In all, 60 exit ramps in San Diego (District 11) and 12 exit ramps in Sacramento (District 3) received one or more of the following countermeasures: 1) Installing DO NOT ENTER and WRONG WAY signs (R5 Series) with LED Illumination, 2) Adding Type V Pavement Arrows with red on backside reflective markers outlining the Type V arrows, 3) Installing two-way, red/clear and red/yellow retro reflective markers along ramp lane lines ,edge lines and limit lines, 4) Installing Advanced Detection and Notification Systems with camera verification and automated notification to Traffic Management Centers with web based access, and 5) Installing Red LED in pavement lights across limit lines.

Wrong-way driving (WWD) collisions are a very small percentage of statewide total collisions. These collisions often result in serious injuries and fatalities. Wrong-way driver collisions gained attention after a series of wrong-way collisions began occurring in the first half of 2015 that resulted in several fatalities in both the Sacramento and San Diego regions. Caltrans Traffic Accident Surveillance and Analysis System (TASAS) data from 2014 to 2018 show that 1104 WWD collisions occurred on freeways, which is an increase over the previous 5-year period between 2008-2013 which was 913 total collisions. A total of 144 fatal collisions and 560 injury collisions occurred on state freeways in California because of WWD between 2014 - 2018 as compared to 95 fatal collisions and 498 injury collisions between 2009 -2013. The goal of this research was to summarize data collected from the pilot projects in District 3 – Sacramento and District 11 – San Diego to better evaluate new and emerging technologies and treatments for wrong way prevention and implement treatments that proved effective.

RESEARCH OBJECTIVES

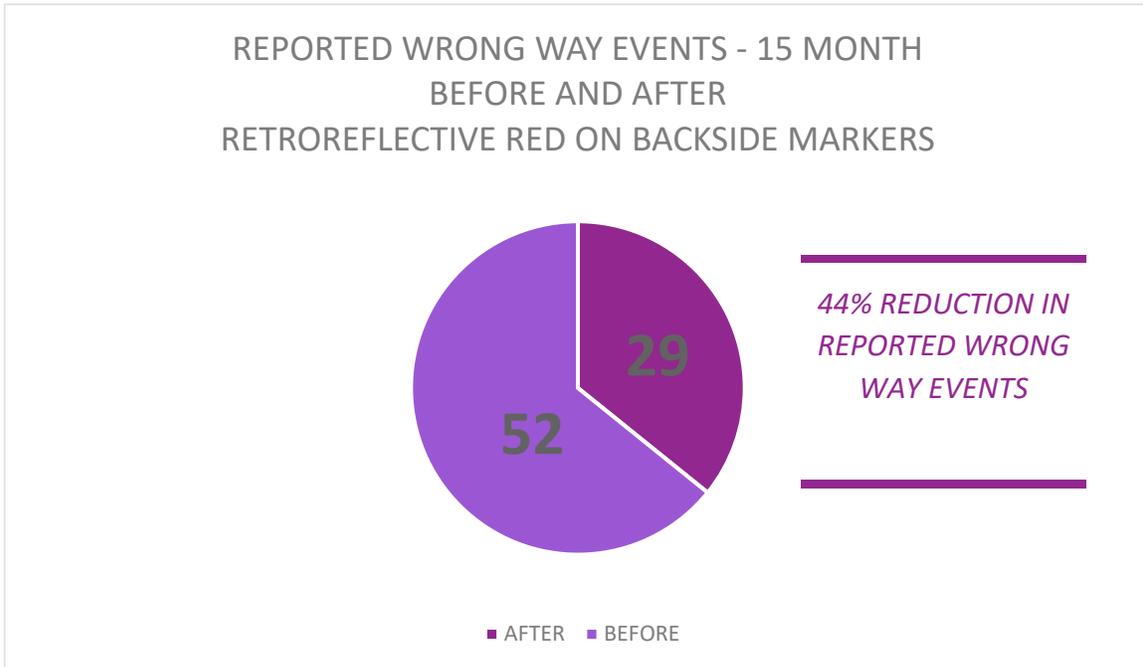
Objectives of this research were to review the pilot projects data and outcome as required the Departments mandate under California Vehicle Code Section 21651.1 which states:

21651.1. (a) The Department of Transportation, in consultation with the Department of the California Highway Patrol, shall update the June 1989 report entitled "Prevention of Wrong-Way Accidents" prepared by the Department of Transportation pursuant to Chapter 153 of the Statutes of 1987. The update shall account for technological advancements and innovation since publication of the 1989 report and shall include a review of methods studied or implemented by other jurisdictions, including state or local agencies within or outside the state, and methods studied by nongovernmental entities to prevent wrong-way drivers from entering state highways.

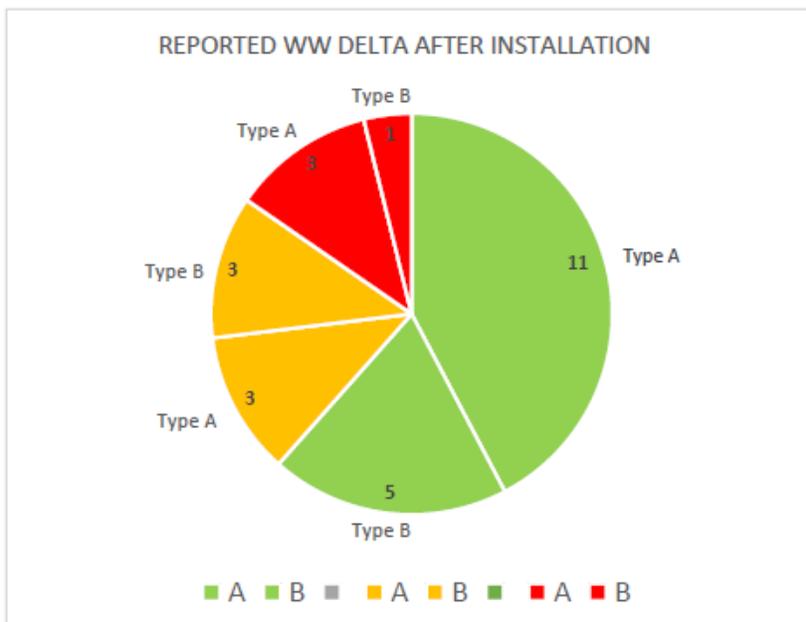
Primarily, Caltrans was tasked with accounting for technology advancements and innovation that may have become available since the Wrong Way Driver Prevention on California Freeways report was updated in 1989.

SUMMARY OF FINDINGS – DISTRICT 11

D11 - RED ON BACKSIDE MARKERS PLACED ON RAMPS AND DIRECT ACCESS RAMPS

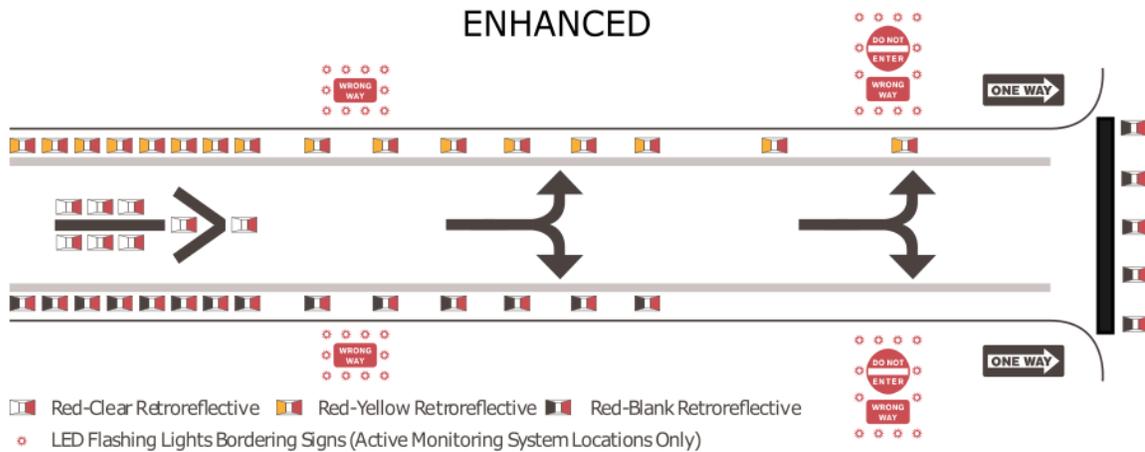


The chart above shows the before and after WWD data when red on backside markings were placed on ramps as compared to not. The chart below shows the delta of reported wrong way driver events at ramps where red on backside pavement markers were placed on ramps in San Diego County on Interstate 15. Twenty six of the sixty ramps treated had reported wrong way drivers within the 15 months leading up to the pilot project according to California Highway Patrol – Computer Aided Dispatch (CHP-CAD) logs. The 15 month period after the pilot started resulted in 16 ramps reducing the number of reported wrong way drivers, 6 being neutral with no change and 4 reporting an increase in reported wrong way drivers.



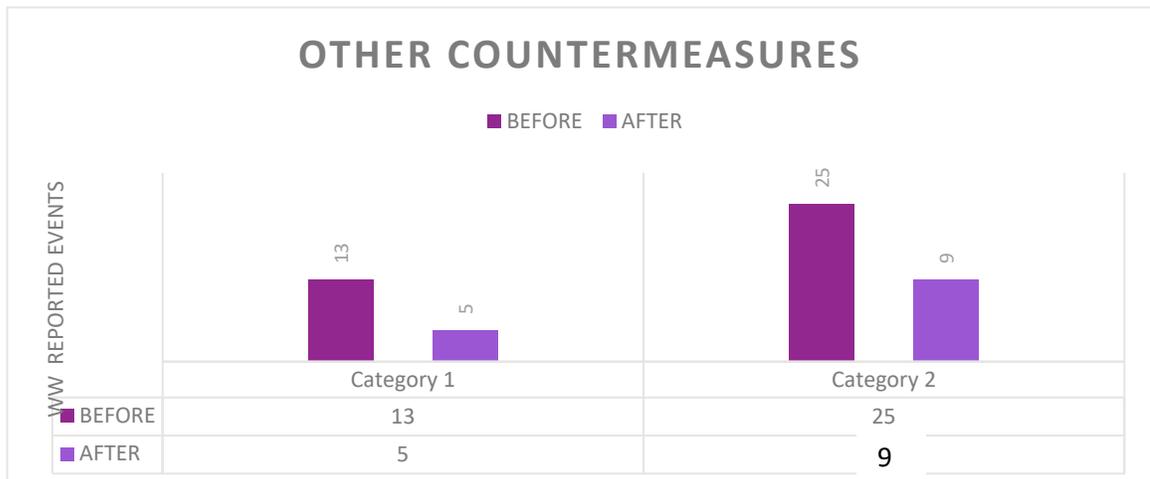
Marker Treatment	Type
A	Standard spaced red on backside markings placed on ramp limit lines, lane lines and Type V arrows
B	Closer spaced red on backside markings placed on ramp limit lines, lane line (See Figure A)

Figure A



Segregating out the enhanced red reflective marking pattern to standard spaced markers, a 64% reduction is reported wrong way drivers per CHP-CAD was realized. In addition to red reflective pavement markings placed on ramps, two other cost effective countermeasures were tested at limited ramps. Light Emitting Diode (LED) wrong way signs were placed on both sides of a ramp at 5 locations. Of the 5, 3 had a reduction in reported wrong way drivers in the 15 month before and after study period according to CHP-CAD data. The other was placing red flashing in pavement lights embedded within the pavement across the limit line. The lights flashed 24/7. Given that only 2 locations had this countermeasure installed, the data set was not large enough to be conclusive. Although both ramps realized a reduction in reported wrong way drivers during the 15-month before and after study period per CHP-CAD, the two ramps also had Flashing LED signs and enhancement B pavements markings, which could have been attributed to the reduction as well.

D11 – LED ILLUMINATED WRONG- WAY SIGNS AND IN PAVEMENT RED LED FLASHING LIGHTS

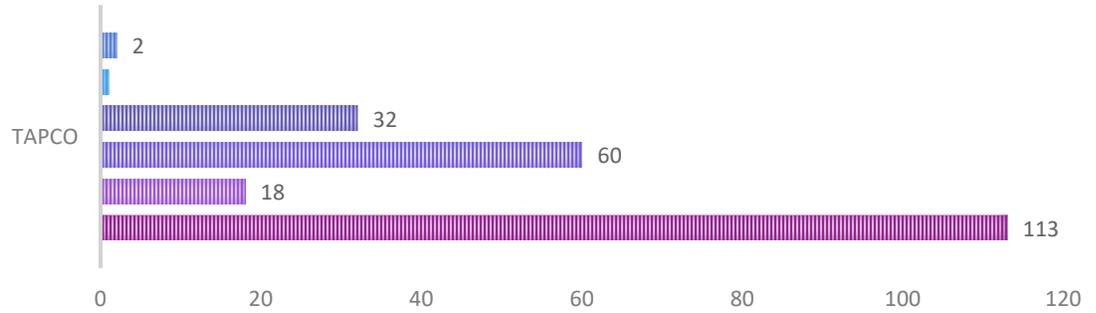


CATEGORY 1
**60% REDUCTION IN REPORTED
 WRONG WAY EVENTS
 LED ILLUMINATED SIGNS ONLY**

CATEGORY 2
**64% REDUCTION IN REPORTED
 WRONG WAY EVENTS
 ENHANCED MARKINGS B**

D11 ADVANCED DETECTION AND NOTIFICATION SYSTEM LOGGED TAPCO EVENTS

■ OTHER2
 ■ EMERGENCY VEHICLES
 ■ MAINT VEHICLES
 ■ FALSE POSITIVE
 ■ VALID WW EVENTS
 ■ TOTAL



	TAPCO
OTHER2	2
EMERGENCY VEHICLES	1
MAINT VEHICLES	32
FALSE POSITIVE	60
VALID WW EVENTS	18
TOTAL	113

District 11 – TAPCO IMAGERY OF DETECTED WRONG WAY DRIVER – DEPARTING CAMERA



Correct Traffic Flow: ✔ **BlinkLink**
System: SR15 NB off-ramp from El Cajon Blvd Alert Time: 2/3/2019 9:08:43 PM Powered by TAPCO

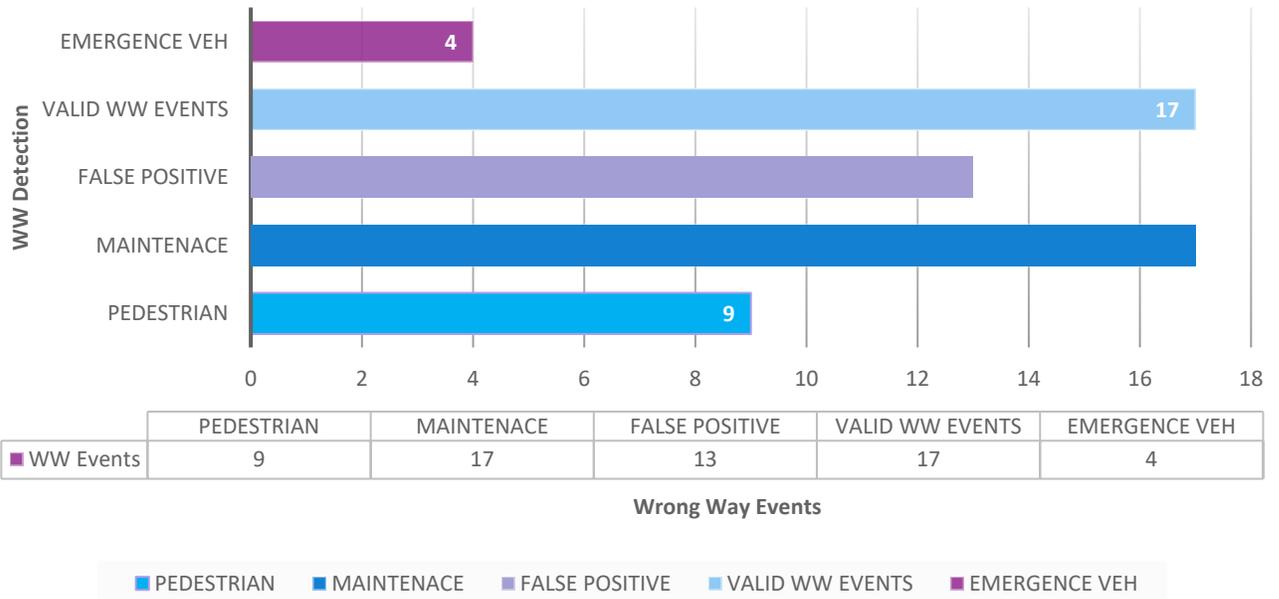


Correct Traffic Flow: ✔ **BlinkLink**
System: SR15 NB off-ramp from El Cajon Blvd Alert Time: 9/14/2019 2:17:08 AM Powered by TAPCO



Correct Traffic Flow: ✔ **BlinkLink**
System: SR15 NB off-ramp from El Cajon Blvd Alert Time: 9/14/2019 2:17:08 AM Powered by TAPCO

D3 ADVANCED DETECTION AND NOTIFICATION SYSTEM LOGGED TAPCO EVENTS



DISTRICT 3 – TAPCO IMAGERY OF DETECTED WRONG WAY DRIVER – APPROACH CAMERA



BACKGROUND

Assembly Bill 162 which added Section 21651.1 to the Vehicle Code required Caltrans in consultation with the California Highway Patrol to update the June 1989 report titled “Prevention of Wrong-Way Accidents” prepared by the Department of Transportation pursuant to Chapter 153 of the Statutes of 1987.

21651.1. (a) The Department of Transportation, in consultation with the Department of the California Highway Patrol (CHP), shall update the June 1989 report entitled “Prevention of Wrong-Way Accidents” prepared by the Department of Transportation pursuant to Chapter 153 of the Statutes of 1987.

Caltrans and the California Highway Patrol continue to gather data and information from other states and nongovernmental agencies, and findings from their pilot and research projects. California has pledged support for the Federal Highway Administration’s (FHWA) “Toward Zero Deaths” initiative and will strive to reduce the number of wrong-way driving incidents

WHAT WE DID

On July 1, 2016, Caltrans submitted a final report update to the “Prevention of Wrong-Way Accidents” to the legislature. The Final Report titled “Prevention and Detection of Wrong-Way Collisions on Freeways” outlined steps Caltrans and the CHP would take to review and implement new treatments and technology that may be available since the last update to the report in 1989.

Caltrans and CHP set up a working group in May 2015 and established pilot projects in both District 3 (Sacramento County) and D11 (San Diego County).

The pilot projects installed additional two-way, red/clear retroreflective pavement markers, revised signage, signage with red LED illuminated wrong way signage, red LED in-pavement lighting across the limit line, and active monitoring systems to reduce the potential for wrong-way drivers from entering the highway system. The active monitoring systems utilized dual radars to detect the wrong-way drivers and activate red flashing lights bordering the wrong-way signs. Caltrans and the CHP were notified in real-time of the wrong-way drivers through photos and alerts sent to joint Traffic Management Centers (TMC). A separate, auxiliary research project was conducted by AHMCT with oversight and direction provided by Caltrans’ Division of Research, Innovation and System Information (DRISI) to study the effectiveness of the pilot project enhancements with before-and-after studies.

In addition, traffic engineers from several states were surveyed to review current practices with the potential to reduce the number of instances of wrong-way driving on state highways. Site visits to Texas and Florida Departments of Transportation provided Caltrans first-hand information on their on-going wrong-way driving pilot projects. All three state Departments of Transportation are committed to working together, and with others, to reduce the number and severity of wrong-way collisions.

DISTRICT 11 PILOT PROJECTS PHASE 1 – RED ON BACKSIDE PAVEMENT MARKINGS PLACED ON RAMPS

BACKGROUND:

On March 3, 2016 the California Traffic Control Devices Committee (CTCDC) approved the Caltrans District 11 request to experiment with a Request for Permission to use wrong way retroreflective markers for ramp edge lines and ramp directional arrows Type 11, III and V.

The District 11 pilot project was located on State Route 15 (SR-15) starting at post mile (PM) M4.54 through Interstate 15 (1-15) ending at PM M30.85. This segment of the Route 15 corridor was chosen based on a review of the last five Wrong Way Monitoring Report (WWMR) Table A Collision Locations. Two areas of this route were in the WWMR for 2009, 2011 and 2013 (latest one currently available). For SR-15, at the southern area of this segment, post mile (PM) M5.63 to PM R6.02 was in the 2011 and 2013 WWMRs. For 1-15, at the northern area, PM 26.18 to PM M27.01, PM 26.18 to PM M27.17 and PM M25.85 to PM M26.86 were in the WWMR for 2009, 2011 and 2013, respectively.

Based on a review of Regular Ramps (R) and Direct Access Ramps (DAR)(X) between PM M4.54 and PM R30.85, it was concluded that two groupings would be proposed for enhancements. Group 1 ramps were those that were approximately within 5 miles of the wrong way incident segments of the WWMR's and Group 2 were the ramps in between the two WWMR segments (and the ramps in Group 1). Therefore, one to three enhancements were to be provided for every ramp between PM M4.54 and PM R30.85 on Route 15.

The following were the enhancements that were complete as of April 15, 2016:

Enhancements "A", and "A" and "B" (See Exhibit A) were installed on 60 R and X ramps from Group 1 and 2 (34 and 26, respectively) receiving Enhancement "A", 17 of the 34 from Group 1 also receiving Enhancement "B", for the R and X exit ramps on the Route 15 corridor. The enhancement "B" built on enhancement "A" with additional edge line and lane line markings placed closer in spacing over a set distance from the ramp terminus.

Enhancement "A" was a replacement on the exit ramp of all the one-way retro-reflective pavement markers to a two-way type with red on the backside. This simple and relatively inexpensive enhancement to "red alert" a wrong way motorist was appropriate for all the exit ramp locations in the pilot test area.



Refreshing or installing a Detail 41 left edge line guideline was also included, where applicable, with this enhancement.



Enhancement "B" was the installation of rows of one and two-way red retro-reflective pavement markers in a closely-spaced pattern near the end of the exit ramp.

It was recommended at all the X exit ramps because they are shorter in length and often one lane, thereby providing less opportunity for marker replacement by the "A" enhancement. The "B" enhancement was also recommended for several of the more complicated R exit ramps (like those with a transit facility or an adjacent entrance ramp) located within the WWMR investigation areas in the Group 1 list.



In addition, all ramps that had a Type V Arrow had the arrows modified with the addition of (Clear/Red) or (Blank/Red) Reflective Markings on the Type V ramp pavement arrows.

Enhancement "C" was the last and final stage of the Wrong Way Pilot and began construction in District 11 in late September 2017, but did not require CTCDC approval for implementation. This enhancement included the installation of signing with blinking LED-bordered wrong way signs and with TMC/CHP dispatch notification and camera verification of a wrong way driver. This was recommended for six locations with shorter ramps and possibly more confusing intersections at city streets and known or suspected wrong way locations.

DISTRICT 11-ROUTE-15 (D11-RTE-15)

EXIT RAMP WRONG WAY (WW) ENHANCEMENTS FOR REGULAR AND EXPRESS (RX) LANES [D11-RTE-15 WW-RX] PILOT PROJECT PROPOSAL

LOCATION AND ENHANCEMENT

GROUP 1

Location	Postmile	RAMP(R) or DAR(X)	WW RX
R1N	M4.542	NB OFF TO UNIVERSITY AVENUE	A, B and C
R1S	M4.755	SEG SB OFF TO UNIVERSITY AVENUE	A, B and C
R2N	M4.925	SEG NB OFF TO EL CAJON BOULEVARD	A, B and C
R2S	M5.150	SB OFF TO EL CAJON BLVD	A, B and C
R3N	M5.487	NB OFF TO ADAMS AVENUE	A only
R3S	M5.634	SB OFF TO ADAMS AVENUE	A and B
R4N	R5.880	SEG NB OFF TO CAMINO DEL RIO S	A only
R4S	R6.211	SEG SB OFF TO CAMINO DEL RIO S	A Only
X1N	15.64	NB OFF HILLERY DRIVE	A, B and C
X1S	15.64	SB OFF HILLERY DRIVE	A, B and C
X2N	19.29	NB OFF SABRE SPRINGS PARKWAY	A and B
X2S	19.29	SB OFF SABRE SPRINGS PARKWAY	A and B
R5N	M21.717	NB OFF TO CAMINO DEL NORTE	A only
R5S	M22.125	SB OFF TO CAMINO DEL NORTE	A only
R6N	M22.744	NB OFF TO BERNARDO CENTER DRIVE	A only
R6S	M23.130	SB OFF TO BERNARDO CENTER DRIVE	A only
X3N	23.240	NB OFF W. BERNARDO DRIVE	A and B
X3S	23.240	SB OFF W. BERNARDO DRIVE	A and B
R7N	M 23.465	NB OFF TO RANCHO BERNARDO ROAD	A only
R7S	M 23.909	SB OFF TO RANCHO BERNARDO ROAD	A only
R8N	M 25.802	NB OFF TO POMERADO/W.BERNARDO DRIVE	A only
R8S	M 26.040	SB OFF TO POMERADO/W.BERNARDO DRIVE	A and B
R9N	M 26.728	NB OFF TO VIA RANCHO PARKWAY	A and B
R9S	M 26.999	SB OFF TO VIA RANCHO PARKWAY	A only
X4N	27.26	NB OFF DEL LAGO BOULEVARD	A, B and C
X4S	27.26	SB OFF DEL LAGO BOULEVARD	A, B and C
R10N	M27.388	NB OFF TO CENTRE CITY PARKWAY	A and B
R11N	R28.496	NB OFF TO CITRACADO PARKWAY	A only
R11S	R29.095	SB OFF TO CITRACADO PARKWAY	A only
R12N	R29.830	NB OFF TO NINTH AVENUE	A only
R12S	R30.325	SB OFF TO NINTH AVENUE	A only
X5N	R30.85	NB OFF HALE AVENUE	A, B and C
R13N	R30.504	NB OFF TO VALLEY PARKWAY	A only
R13S	R30.848	SB OFF TO VALLEY PARKWAY	A only

DISTRICT 11-ROUTE-15 (D11-RTE-15)

EXIT RAMP WRONG WAY (WW) ENHANCEMENTS FOR REGULAR AND EXPRESS (RX) LANES [D11-RTE-15 WW-RX] PILOT PROJECT PROPOSAL

LOCATION AND ENHANCEMENT

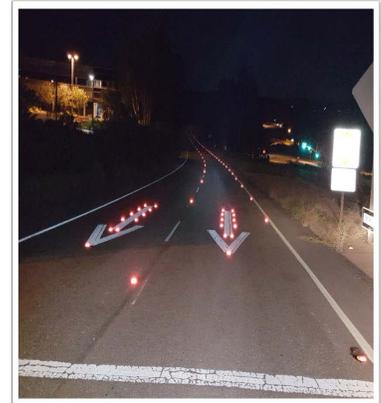
GROUP 2

Location	Postmile	RAMP(R) or DAR(X)	WW RX
R14NE	R6.600	NB OFF TO EB FRIARS ROAD	A only
R14NW	R6.861	NB OFF TO WB FRIARS ROAD	A only
R14S	R6.966	SB OFF RAMP FRIARS ROAD	A only
R15N	R8.106	NB OFF TO AERO DRIVE	A only
R15S	R8.524	SB OFF TO AERO DRIVE	A only
R16NW	R8.930	SEG NB OFF WB BALBOA AVENUE	A only
R16NE	R9.074	SEG NB OFF TO EB TIERRASANTA BLVD	A only
R16S	R9.432	SB OFF TO TIERRASANTA BLVD	A only
R17N	R9.812	NB OFF TO CLAIREMONT MESA BLVD	A only
R17S	R10.155	SEG SB OFF TO CLAIREMONT MESA BLVD	A only
R18N	M13.077	NB OFF TO MIRAMAR WAY	A only
R18S	M13.655	SB OFF TO MIRAMAR WAY	A only
R19N	M14.016	NB OFF TO POMERADO ROAD/MIRAMAR ROAD	A only
R19S	M14.515	SB OFF TO MIRAMAR ROAD/POMERADO ROAD	A only
R20N	M14.843	NB OFF TO CARROLL CANYON RD	A only
R20S	M15.118	SB OFF TO CARROLL CANYON RD	A only
R21N	M15.683	NB OFF TO MIRA MESA BOULEVARD	A only
R21S	M16.183	SB OFF TO MIRA MESA BOULEVARD	A only
R22N	M17.118	NB OFF TO SCRIPPS-POWAY PRKY/MERCY ROAD	A only
R22S	M17.514	SB OFF TO MERCY ROAD/SCRIPPS-POWAY PRKY	A only
R23N	M17.953	NB OFF TO POWAY ROAD/RANCHO PENASQUITOS	A only
R23S	M18.400	SB OFF TO RANCHO PENASQUITOS/POWAY ROAD	A only
R24N	M18.970	NB OFF TO TED WILLIAMS PARKWAY/SR-56	A only
R24S	M19.640	SB OFF TO SR-56/TED WILLIAMS PARKWAY	A only
R25N	M20.428	NB OFF TO CARMEL MOUNTAIN ROAD	A only
R25S	M20.772	SB OFF TO CARMEL MOUNTAIN ROAD	A only

WHAT WE DID:

PRE-PILOT DATA – COLLECTED FROM CHP COMPUTER AIDED DISPATCH – JANUARY 1, 2015 THROUGH MARCH 31, 2016

A request was made to the CHP to pull all code W – Wrong Way reported events, see Table 1 for sample data set, that occurred for as far back in time they could retrieve data. The data provided included events from January 1, 2015 through April 30, 2016. The requirement for data was that the event identified the ramp that the



wrong way event occurred on based on received caller data, and CAD log information identifying the event. All State Highway data in San Diego County was requested and State Route (SR) -15 and Interstate-15 data were segregated to analyze the 60 ramps that were proposed to have new wrong way enhancements installed. A sample of the provided data is on the following page. It included a date of the event, time event was reported, corresponding CAD log numbers, direction, County, ramp type if known, location event was reported as occurring and outcome. If the event was unable to be located or did not result in any further events, then it was listed by CHP as a UTL – Unable to Locate. If the event was located the final enforcement event was listed or if a resulting collision occurred, then that event was stated.

The 60 ramps chosen to be part of the pilot project were segregated from the total data set and the number of reported events that occurred for the 15 months prior to any treatment being applied to the ramps selected was tabulated and became the BEFORE data. If multiple calls were made for the same event, those additional event reporting’s were removed as it was all part of the same event and eliminated double counting of the same reported event.

Table 1 - SAMPLE DATA SET – PRE-PILOT RAMPS

Date	CAD Log	RTE	DIR	Location	Type	Disposition	CAD Start Time
1/13/2015	1285, 1286	15	NB	EL CAJON BLVD	WW	UTL	22:14
1/28/2015	1078	15	NB	BERNARDO CTR DR	WW	UTL	19:15
1/29/2015	1008	15	NB	SR 76	WW	UTL	15:32
2/13/2015	868	15	NB IN SB	RAINBOW VALLEY	WW	NONE	15:14
2/17/2015	60	15	SB IN NB	GOPHER CANYON	WW	UTL	2:33
3/4/2015	68	15	NB IN SB	EL CAJON BLVD	WW	UTL	3:14
3/8/2015	259	15	NB IN SB	EL NORTE PKWY	WW	UTL	6:09

POST PILOT DATA – COLLECTED FROM CHP COMPUTER AIDED DISPATCH – MAY 1, 2016 THROUGH JULY 31, 2017

The same process was used to obtain the post pilot project data once 15 months had passed. This ensured a comparable data set of the same number of months could be used for comparison. Some statistical margins of error may be inherent if for example, more events occur and were reported in certain months. For example, for the pre-data, the months of January -March were included for both 2015 and 2016 and for the post data, the months of May-July 2016 and 2017 were included. If a higher number of events were traditionally reported in January-March, some statistical error may be observed.

The target goal of the pilot was to reduce the number of wrong way driver incidents occurring at ramps with data showing previous reported wrong way drivers, and in doing so reduce the number of potential collisions that may have occurred because of a wrong way driver occurrence.

The same criteria requested from the California Highway Patrol Computer Aided Dispatch System was used to request the data and the same format was used to compare the data. See Table 2 - Sample Data Set, page 11.

Any of the 60 ramps that had a reported wrong way driver (WWD) was tabulated in both the 15-month pre- and 15-month post event tabulation. Ramps that had more than one reported WWD over the 15 months were considered as more likely to have repetitive events as compared to a ramp that only had one reported WWD over the 15-month period. Ramps that had no reported WWD's were not listed. If a ramp did not have an event occur in the 15-month pre-pilot data set but one or more occurred in the post -pilot data set, then it was added to the post data field. Ramps that had an increase from the pre-pilot data, if the ramp had multiple reported WWD's, then the ramp was considered more likely to have repetitive events, and those ramps were also analyzed for the type of treatment received and if that treatment resulted in a decrease in reported events or if an increase in reported WWD's occurred, if a certain treatment type proved less effective in decreasing reported events.

Table 2 - SAMPLE DATA SET – PRE-PILOT RAMPS

City	County	Route	Cross Street	Incident Number	Date/Time	CHP Area	Incident Type	Location	Call Disposition
Coachella	Riverside	10	Dillon	180402IC00392	4/2/18 20:47	76-Indio	WW-Wrong Way Driver	I10 W Eo / Dillon Rd Mm 59	BC-Broadcast,UI-Unit Informed
Unincorporated	Riverside	10	Dillon	180620IC00234	6/20/18 17:05	76-Indio	WW-Wrong Way Driver	I10 E Eo / Dillon Mm 67	UTL-Unable to Locate
Indio	Riverside	10	Dillon	180928IC00023	9/28/18 2:02	76-Indio	WW-Wrong Way Driver	I10 E Wo / Dillon Rd Mm 58	UTL-Unable to Locate
Unincorporated	Riverside	10	Dillon	181028IC00221	10/28/18 15:57	76-Indio	WW-Wrong Way Driver	I10 E Eo / Dillon Mm 67	UTL-Unable to Locate
Unincorporated	Riverside	10	Dillon	181102IC00323	11/2/18 20:10	76-Indio	WW-Wrong Way Driver	I10 E Eo / Dillon Mm 67	F-File

PILOT PROJECT POST DATA – 24 MONTH DATA SET

Additional data was requested from CHP-CAD for the 24-month post pilot project that treatments were applied to the ramps. This included the original 15-month period and an additional 9-months of new data.

Since a full 24-month of pre-pilot data were not available, a rate per month was used to produce a post 24-month analysis. This was based on the total number of events that were reported over the 24-month period and divided by 24 to produce a rate per month.

The same was done for the 15-month pre-and post-data sets. It should be noted that the month of April 2016 was excluded from the data analysis as this month was the month that three treatment types were applied to the 60 ramps and this occurred over a period of about 2-3 weeks. This data would provide no useful comparison for before and after data unless the date of enhancements for each ramp was determined and a micro analysis of each ramp was conducted. It was determined that to conduct this micro analysis would be time exhaustive and would not significantly result in better data analysis if included, and therefore was discarded from analysis.

SUMMARY OF RED REFLECTIVE PAVEMENT MARKINGS PILOT

There are many ways to analyze the produced data, and each will have varying result of success or failure. In its simplest form, if a ramp had more than one event reported in the pre-pilot data set, and the resulting post pilot 15 and/or 24-month data set showed that the number went and stayed at zero for the entire post pilot period, then the treatments at those ramps may have had some positive affect to reduce those reported events. If a ramp had 3 or more reported events in the pre-pilot data set and were reduced to 1 or zero events in the post pilot data, then the treatments more than likely produced a positive result in reducing the reported events.

Ramps that had an increase or had at least one event in the pre-pilot condition and the reported events remained unchanged or increased in the post-pilot data set, the treatments were considered not effective in reducing reported events.

It must be realized that these events are very randomized, but if a ramp experiences multiple reports of events, especially 3 or more reported events and that number can effectively be reduced to 1 or zero events, then applying some form of the enhancements is more likely to be a positive than a negative. This becomes more weighted considering that the cost to place red on the back side of markers is negligible, meaning that it costs no more to place red on the back side of a marker than it does to purchase it without red on the backside. The cost is less than 1 cent per marker. When the cost of an actual event resulting in a collision occurring is considered, especially if a fatal event occurs, millions of markers with red on the back side could be placed and would likely result in a higher benefit to cost than not placing red on backside markers.

Therefore in 2018, headquarters Traffic Operations management decided that based on the 15-month before and after comparison, any location that could have a red on backside marker placed to reduce the potential of a reported event or an event that results in a collision, would have significantly more benefit than not, and new standard plan details were developed based on the configurations that District 11 utilized in the pilot project. The Standard Plans were in place for statewide use on May 31, 2018.

This analysis did not include how the TAPCO advanced detection and notification systems, or Pilot Project enhancement C performed. That task and analysis will be discussed in another section of this summary report. The research was conducted by DRISI through a research contract with UC Davis. That analysis and report will be produced sometime after March 30, 2020. Since District 11 only had 4 of the 60 ramps equipped with the red reflective markers and advanced systems, it did not have a significant factor in the analysis of the 60 ramps.

Overall, most of the ramps that received enhancement A or B resulted in significant reduction in reported WWD's on the State Route-15 and Interstate-15 corridor where the pilot project occurred, while the remaining highways that are owned and maintained by the State in San Diego County that had no treatments applied remained relatively unchanged in reported WWD's from CHP-CAD data.

As time progresses and more ramps have the red on backside markers placed and more comprehensive analysis of the effect of red on back side markers can occur. This may have even

more significance, as every marker on a freeway will now have a red on the back-side marker place as compared to the previous standard of 1000 feet in advance of a ramp for a wrong way driver to see. As Mr. John Liu, Acting Assistant Division Chief, Division of Traffic Operations, stated so correctly, “You’re just going to see a sea of red reflectors and hopefully you will know you’re going the wrong way.” (Sacramento Bee, January 15, 2018).

It is hopeful and expected that drivers who are prudent and of sound driving habits and not under the influence of any substance will observe this drastic change in color on the roadway and determine that the direction and course they chose is in error and be able to safely traverse off the freeway as soon as possible or self-correct before they enter the freeway zone. Since the red on backside markers have no real significant cost to the State as they can be placed as projects or maintenance occur on State highways, freeways and ramps or where wrong way drivers enter more frequently before projects, there is very little if no downside to their placement.

In addition, as an added prohibitive treatment, details for placement of red markers across the limit line or crosswalk line were added after the initial pilot of enhancement A and B. It is unknown how much if any added benefit this treatment may provide, but the visual impact to a driver, is one more set of red markers that a driver must pass to enter the wrong way and again are considered very low cost for a significant benefit.

OTHER COUNTERMEASURES TESTED AS PART OF WRONG WAY PILOT PROJECT IN D11

District 11 installed some additional countermeasures at other ramps on the Interstate 15 corridor as part of the pilot projects. These additional countermeasures included LED illuminated Wrong Way package signs that were placed on 24/7 flash and placed at the front of the ramp where a wrong way driver may enter. These locations did not provide detection and notification services. The LED illuminated signs were placed at 5 ramps; SB Adams Ave off-ramp., SB Balboa Ave off-ramp, SB Clairmont Mesa Blvd off-ramp, NB Scripps Poway Parkway off-ramp and SB El Norte Parkway offramp.

Combined these ramps had 15 reported wrong way events in the January 2015- September 2017 before treatment conditions. After treatment, the combined total reported wrong way events were 5 with 3 ramps not having any reported wrong way events from October 2017 through December 2018 and one ramp experiencing 4 of the 5 post treatment events.

While the number of locations and available post installation data is not large enough to make any statistical determinations of how well the LED illuminated signs work, the initial data shows promise that placing LED illuminated signs as a countermeasure may have a benefit at a low cost compared to the advanced detection and notification systems.

ROUTE		PRE - January 2015-September 2017 POST - October 2017 - December 2018 REPORTED WW REPORT		
		BEFORE	AFTER	TOTAL
15	Adams Ave	1	1	2
15	Balboa Ave	3	0	3
15	Bernardo Center	4	2	6
15	Centre City	4	2	6
15	Clairmont Mesa Blvd	3	0	3
15	El Cajon (TAPCO SYSTEM INSTALLED)	3	5	8
15	El Norte	4	0	4
15	Friars Rd.	4	2	6
15	Mira Mesa	3	1	4
15	Miramar Road	3	1	4
15	Rancho Bernardo Road	3	5	8
15	Scripps Poway Parkway	2	4	6
15	University Ave (TAPCO SYSTEM INSTALLED)	3	4	7
15	El Norte Parkway	4	0	4
	LED ILLUMINATED SIGNS ONLY	13	5	62% REDUCTION
	ENHANCED MARKINGS INSTALLED ONLY	25	13	52% REDUCTION

DISTRICT 11 PILOT PROJECTS PHASE 3 – ADVANCED DETECTION AND NOTIFICATION SYSTEMS – 4 LOCATIONS – TAPCO WRONG WAY ALERT

San Diego, District 11, tested four locations with TAPCO Wrong Way Alert systems. The four systems were installed in November of 2017 between November 3rd, 2017 and November 16, 2017. Due to the configuration of the ramps, which had retaining walls on one side of the ramp, the TAPCO systems were picking up traffic from mainline State Route 15 and required additional hardware from the manufacturer to minimize false detections. The additional hardware and work to install was complete in April 2018 which reduced the number of false positives being detected on the systems from the freeway mainline traffic.

The four TAPCO units detected 20 wrong way events, see Table 3, that were verified by TAPCO with imagery taken by their devices for each event. Of the 20 detections two were related to bicycles using the ramps in the wrong direction. Eighteen of the events were verified wrong way detection triggers which activated the systems including the LED illuminated WRONG WAY signs downstream of the ramp and sent notifications of the events to the Transportation Management Center operators. Three detections occurred on the SR 15 NB off-ramp from El Cajon, five occurred on SR 15 NB off-ramp from University Avenue, nine occurred from SR 15 SB off-ramp from El Cajon Boulevard, and one occurred on SR 15 SB off-ramp from University Avenue. Of the 18 valid detections of a wrong way driver, not one driver self-corrected and every driver continued to the ramp throat opening, slowed and made a right turn onto the freeway to travel in the correct direction. Ten of the seventeen events resulted in near miss collisions within the ramp itself as drivers existing the freeway were suddenly confronted with a wrong way driver, often in the section of ramp that has only one lane for freeway departing traffic.

DETECTED WRONG WAY DRIVER – TAPCO – STATE ROUTE 15 NB OFF-RAMP AT EL CAJON –

NOVEMBER 17, 2019



Several wrong way drivers passed multiple right way drivers on the ramps before traveling the correct way once they reached the freeway.

In addition to the 20 wrong way driver detections of which two were triggered by bicyclists, there were 60 false positive detections, see Table 4, by the TAPCO systems at the four ramps, which sent notifications to the TMC of a wrong way event of which one didn't occur. Reviewing the imagery showed varied reasons for the detections, such as weather and queuing traffic on the ramp.

There were 32 detections of maintenance or construction related vehicles on the ramps, and one event from an emergency vehicle responding to an incident, See Table 5,

The imagery provided by the detection equipment was approximately 16 pictures of the vehicle prior to a trigger being made, additional LED illuminated lights being activated, and a message sent to the TMC. Once the system verified the driver did not self-correct, an additional 16 photos were taken of the wrong way driver. The photos were clear and provided enough visual assessment to determine where the driver entered the ramp the wrong way, but also if the driver self-corrected, or continued onto the freeway.

As was stated previously, all 18 actual wrong way events that were verified, resulted in zero self-corrections of wrong way drivers until they reached the freeway, where every driver slowed and continued onto the freeway in the right direction, after maneuvering a right/U-turn to travel in the correct direction.

Given that no self-corrections occurred within the ramp itself, and almost half of the wrong way drivers almost resulted in a collision, the systems did not provide a level of success in self-correcting the wrong way driver. The systems likely provided enough feedback to the wrong way driver of their disposition on the ramp in the wrong direction, and those drivers then made a move to get back on the freeway in the correct direction. The determination can be made by viewing the photos in progressive order in a slide display which allows for the pictures to be viewed as short movie style clips. When the LED signs were activated after a wrong way detection was determined by the system, each vehicle's brake lights were illuminated which leads to determination that the systems did provide some notice to the driver that caused them to apply their brakes. This indication likely prevented the vehicles from continuing down the ramp at speed unknowingly going the wrong way, as each driver slowed, moved to one side of the ramp and self-corrected at the mouth or base of the ramp to travel the correct direction on the freeway.

Since all 18 wrong way drivers ended up traveling the correct way on the freeway once they reached the throat of the off-ramp, there would not have been enough time for a law enforcement officer to respond as the driver would have corrected their position and been well traveled on the freeway before law enforcement would have arrived on scene.

The benefit of the imagery from the system was that it allowed for the determination of how the drivers were entering the ramp in the wrong direction.

The ramps at El Cajon Boulevard and University from SR 15 are constructed almost identically with a left turn lane, which starts prior to the intersection opening, where the wrong way movements are being made. There are no signs for NO LEFT TURNS and no pavement marking indicating that the driver needs to continue straight through the intersection before turning left on the other side of the bridge. For drivers not familiar with area of ramps configuration, entering the wrong way may

not be realized until the either confront a right way driver on the ramp or continue far enough down the ramp to realized freeway traffic is coming head on at them.

While ten of the wrong way events occurred between the hours of midnight and 5:00AM, the other seven occurred during hours not traditionally realized by wrong way drivers which is between 6:00AM and midnight, with all seven occurring during mid-morning or early evening hours when freeway traffic volumes were still heavy. None of the events captured occurred during the time period from 5:00AM to 6:00AM.

WRONG WAY DRIVER DETECTION – TAPCO –
JANUARY 18, 2020

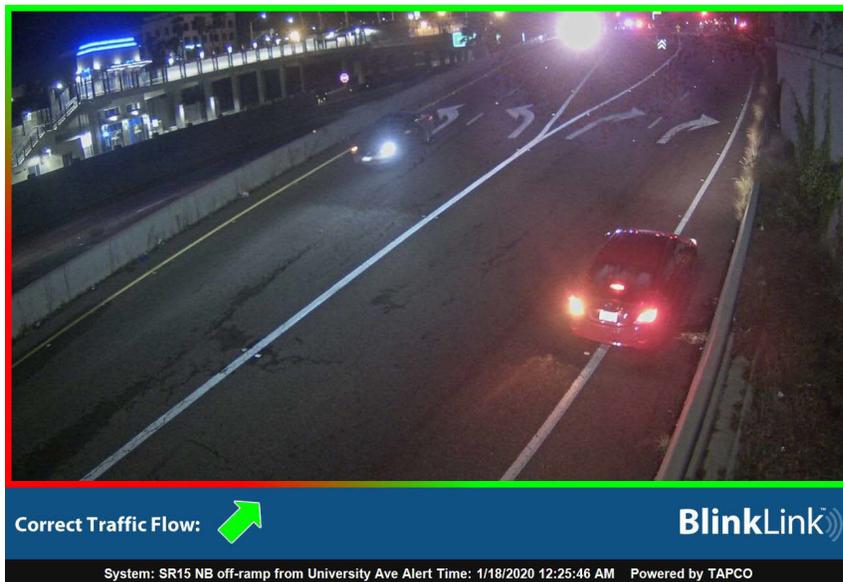


TABLE 3 – DETECTED WRONG WAY EVENTS – MAY 10, 2017 THROUGH NOVEMBER 11, 2019

	Time	Date	ID	Detection	TAPCO LOCATION	SYSTEM TYPE	EVENT TYPE
1	2:17:00 AM	9/14/2019	1149607	Incoming Camera	SR15 NB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
2	2:01:49 AM	12/18/2018	981935	Incoming Camera	SR15 NB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
3	10:18:30 AM	5/29/2019	1077877	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Vehicle
4	12:25:22 AM	7/5/2019	1101737	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Vehicle
5	8:03:24 PM	8/18/2019	1131096	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Vehicle
6	4:13:31 PM	2/3/2019	1027448	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Vehicle
7	6:08:32 AM	9/1/2019	1140448	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Vehicle
8	12:44:29 AM	5/10/2017	1065286	Outgoing Camera	SR 15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Vehicle
9	2:19:06 AM	10/14/2018	921027	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
10	10:11:10 PM	6/23/2019	1095454	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
11	1:04:22 AM	10/28/2019	1272522	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
12	12:15:51 AM	7/9/2019	1103815	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
13	2:19:01 AM	10/14/2018	921026	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
14	4:39:24 AM	5/26/2018	871435	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
15	9:50:00 PM	11/11/2019	1293844	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
16	12:01:37 AM	11/10/2019	1292954	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
17	1:04:29 AM	10/28/2019	1272523	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
18	6:40:15 AM	3/16/2019	1032790	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle
19	1:00:28 AM	11/8/2019	1291699	Incoming Camera	SR15 SB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Vehicle
20	1:30 PM	1/17/2019	1303417	Incoming Camera	SR15 NB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Vehicle

TAPCO WRONG WAY INSTALLATION AND CALIBRATION DATES:

CALIBRATION DATES	LOCATION
11 14 2017	NB OFF-RAMP UNIVERSITY
4 18 2017	
11 3 2017	SB OFF-RAMP UNIVERSITY
11 16 2017	
4 19 2018	
11 15 2017	SB OFF-RAMP EL CAJON
4 18 2018	
11 15 2017	SB OFF-RAMP EL CAJON
4 18 2018	

TABLE 4 – FALSE POSITIVE DETECTED EVENTS - MAY 10, 2017 THROUGH NOVEMBER 11, 2019

Number	Time	Date	ID	Controller Name	System Name	System Type	Alert Type	Resolution
1	7:50:51 AM	5/10/2018	868122	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
2	7:09:43 AM	10/18/2018	943813	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
3	7:18:07 AM	10/18/2018	943818	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
4	7:25:34 AM	10/18/2018	943820	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
5	7:45:04 AM	10/18/2018	943832	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
6	7:54:15 AM	10/18/2018	943837	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
7	7:55:51 AM	11/8/2018	962105	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
8	2:58:46 PM	11/16/2018	967849	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
9	5:16:47 PM	12/31/2018	986011	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
10	2:44:37 PM	1/29/2019	1009747	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
11	8:09:55 AM	2/4/2019	1012264	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
12	7:52:46 AM	8/28/2019	1137862	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
13	3:04:17 PM	8/28/2019	1138226	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
14	1:15:36 PM	10/10/2019	1235113	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
15	7:33:31 AM	6/7/2019	1083302	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
16	7:52:46 AM	8/28/2019	1137862	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
17	3:04:17 PM	8/28/2019	1138226	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
18	1:15:36 PM	10/10/2019	1235113	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
19	7:52:46 AM	8/28/2019	1137862	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
20	3:04:17 PM	8/28/2019	1138226	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
21	1:15:36 PM	10/10/2019	1235113	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
22	7:50:32 AM	5/10/2018	868121	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
23	7:09:49 AM	10/18/2018	943814	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
24	7:18:13 AM	10/18/2018	943819	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
25	7:25:40 AM	10/18/2018	943821	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
26	7:45:11 AM	10/18/2018	943833	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
27	7:54:22 AM	10/18/2018	943838	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
28	7:55:50 AM	11/8/2018	962104	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
29	2:58:43 PM	11/16/2018	967848	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
30	5:16:50 PM	12/31/2018	986012	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
31	2:44:38 PM	1/29/2019	1009748	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
32	8:09:59 AM	2/4/2019	1012265	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
33	7:52:50 AM	8/28/2019	1137863	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
34	3:04:20 PM	8/28/2019	1138227	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
35	1:15:39 PM	10/10/2019	1235114	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
36	7:33:25 AM	6/7/2019	1083301	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
37	7:52:50 AM	8/28/2019	1137863	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
38	3:04:20 PM	8/28/2019	1138227	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
39	1:15:39 PM	10/10/2019	1235114	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive

40	7:52:50 M	8/28/2019	1137863	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
41	3:04:20 PM	8/28/2019	1138227	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
42	1:15:39 PM	10/10/2019	1235114	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
43	11:43:21 AM	11/29/201	974523	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
44	3:45:38 PM	12/5/2018	977113	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
45	3:45:56 PM	12/5/2018	977115	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
46	4:50:05 PM	12/5/2018	977130	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
47	3:05:51 AM	12/6/2018	977260	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
48	4:21:22 PM	12/6/2018	977574	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
49	5:18:26 PM	12/6/2018	977594	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
50	5:18:41 PM	12/6/2018	977596	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
51	11:43:28 AM	11/29/201	974524	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
52	3:45:44 PM	12/5/2018	977114	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
53	4:50:06 PM	12/5/2018	977131	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
54	3:05:59 AM	12/6/2018	977261	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
55	4:21:26 PM	12/6/2018	977575	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
56	5:18:34 PM	12/6/2018	977595	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
57	9:35:29 AM	12/25/2018	984167	Incoming Camera	SR15 SB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
58	3:29:26 PM	2/2/2019	1011711	Incoming Camera	SR15 SB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	False Positive
59	9:35:36 AM	12/25/2018	984168	Outgoing Camera	SR15 SB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive
60	3:29:33 PM	2/2/2019	1011712	Outgoing Camera	SR15 SB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	False Positive

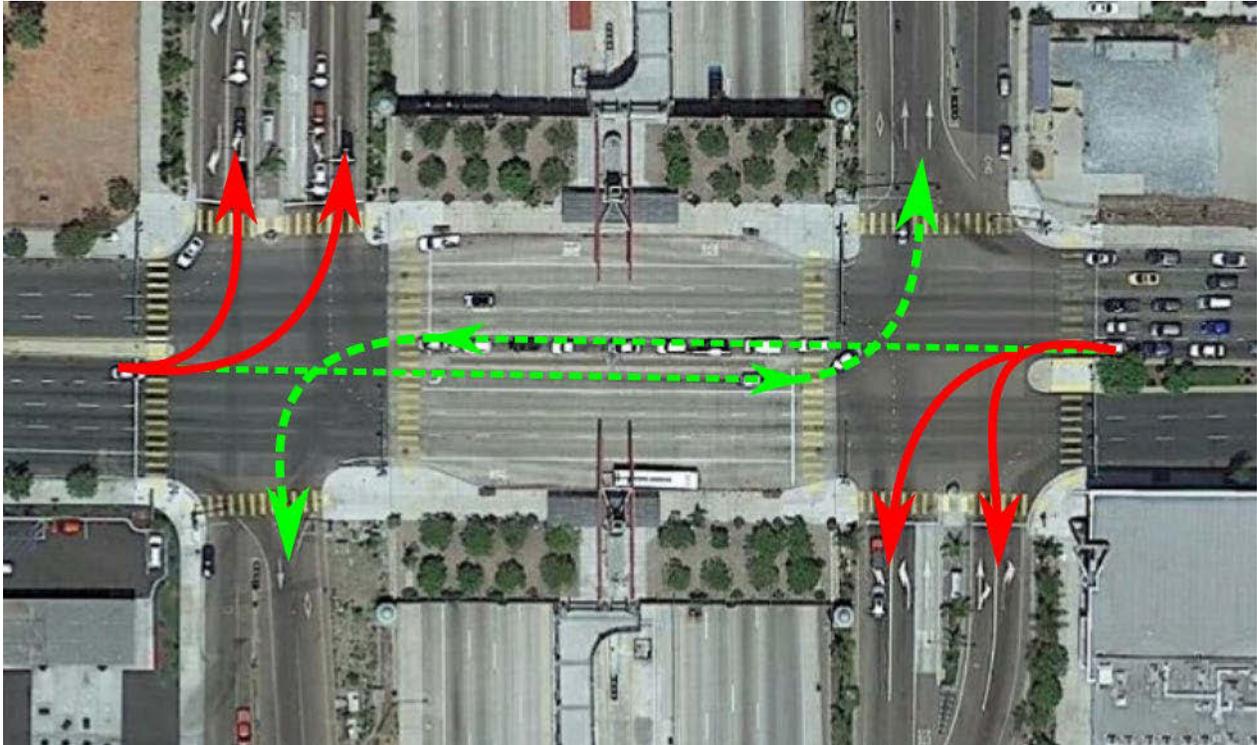
TABLE 5 – OTHER DETECTIONS - MAY 10, 2017 THROUGH NOVEMBER 11, 2019

Number	Time	Date	ID	Controller Name	System Name	System Type	Alert Type	Resolution
1	3:43:06 AM	10/24/2019	1270068	Incoming Camera	SR15 NB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
2	3:33:19 AM	11/6/2018	961103	Incoming Camera	SR15 NB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
3	2:50:01 AM	3/29/2019	1041023	Incoming Camera	SR15 NB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
4	3:43:15 AM	10/24/2019	1270069	Outgoing Camera	SR15 NB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
5	3:33:28 AM	11/6/2018	961104	Outgoing Camera	SR15 NB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
6	12:07:36 PM	10/16/2018	936725	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
7	10:08:31 AM	10/25/2018	948212	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
8	12:09:31 AM	8/12/2019	1126219	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
9	12:21:34 AM	8/12/2019	1126224	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
10	12:23:36 AM	8/12/2019	1126226	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
11	12:09:31 AM	8/12/2019	1126219	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
12	12:21:34 AM	8/12/2019	1126224	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
13	12:23:36 AM	8/12/2019	1126226	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
14	12:09:31 AM	8/12/2019	1126219	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
15	12:21:34 AM	8/12/2019	1126224	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
16	12:23:36 AM	8/12/2019	1126226	Incoming Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
17	12:07:40 PM	10/16/2018	936727	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
18	10:08:32 AM	10/25/2018	948213	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
19	12:09:34 AM	8/12/2019	1126220	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
20	12:21:41 AM	8/12/2019	1126225	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
21	12:23:43 AM	8/12/2019	1126228	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
22	12:09:34 AM	8/12/2019	1126220	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
23	12:21:41 AM	8/12/2019	1126225	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
24	12:23:43 AM	8/12/2019	1126228	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
25	12:09:34 AM	8/12/2019	1126220	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
26	12:21:41 AM	8/12/2019	1126225	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
27	12:23:43 AM	8/12/2019	1126228	Outgoing Camera	SR15 NB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
28	10:26:09 PM	10/24/2018	947848	Outgoing Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
29	4:12:04 AM	5/15/2019	1068539	Incoming Camera	SR15 SB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
30	2:56:51 AM	1/9/2018	963386	Incoming Camera	SR15 SB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Detection	Maintenance Vehicle
31	4:12:11 AM	5/15/2019	1068540	Outgoing Camera	SR15 SB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle
32	2:56:57 AM	1/9/2018	963387	Outgoing Camera	SR15 SB off-ramp from University Ave	Wrong Way BlinkerSign System	Wrong Way Overview	Maintenance Vehicle

Number	Time	Date	ID	Controller Name	System Name	System Type	Alert Type	Resolution
1	10:26:05	10/24/2020	947847	Incoming Camera	SR15 SB off-ramp from El Cajon Blvd	Wrong Way BlinkerSign System	Wrong Way Detection	Emergency Response Vehicle

The images shown on the following pages are the typical pattern a detected wrong way driver traveled within the ramp to proceed down the ramp the wrong way. At both State Route 15 and El Cajon Boulevard as well as State Route 15 and University Avenue, the ramps are set up to start the left turn lane prior to the off-ramp intersection for both directions of travel on the local road. Drivers unfamiliar with the area may not realize they cannot turn left until they proceed through the intersection. No pavement markings or intersection channelizing lines were placed. Almost every wrong way driver that entered at University Avenue and El Cajon Boulevard entered by making a left turn mistakenly and began to travel down the ramp the wrong way.

WRONG WAY MOVEMENT SCHEMATIC – EL CAJON BOULEVARD AND UNIVERSITY AVENUE



WRONG WAY MOVEMENT COUNTERMEASURE SCHEMATIC—EL CAJON BOULEVARD AND UNIVERSIITY AVE.



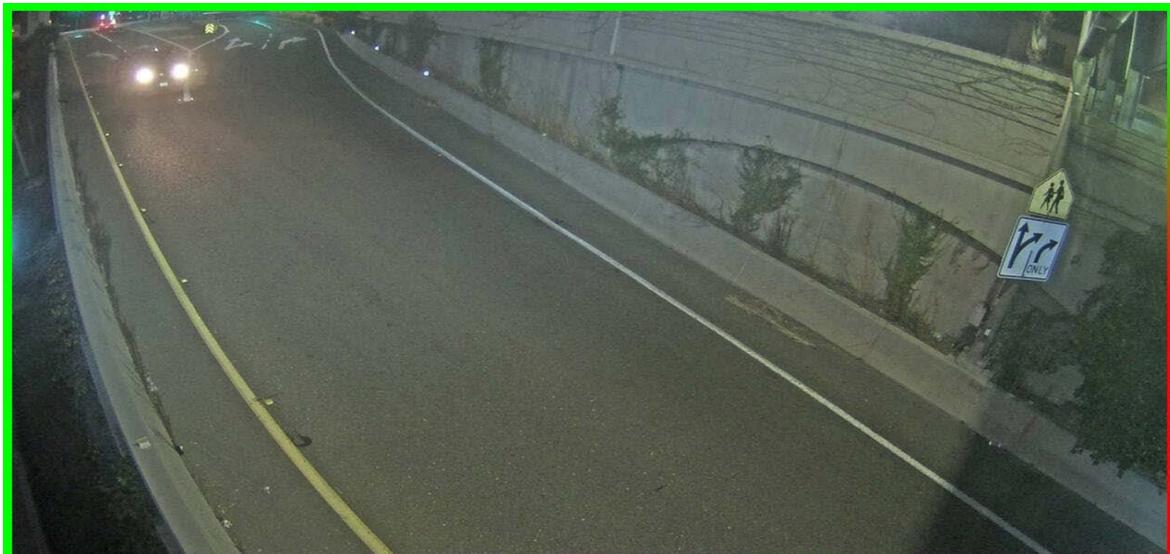
The above striping details are all standard details found in the current 2018 Caltrans Standard Plans publication and 2014 California Manual on Uniform Traffic Control Devices Revision 5.

WRONG WAY DRIVER DETECTION – TAPCO – NB EL CAJON BOULEVARD

NOVEMBER 17, 2019

TYPICAL WRONG WAY DRIVER PATTERN – APPROACH/DEPARTURE DETECTION

The following imagery shows the clarity of installing HD cameras with both an inbound detection and outbound verification cameras.



Correct Traffic Flow:  **BlinkLink**[™]

System: SR15 NB off-ramp from El Cajon Blvd Alert Time: 11/17/2019 11:30:08 PM Powered by TAPCO



Correct Traffic Flow: 

BlinkLink 

System: SR15 NB off-ramp from El Cajon Blvd Alert Time: 11/17/2019 11:30:14 PM Powered by TAPCO



Correct Traffic Flow: 

BlinkLink 

System: SR15 NB off-ramp from El Cajon Blvd Alert Time: 11/17/2019 11:30:14 PM Powered by TAPCO



Correct Traffic Flow: 

BlinkLink 

System: SR15 NB off-ramp from El Cajon Blvd Alert Time: 11/17/2019 11:30:14 PM Powered by TAPCO



Correct Traffic Flow: 

BlinkLink

System: SR15 NB off-ramp from El Cajon Blvd Alert Time: 11/17/2019 11:30:14 PM Powered by TAPCO



Correct Traffic Flow: 

BlinkLink

System: SR15 NB off-ramp from El Cajon Blvd Alert Time: 11/17/2019 11:30:14 PM Powered by TAPCO

State Route 15 NB OFFRAMP AT EL CAJON BOULEVARD FULL SET OF INBOUND IMAGERY
2-15-2020





**State Route 15 NB OFFRAMP AT EL CAJON BOULEVARD FULL SET OF OUTBOUND
IMAGERY 2-15-2020**







DISTRICT 11 WRONG WAY PILOT PROJECT



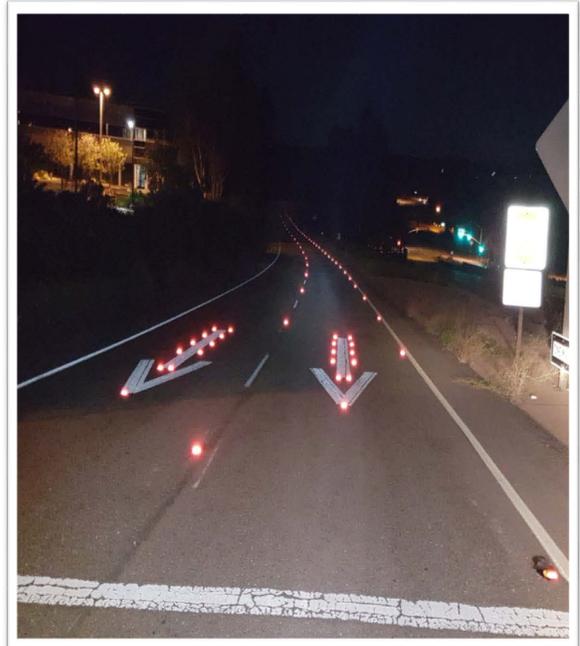
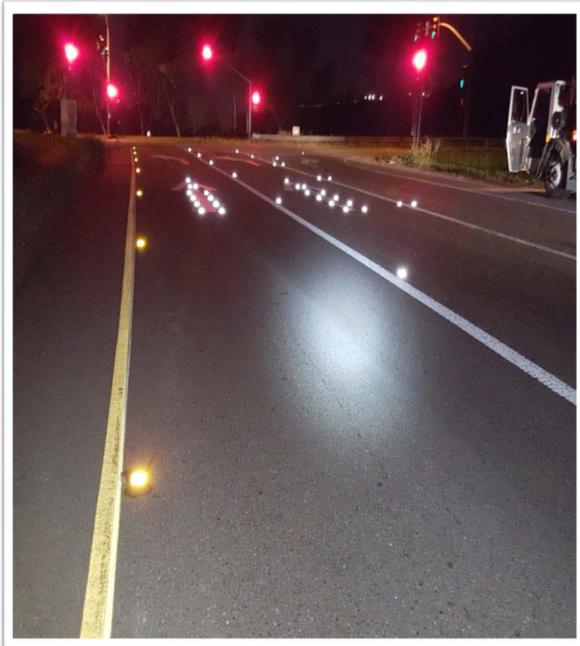
ENHANCEMENT A and B



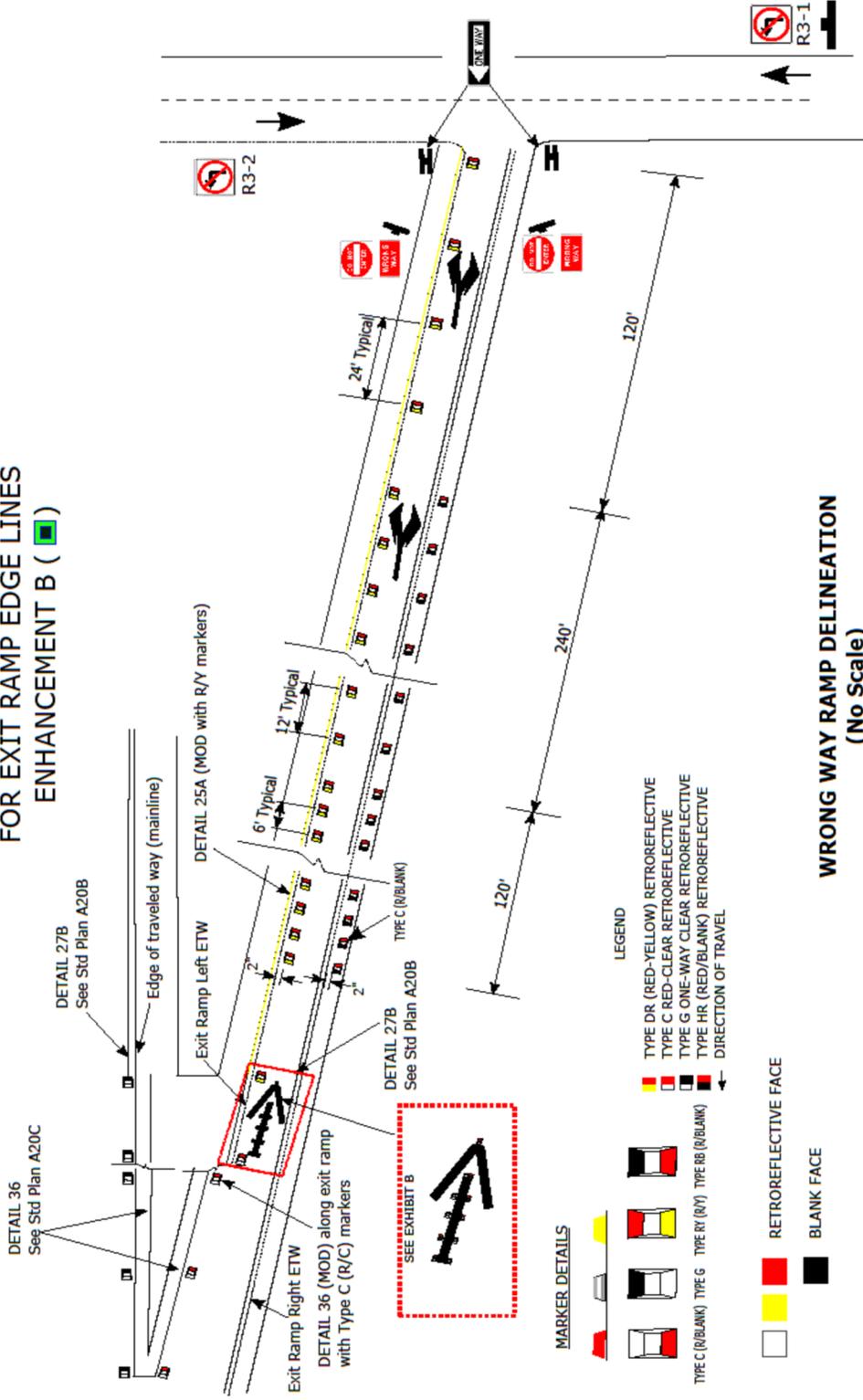
RIGHT WAY DRIVER VIEW



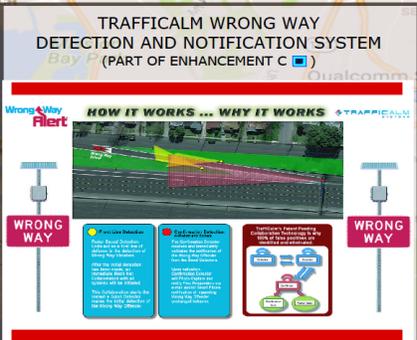
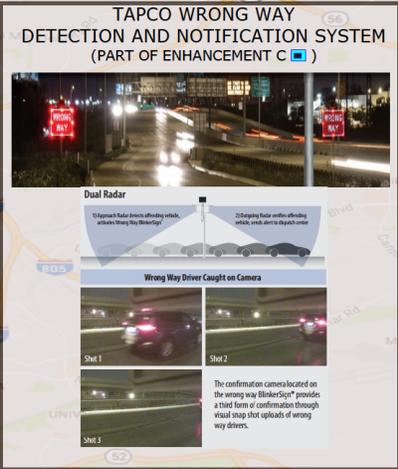
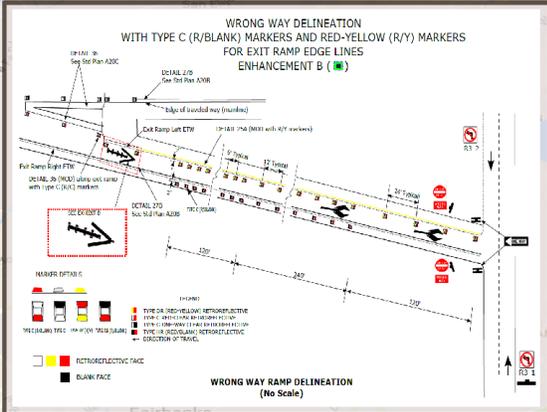
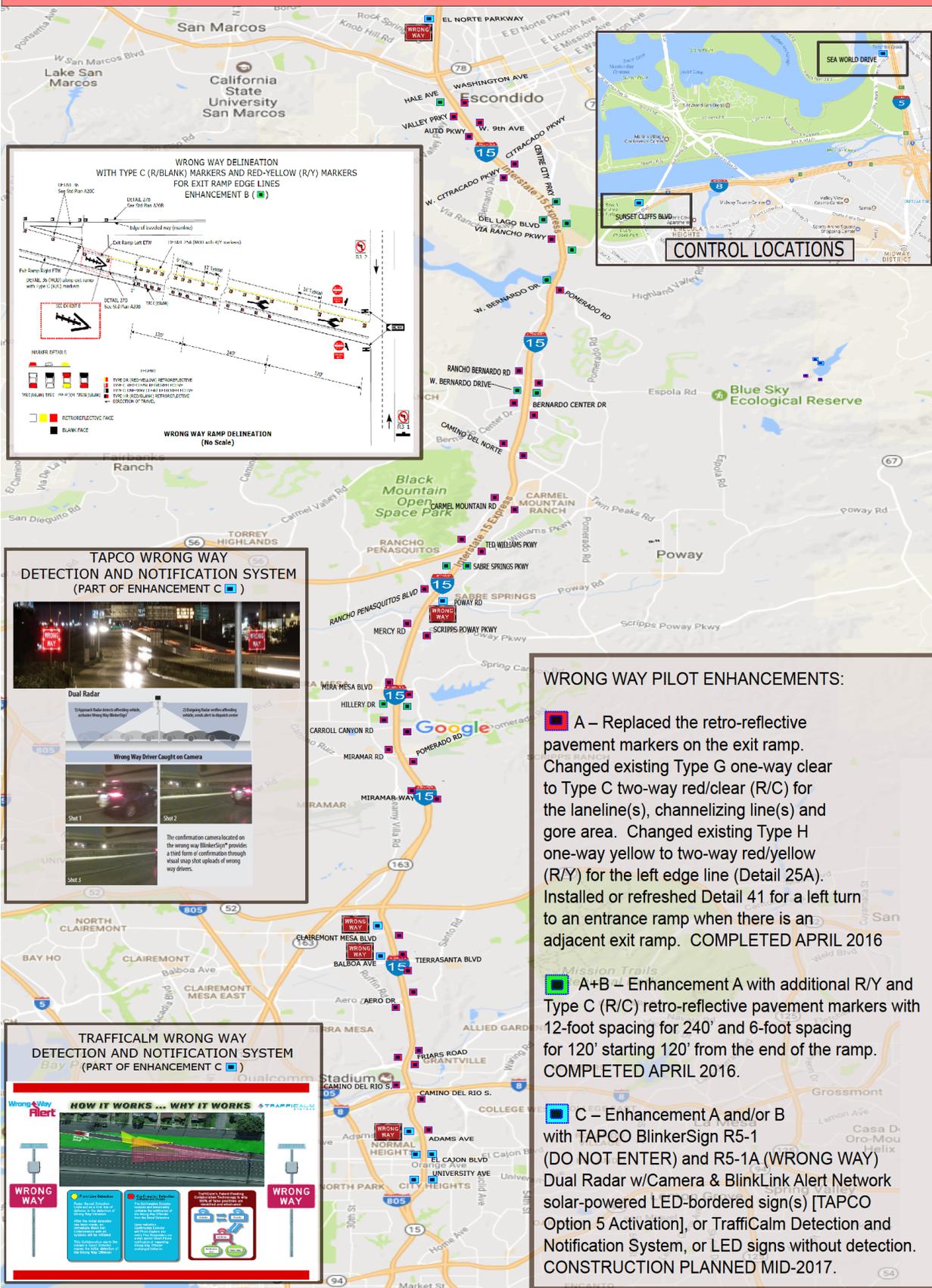
WRONG WAY DRIVER VIEW



**WRONG WAY DELINEATION
WITH TYPE C (R/BLANK) MARKERS AND RED-YELLOW (R/Y) MARKERS
FOR EXIT RAMP EDGE LINES
ENHANCEMENT B ()**



DISTRICT 11 WRONG WAY PILOT PROJECT



WRONG WAY PILOT ENHANCEMENTS:

- A** – Replaced the retro-reflective pavement markers on the exit ramp. Changed existing Type G one-way clear to Type C two-way red/clear (R/C) for the lane line(s), channelizing line(s) and gore area. Changed existing Type H one-way yellow to two-way red/yellow (R/Y) for the left edge line (Detail 25A). Installed or refreshed Detail 41 for a left turn to an entrance ramp when there is an adjacent exit ramp. **COMPLETED APRIL 2016**
- A+B** – Enhancement A with additional R/Y and Type C (R/C) retro-reflective pavement markers with 12-foot spacing for 240' and 6-foot spacing for 120' starting 120' from the end of the ramp. **COMPLETED APRIL 2016.**
- C** – Enhancement A and/or B with TAPCO BlinkerSign R5-1 (DO NOT ENTER) and R5-1A (WRONG WAY) Dual Radar w/Camera & BlinkLink Alert Network solar-powered LED-bordered sign(s) [TAPCO Option 5 Activation], or TrafficCalm Detection and Notification System, or LED signs without detection. **CONSTRUCTION PLANNED MID-2017.**

DISTRICT 3 PILOT PROJECTS PHASE 1 – RED ON BACKSIDE PAVEMENT MARKINGS PLACED ON RAMPS

BACKGROUND

From January to May 2015, there were four nighttime wrong way collisions on Sacramento Area freeways that left a total of 12 killed. All four of the wrong way drivers were intoxicated, with blood-alcohol levels ranging from 0.14% to 0.23%. It is believed that all four drivers were traveling the wrong way on the freeway due to entry of the freeway via an off-ramp. However, the location of entry is known for only two of the four collisions: the WB Yol-50 off-ramp to Harbor Blvd, and the EB Sac-5 off-ramp to 5th St.



The wrong way packages at these off-ramps, as well as other off-ramps in the Sacramento area, meet or exceed the wrong way sign standards outlined in the California edition of the *Manual of Uniform Traffic Control Devices*. Although the high level of intoxication for each driver undoubtedly contributed to the decision to enter the freeway off-ramp in the wrong direction, reasons why the ramp attracted the inebriated driver is unknown.

In response to these collisions, Caltrans decided to conduct a pilot program along a number of Sacramento area off-ramps, with the intent of determining if changing off-ramp pavement marking patterns and installing active warning systems can reduce wrong way movements.

WHAT WE DID

The purpose of the pilot project was to determine if the addition of extra pavement markers, revised signage and active monitoring systems would reduce the potential of a wrong way driver entering the freeway. To that end, 18 off-ramps along SR 50 in the Sacramento area were selected for study. This segment of SR 50 was chosen not only due to wrong way collisions, but also because it is a corridor between the Bay Area and South Lake Tahoe. Non-local drivers are more likely to be unfamiliar with the route and its various interchanges, making a wrong way movement more likely should a driver exit the freeway for gas or food and attempt to reenter the freeway.

Although it is possible for any off-ramp to be driven the wrong way, this project directed its focus on those ramps where the combination of ramp alignment and local road features suggested the ramp may have a higher potential for a wrong way movement than other ramp layouts.

- Off-ramps that enter directly onto a one-way street,
- Isolated off-ramps,
- Off-ramps forming the 4th intersection leg, thereby facing opposing traffic,
- Off-ramps forming a 5th intersection leg, and
- Off-ramps adjacent to an on-ramp

The work was divided into two categories: revision of pavement markings/signs, and installation of an active wrong way monitoring system. Each ramp had a specialized video system installed on the ramps to record wrong way movements. This allowed Caltrans to compare before and after data and see if the improvements had any effect on wrong way movements.

ENHANCEMENTS

Ramp locations were installed with enhancements listed in Table 1.

Table 1

#	Cnty	Rte	PM	Off-ramp	Enhancement					
					A	B	C	D	E	F
1	Yol	80	5.439	Co Rd 32A WB off-ramp	X	X				
2	Yol	80	5.693	Chiles Rd EB off-ramp	X	X				
3	Yol	80	9.004	Enterprise Blvd EB off-ramp	X	X			X	
4	Yol	80	9.417	W Capitol Ave WB off-ramp	X	X				
5	Yol	50	1.210	Harbor Blvd WB off-ramp	X	X				
6	Yol	50	2.811	5th St (River Road) WB off-ramp	X	X	X			X
7	Yol	50	2.812	Jefferson Blvd WB off-ramp	X	X			X	
8	Sac	50	L0.398	5th St EB off-ramp	X	X	X			
9	Sac	50	L1.437	12th & W WB off-ramp	X	X	X	X		
10	Sac	50	L1.600	16th & W WB off-ramp	X	X	X			
11	Sac	50	L2.396	W St WB off-ramp	X	X	X			
12	Sac	50	R0.256	34th St EB off-ramp	X	X				
13	Sac	50	R0.789	Stockton Blvd WB off-ramp	X	X			X	
14	Sac	50	R1.846	59th St EB off-ramp	X	X			X	
15	Sac	50	R2.822	65th St WB off-ramp	X	X			X	
16	Sac	50	R3.915	Howe Ave WB off-ramp	X	X			X	
17	Sac	5	23.090	NB off-ramp to Q St	X	X	X	X		
18	Sac	5	23.090	SB off-ramp to Q St	X	X	X	X		

Enhancement Key

A – Replace retro-reflective pavement markers on the exit ramp

- Change existing one-way white to two-way white/red (W/R) for the lane line(s), channelizing line(s), and gore area.
- Change existing one-way yellow to two-way yellow/red (Y/R) for the left edge line (Detail 25A)
- Install or refresh Detail 41 for a left turn to an entrance ramp where there is an adjacent exit ramp

B – Install Y/R and W/R retro-reflective pavement markers with 24 ft spacing for 240 ft starting at the end of the ramp, changing to 12 ft spacing for 120 ft, then 6 ft spacing for 120 ft, and finally 24 ft spacing to the gore point. Markers which fall between normal marker spacing limits (24 ft) will be non-reflective for right way traffic (but still red for wrong way traffic) to avoid any adverse effect on drivers.

C – Install active monitoring system which can identify, record, and transmit wrong way driver information to a central location, and activate flashing beacon(s). The system proposed is the TAPCO Blinkersign R5-1A (WRONG WAY) Dual Radar w/ Camera and BlinkLink Alert Network solar-powered LED-bordered sign(s) [TAPCO Option 5 Activation]

D – Replace/add new 36" Do Not Enter sign(s)

E – Replace/add new 48" Do Not Enter sign(s)

F – Replace/add new 72" Do Not Enter sign(s)

Caltrans initiated a contract to provide research analysis on how effective Tapco Advanced Detection and notification systems functioned. The work is compiled research titled Vision-Based Sensor System for Site Monitoring: Wrong-Way Driving, Phase 1 under contract Report UCD-ARR-19-09-30-03 by Lasky and Yen. Detailed analysis of the District 3 Wrong Way Pilot should be reviewed in the mentioned report.

Imagery by location is shown on the following pages for ramps in Sacramento County. A summary of the TAPCO system data found that eighteen detections were made by the TAPCO systems from March 25, 2017 through October 27, 2019, see Table 2. Out of the 18 detections, 12 were valid wrong way driving events, 1 was due to construction, 2 were law enforcement in pursuit of a driver, 1 was a pedestrian and 2 were individuals on scooters.

DRISI verification equipment captured 10 unique events 9 of which were not captured by the TAPCO systems. Of the 9 events, the wrong way driver corrected quickly and did not drive down the ramps very far. The one event that both TAPCO and DRISI captured was also a valid wrong way driver. Due to the way the TAPCO and DRISI systems were set up to detect wrong way drivers, if the wrong way driver corrected the wrong way movement before traveling to far down the ramp (typically less than 150 feet), the TAPCO devices would not have detected the wrong way driver and/or would not have sent a notification to the TMC. Therefore, the events that are captured by DRISI systems only are not faults or errors with the TAPCO systems.

TABLE 2
WRONG WAY EVENTS CAPTURED BY TAPCO AND DRISI SYSTEMS

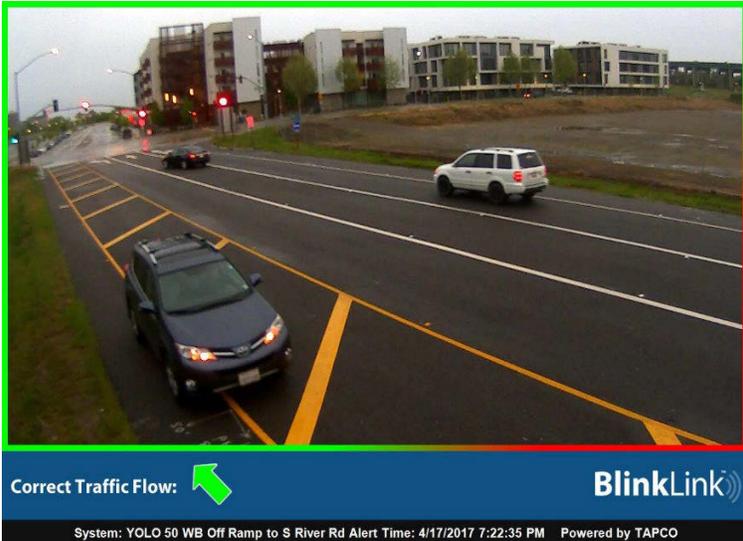
DISTRICT 3 BY LOCATION							
#	TIME	DATE	EVENT ID	SOURCE	DAY	LOCATIONS	RESOLUTION
1	2:44 AM	3/25/2017	753436	TAPCO	Sunday	SAC 50 WB off-ramp to 26th and W	Construction WW Driver
2	7:22 PM	4/17/2017	754568	TAPCO	Monday	YOLO 50 WB off-ramp to S River Rd	Wrong Way Vehicle
3	3:13 AM	7/19/2017	763245	TAPCO	Sunday	SAC 50 WB off-ramp to 26th and W	Wrong Way Vehicle
4	6:48 PM	7/25/2017	765202	TAPCO	Sunday	YOLO 50 WB off-ramp to S River Rd	Wrong Way Vehicle
5	11:16 PM	7/31/2017	768392	TAPCO	Friday	YOLO 50 WB off-ramp to S River Rd	Wrong Way Vehicle
6	5:39 AM	9/13/2017	781200	TAPCO	Sunday	SAC 50 WB off-ramp to 16th and W	WW Veh chase by law Enforcement
7	8:58 PM	6/5/2018	874539	TAPCO	Sunday	YOLO 50 WB off-ramp to S River Rd	Wrong Way Vehicle
8	1:14 PM	8/7/2018	896290	TAPCO	Friday	YOLO 50 WB off-ramp to S River Rd	Wrong Way Vehicle
9	11:30 PM	11/4/2018	N/A	DRISI	Sunday	WB US 50 at S. River Road	Realizes quickly due to oncoming vehicle
10	9:07 AM	11/19/2018	968626	TAPCO	Saturday	YOLO 50 WB off-ramp to S River Rd	Wrong Way Vehicle
11	3:33 AM	12/2/2018	N/A	DRISI	Sunday	WB US 50 at 26th St	Quick turn-around, stops to take a break at side of road
12	5:26 AM	1/14/2019	N/A	DRISI	Thursday	WB US 50 at 26th St	Doesn't enter ramp, continues wrong way on W Street
13	4:14 AM	1/30/2019	N/A	DRISI	Wednesday	WB US 50 at 26th St	Doesn't enter ramp, continues wrong way on W Street
14	1:47 AM	2/2/2019	1011677	TAPCO	Sunday	WB US 50 at 10th St	WW Law Enforcement
15	1:37 AM	2/4/2019	1012140	DRISI/TAPCO	Tuesday	SAC 50 WB 10th Street Off-ramp	Wrong Way Vehicle
16	1:28 AM	2/28/2019	N/A	DRISI	Thursday	WB US 50 at S. River Road	Parks on ramp deliberately
17	5:41 PM	4/21/2019	1053791	TAPCO	Monday	YOLO 50 WB off-ramp to S River Rd	Pedestrian
18	4:21 PM	5/3/2019	N/A	DRISI	Friday	WB US 50 at S. River Road	Realizes quickly due to oncoming vehicle
19	3:33 PM	5/18/2019	N/A	DRISI	Friday		WW Law Enforcement
20	12:18 AM	6/16/2019	1090260	TAPCO	Sunday	YOLO 50 WB off-ramp to S River Rd	Scooter Wrong Way
21	3:06AM	6/22/2019	N/A	DRISI	Saturday	WB US 50 at 26th St	Doesn't enter ramp, continues wrong way on W Street
22	4:58AM	6/22/2019	N/A	DRISI	Saturday	WB US 50 at 26th St	Wrong way
23	10:00 PM	7/21/2019	1113390	TAPCO	Tuesday	YOLO 50 WB off-ramp to S River Rd	Wrong Way Vehicle
24	11:58 AM	10/23/2019	1269596	TAPCO	Tuesday	YOLO 50 WB off-ramp	Wrong Way Vehicle
25	3:04 AM	10/24/2019	1270054	TAPCO	Wednesday	SAC 50 WB 10th Street Off-ramp	Scooter Wrong Way
26	3:33 AM	10/27/2019	1272137	TAPCO	Saturday	SAC 50 WB off-ramp to 16th and W	Wrong Way Vehicle
27	11:30 PM	08/01/2017	768810	TAPCO	Sunday	YOLO 50 WB off-ramp to Jefferson	Wrong Way Vehicle

CAPTURED TAPCO EVENT IMAGERY BY LOCATION

1. 3-25-2017



2. 4-17-2017



3. 7-19-2017



4. 7-25-2017



5. 7-31-2017



6. 9-13-2017



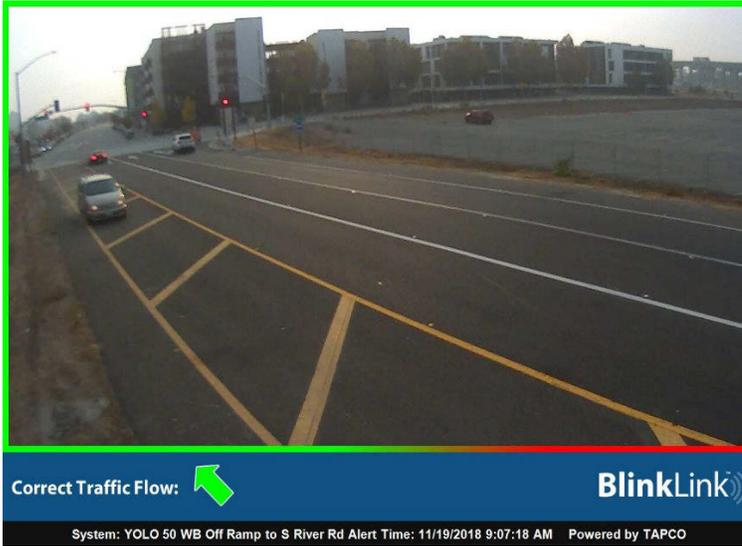
7. 6-5-2018



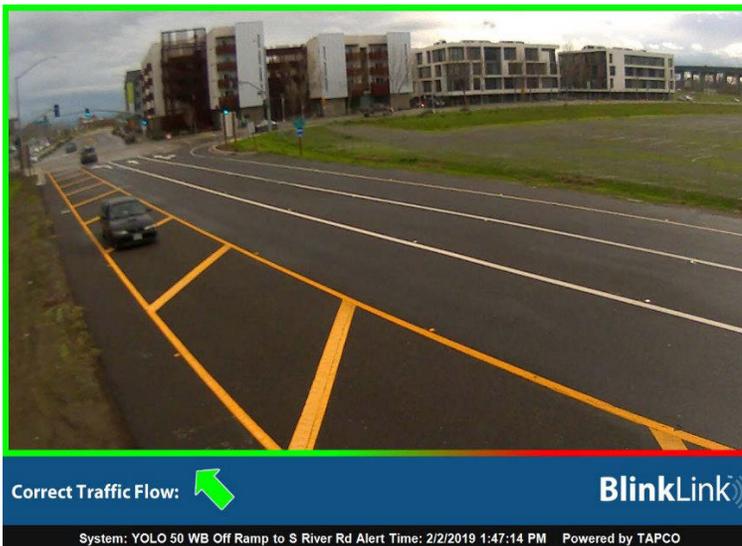
8. 8-7-2018



10. 11-19-2018



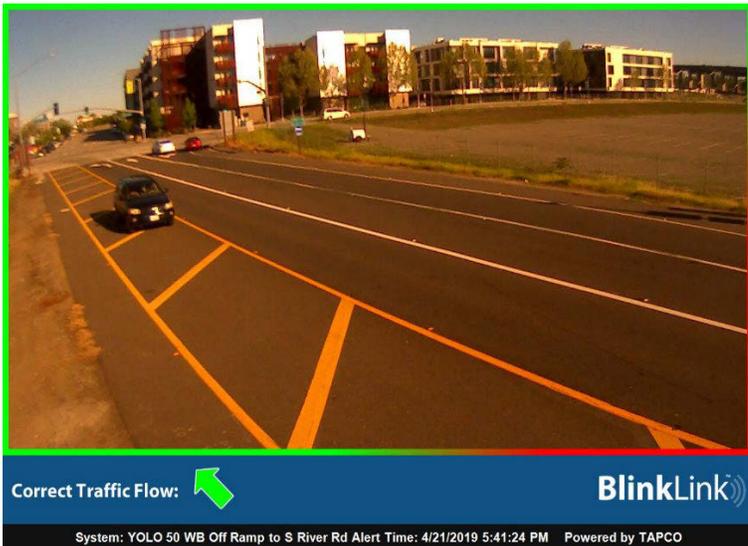
14. 2-2-2019



15. 2-4-2019



17. 4-21-2019



20. 6-16-2019



23. 7-21-2019



24. 10-23-2019



25. 10-24-2019



26. 10-27-2019



27. 8-21-2017

