

MSAR WATERSHED TMDL TASK FORCE

MSAR Bacteria Synoptic Study

Project Update

October 22, 2019

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ACKNOWLEDGMENTS

- Riverside County Flood Control & Water Conservation District – Data collection at Santa Ana River, Tier 1 and Tier 2 sites in Riverside County
- San Bernardino County Flood Control District – Data collection at Tier 1 & Tier 2 sites in San Bernardino County
- POTWs – Collection of weekly effluent sample for *Bacteroides* analysis
 - Inland Empire Utilities District
 - Riverside Regional Water Quality Control Plant
 - City of San Bernardino Municipal Water Department
 - City of Rialto
- CWE/CDM Smith – Coordinate routine Regional Bacteria Monitoring Program sample collection at compliance sites with this Study

MSAR SYNOPSIS STUDY

- Study Objectives
- Study Design



SYNOPTIC STUDY OBJECTIVES

- **Characterize Current Conditions**

- Characterize the current concentration of *E. coli* bacteria in impaired waters
- Characterize the flows and *E. coli* concentrations discharged into the impaired waters from all major tributaries
- Use Microbial Source Tracking techniques to determine the extent to which human sources (as measured by *Bacteroides*) may or may not be contributing to elevated *E. coli*
- Confirm what specific areas of the MSAR watershed have been hydrologically-disconnected from impaired waters during dry weather conditions

SYNOPTIC STUDY OBJECTIVES

- **Evaluate Changes Over Time**
 - Evaluate/quantify the degree to which dry weather urban flows have declined in the time since the TMDL was approved in 2005
 - Characterize any significant changes in the concentration and mass of bacteria that have occurred during the period of TMDL implementation
 - Estimate the net change in bacterial mass loads associated with the reduction in dry weather flows discharged from the MS4
 - Update and revise the bacteria mass balance analyses
 - Update the Risk-Based Prioritization Score for Tier 1 sites and summarize how scores have changed since the previous 2013 ranking

SYNOPTIC STUDY OBJECTIVES

- **Compliance Evaluations**

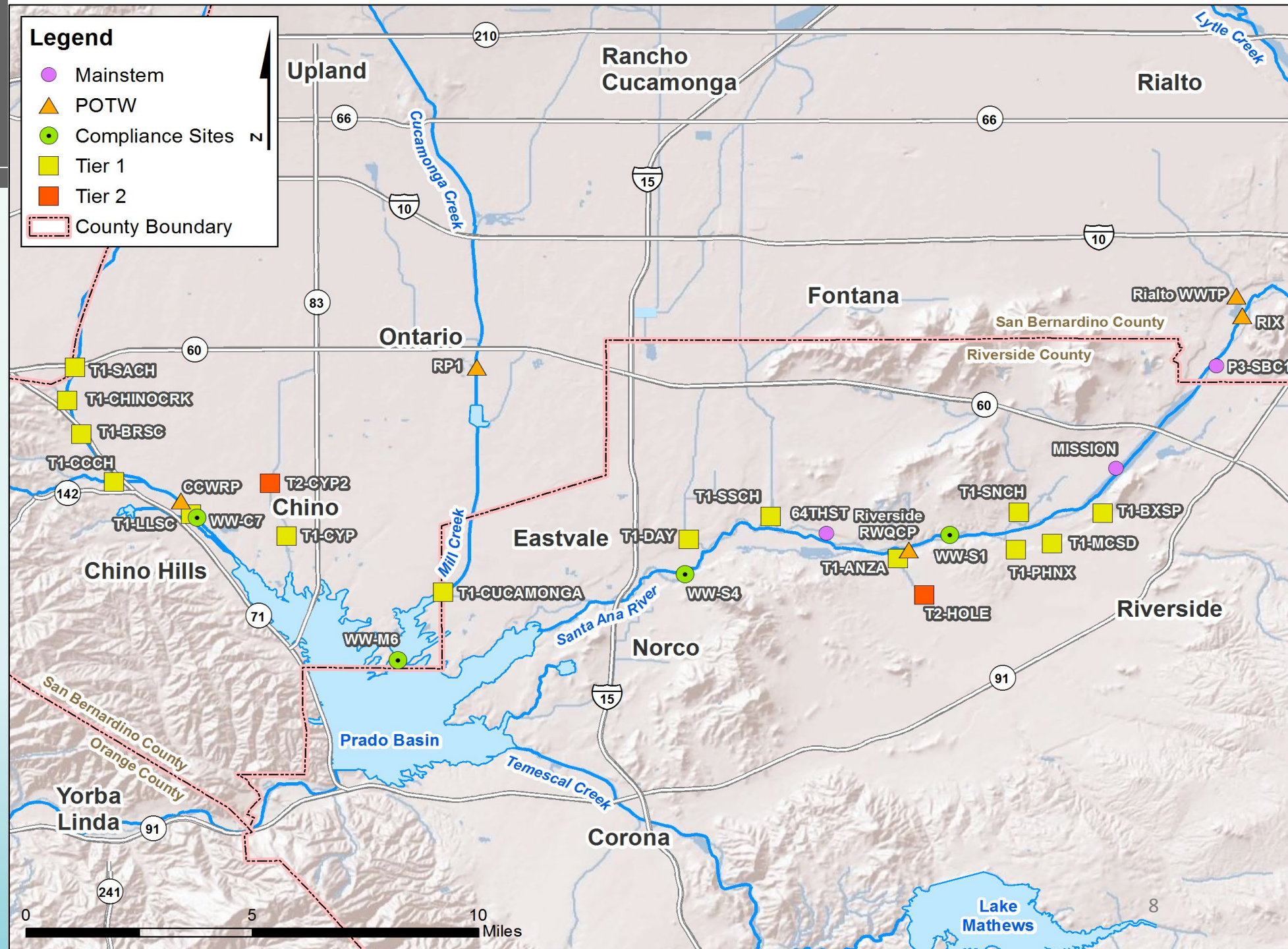
- Determine whether the estimated bacterial load reductions described in the CBRPs have been achieved and evaluate the net effect of the actual reductions achieved on receiving water quality at compliance sites
- Update the estimated load reductions required to achieve compliance with:
 - *E. coli* targets in the 2005-adopted TMDL; and
 - New *E. coli* objectives adopted by the State Water Board in 2018

DATA COLLECTION

- Sample Period – Weekly samples collected over six-week period from week of July 29 through week of September 2
- Data Collection activities
 - Flow measurement
 - Field measurements (temperature, dissolved oxygen, pH, conductivity, turbidity)
 - Water samples collected for *E. coli* and *Bacteroides* analysis
 - Site photographs/field observations
- Laboratories
 - Babcock Laboratories – *E. coli*
 - Orange County Public Health Laboratory - *Bacteroides*

STUDY SITES

- 4 - TMDL Compliance Sites
- 3 - Mainstem Sites
- 14 - Tier 1 Sites
- 2 - Tier 2 Sites
- 5 - POTW Sites



COMPLIANCE SITES

- WW-S1 (MWD Crossing)
- WW-S4 (Pedley Avenue)
- WW-M6 (Mill-Cucamonga Creek)
- WW-C7 (Chino Creek)



MAINSTEM SITES

- PBC-3 (SAR 4 abv Riverside Ave Bridge)
- MISSION (SAR 3 at Mission Blvd)
- 64THST (SAR 3 at 64th Street)



- Santa Ana River Reach 3 Sites
 - 7 Tier 1 Sites
 - 1 Tier 2 Site



**Chino Creek
(T1-CHINOCRK)**



San Antonio Channel (T1-SACH)



**Boys Republic
South Channel
(T1-BRSC)**



Cypress Channel (T2-CYP2)



Carbon Canyon Channel (T1-CCCH)



- Chino, Cypress & Cucamonga Creek Sites
 - 7 Tier 1 Sites
 - 1 Tier 2 Site

10/22/2019

Lake Los Serranos Channel (T1-LLSC)



Cypress Channel (T1-CYP)



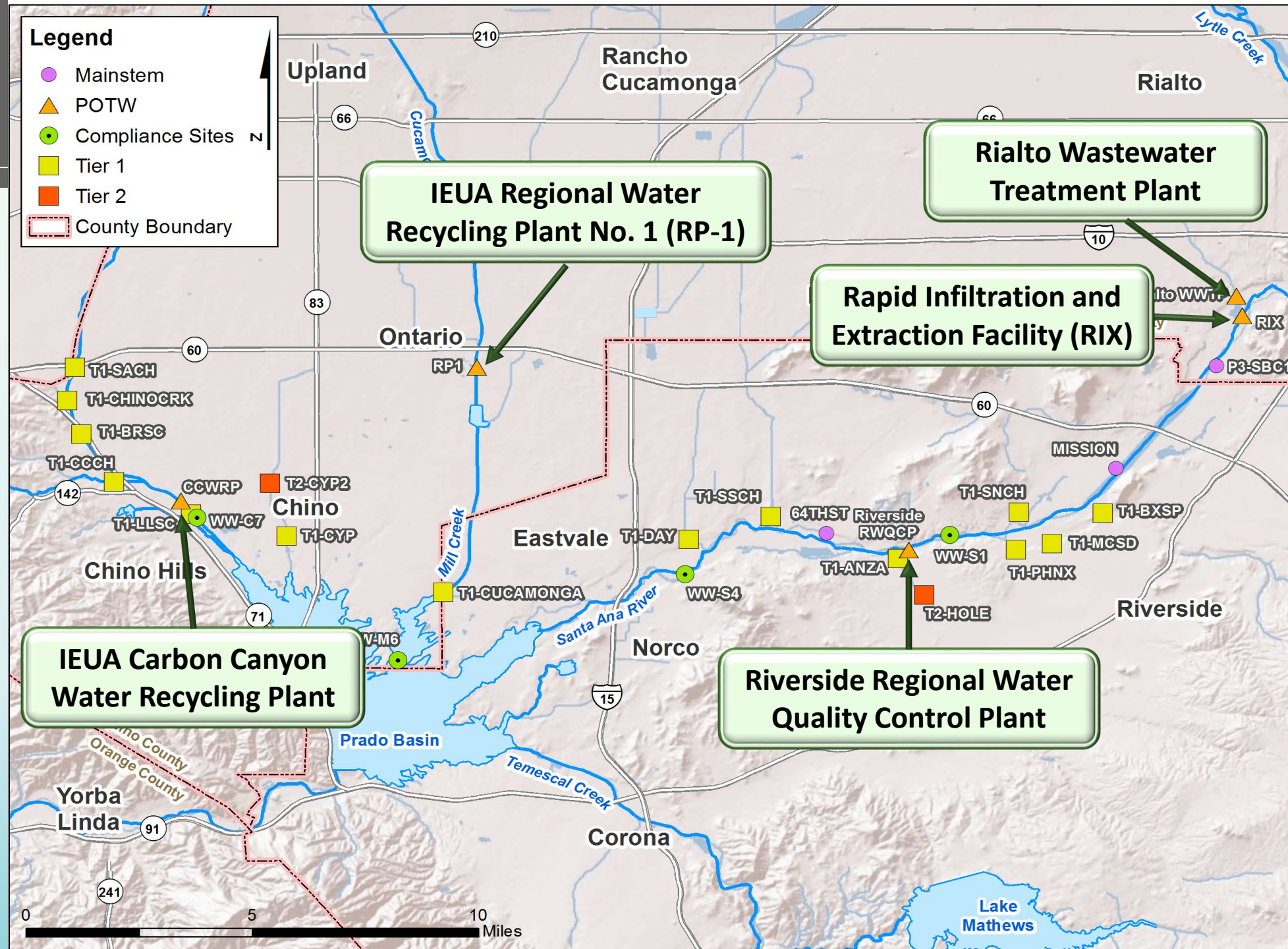
Cucamonga (T1-CUCAMONGA)



Coro

POTWS

- Weekly *Bacteroides* samples collected
- Total coliform assumed to be compliant with effluent limit (e.g., weekly average < 2.2 MPN/100 mL)
- Effluent flow data provided



PRELIMINARY RESULTS (OCTOBER 22, 2019)

- Flow Measurements
 - Methods
 - Comparisons between 2012 and 2019
 - CBRP Dry Weather Flow Targets
- *E. coli* at Tier 1 outfalls
 - Concentrations and Loads
 - Comparisons between 2012 and 2019
- Source Contribution Analysis
 - Blended Flow Analysis
 - Comparisons between 2012 and 2019
- Santa Ana River Findings
 - Role of Non-MS4 Sources of *E. coli*
 - Hole Lake
- Chino Creek Findings
 - Imported Water Turnout 2016
 - Channel Resuspension
- Preliminary *Bacteroides* Results
 - First sample week

PRELIMINARY RESULTS

- Flow Measurements



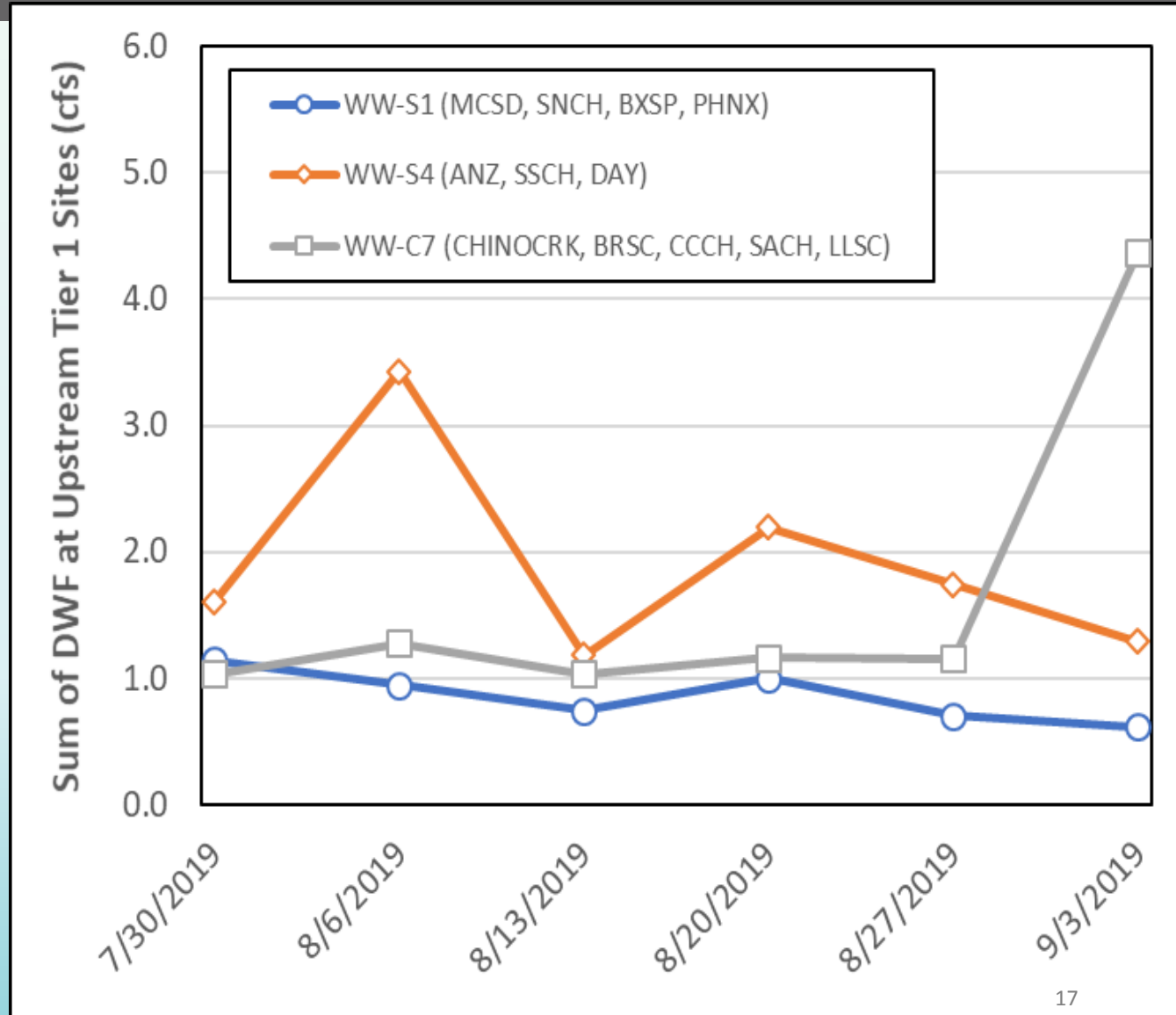
FLOW MEASUREMENT METHODS

- To support mass balance analysis during dry weather, implemented more accurate methods than previously deployed, i.e., 10%, 50%, 90% cross-sectional measurement approach
- Volumetric methods are most accurate where feasible (i.e., bucket and stopwatch)
 - Retrofitted flood barriers
- Acoustic doppler velocity meter used for larger flows and unlined segments



FLOW MEASUREMENT RESULTS

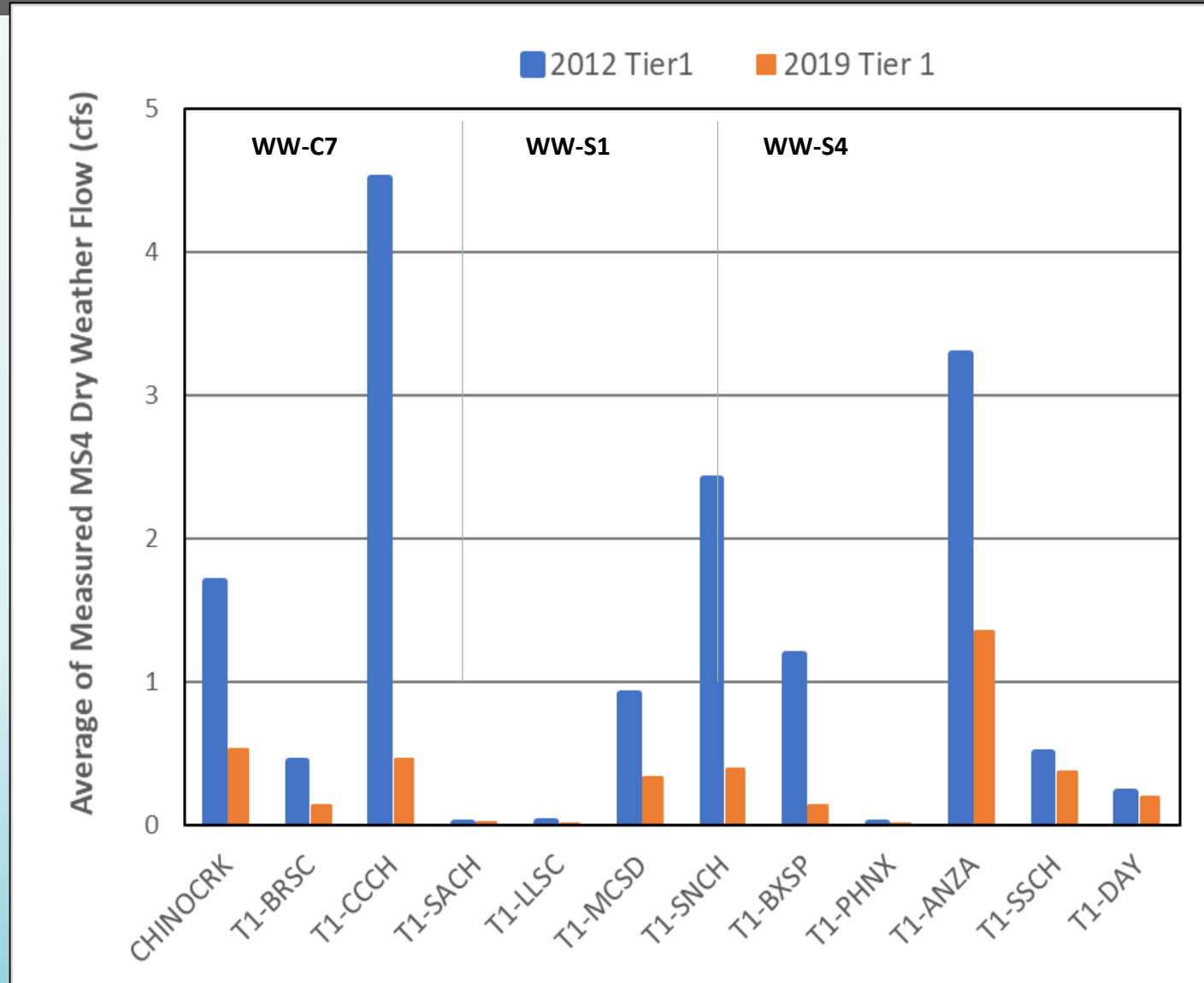
- Sum of inflows from upstream Tier 1 sites
- Measurements showed lower week to week variability than in prior Tier 1 studies
- Elevated flows on 9/3/19 in Chino Creek associated with non-MS4 discharge



FLOW MEASUREMENT RESULTS

- All Tier 1 sites showed a reduction in average dry weather flow in 2019 as compared to 2012
- All other Tier 1 outfalls upstream of compliance sites were dry

Measured flow from T1-SACH on 9/3/19 not included in average because of a broken valve upstream of the site that caused an atypical increase in flow



CBRP COMPLIANCE METRIC: DRY WEATHER FLOW REDUCTION

- Source: Table 3-4. San Bernardino County MS4 Program CBRP

Compliance Monitoring Location	Chino Creek at Central Ave	Mill-Cucamonga Creek at Chino-Corona Rd	Total
Hydrologically Connected Drainage (total acres)	17,678	5,510	23,188
Bacteria Reduction Target from MS4 (billion cfu/day)	37	71	107
Approximate Target DWF Reduction (gal/day) ¹	767,082	1,481,465	2,248,548
BMP Implementation necessary to provide target DWF Reduction (irrigated acres managed) ²			
Enforce water conservation ordinances ^{3,6}	1,743	3,367	5,110
Replace grass with artificial turf ⁴	1,534	2,963	4,497
Replace grass with native plants ⁴	1,534	2,963	4,497
Installation of a WBIC ⁵	1,826	3,527	5,354
Landscape irrigation audit ^{3,6}	1,743	3,367	5,110
Enhanced Sweeping ^{4,7,8}	21,420	41,440	62,860
WQMP with redevelopment ⁴	1,534	2,963	4,497
Regional structural controls ⁴	1,534	2,963	4,497

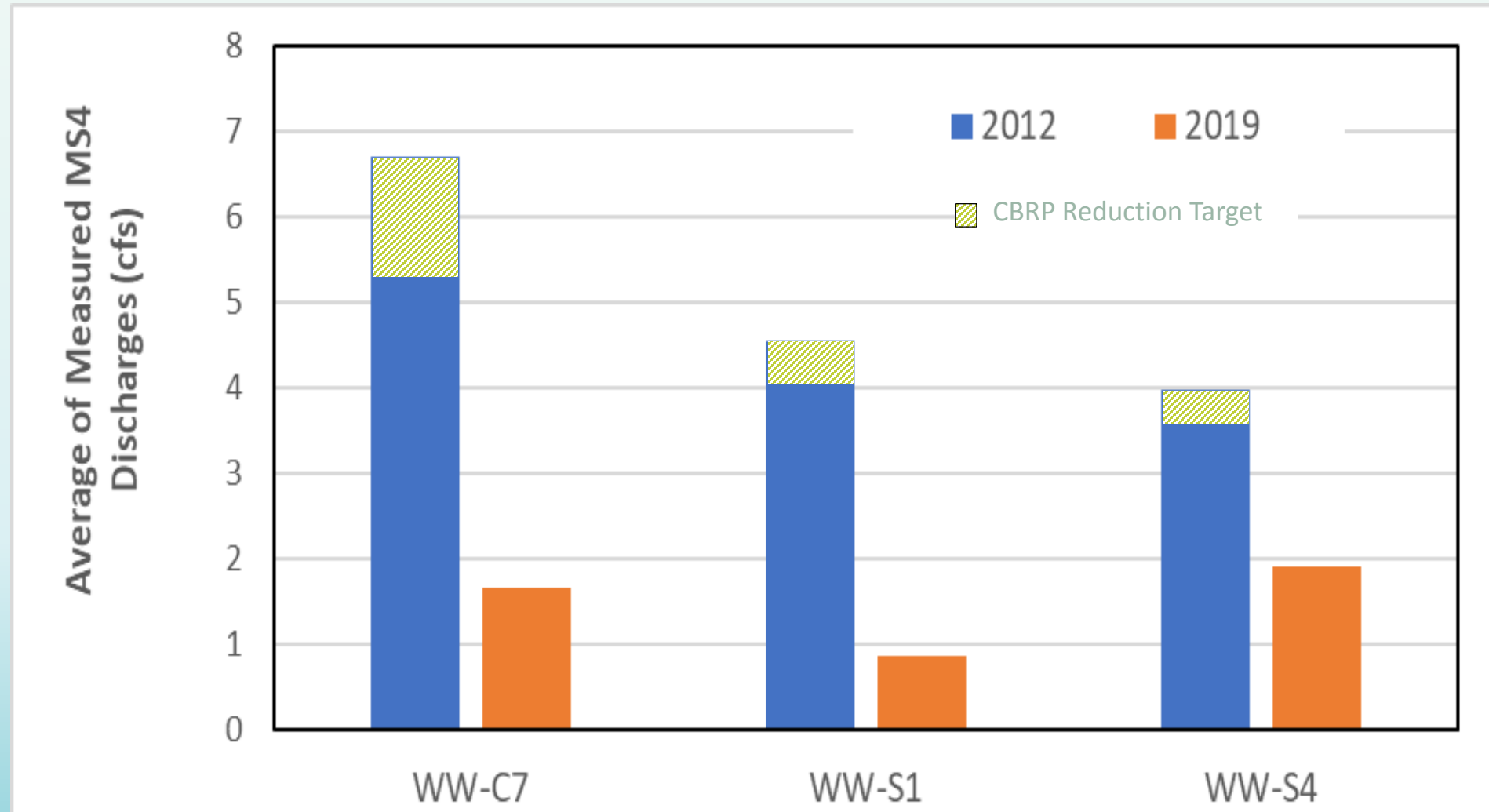
CBRP COMPLIANCE METRIC: DRY WEATHER FLOW REDUCTION

- Source: Table 3-4. Riverside County MS4 Program CBRP

Compliance Monitoring Location	Santa Ana River at MWD Crossing	Santa Ana River at Pedley Ave	Total
Hydrologically Connected Drainage (total acres)	10,700	17,900	28,600
Bacteria Reduction Target from MS4 (billion cfu/day)	15	10	24
Approximate Target DWF Reduction (gal/day) ¹	305,000	206,000	512,000
BMP Implementation necessary to provide target DWF Reduction (irrigated acres managed) ²			
Enforce water conservation ordinances ^{3,6}	690	470	1,160
Replace grass with artificial turf ⁴	610	410	1,020
Replace grass with native plants ⁴	610	410	1,020
Installation of a WBIC ⁵	730	490	1,220
Landscape irrigation audit ^{3,6}	690	470	1,160
Enhanced Sweeping ^{4,7,8}	8,540	5,740	14,280
WQMP with redevelopment ⁴	610	410	1,020
Regional structural controls ⁴	610	410	1,020

CBRP COMPLIANCE METRIC: DRY WEATHER FLOW REDUCTION

- Dry weather flow reduction targets in CBRPs have been met



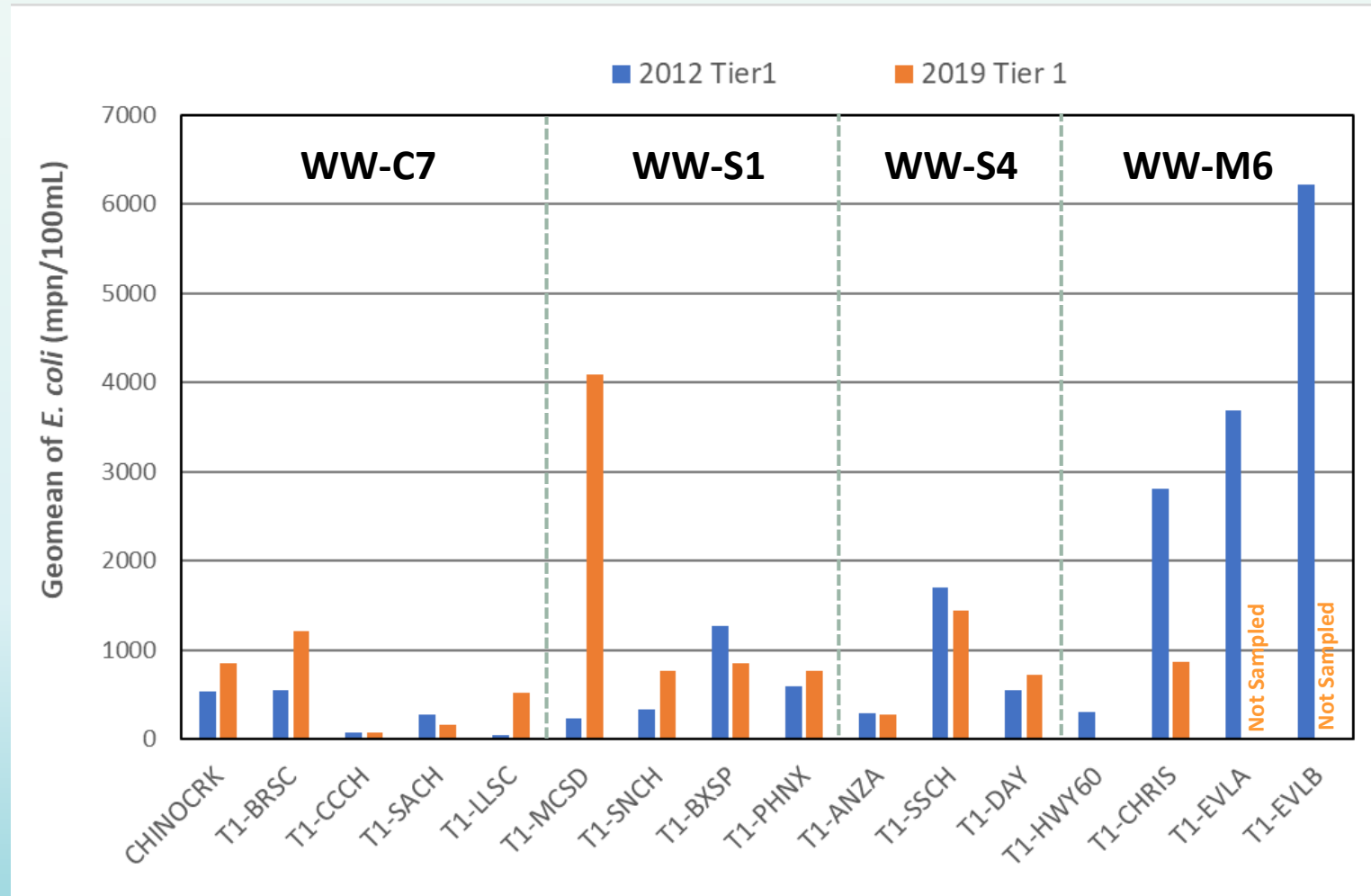
PRELIMINARY RESULTS

- *E. coli* - Tier 1 Sites



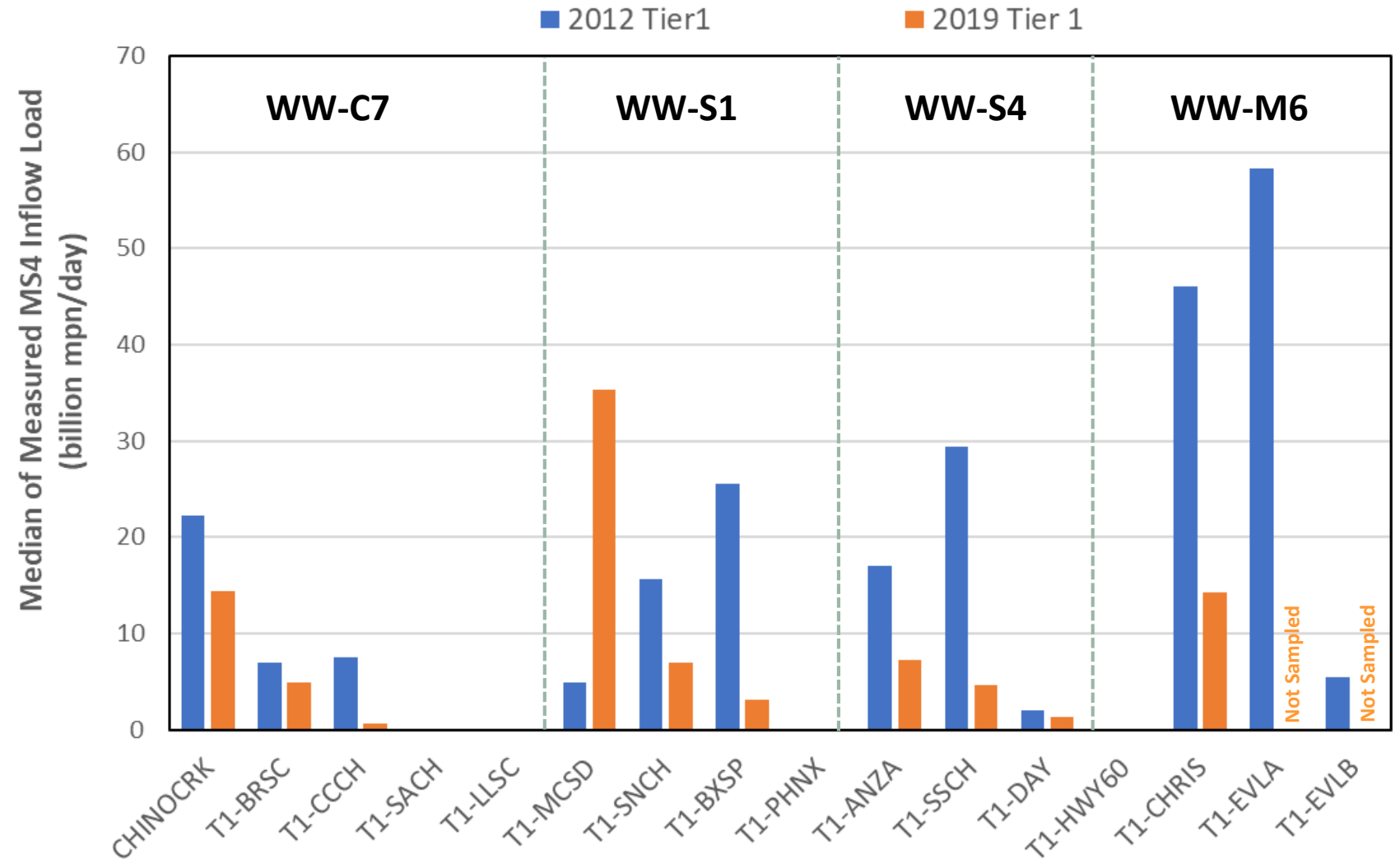
TIER 1 SITES - *E. COLI* CONCENTRATIONS

- Study limited Tier 1 sample locations to sites that accounted for more than 99% of bacteria load in 2012
- Concentrations generally similar to 2012, except for a sharp rise at two sites:
 - Magnolia Center Storm Drain (MCSD)
 - Lake Los Serrano Channel (LLSC)



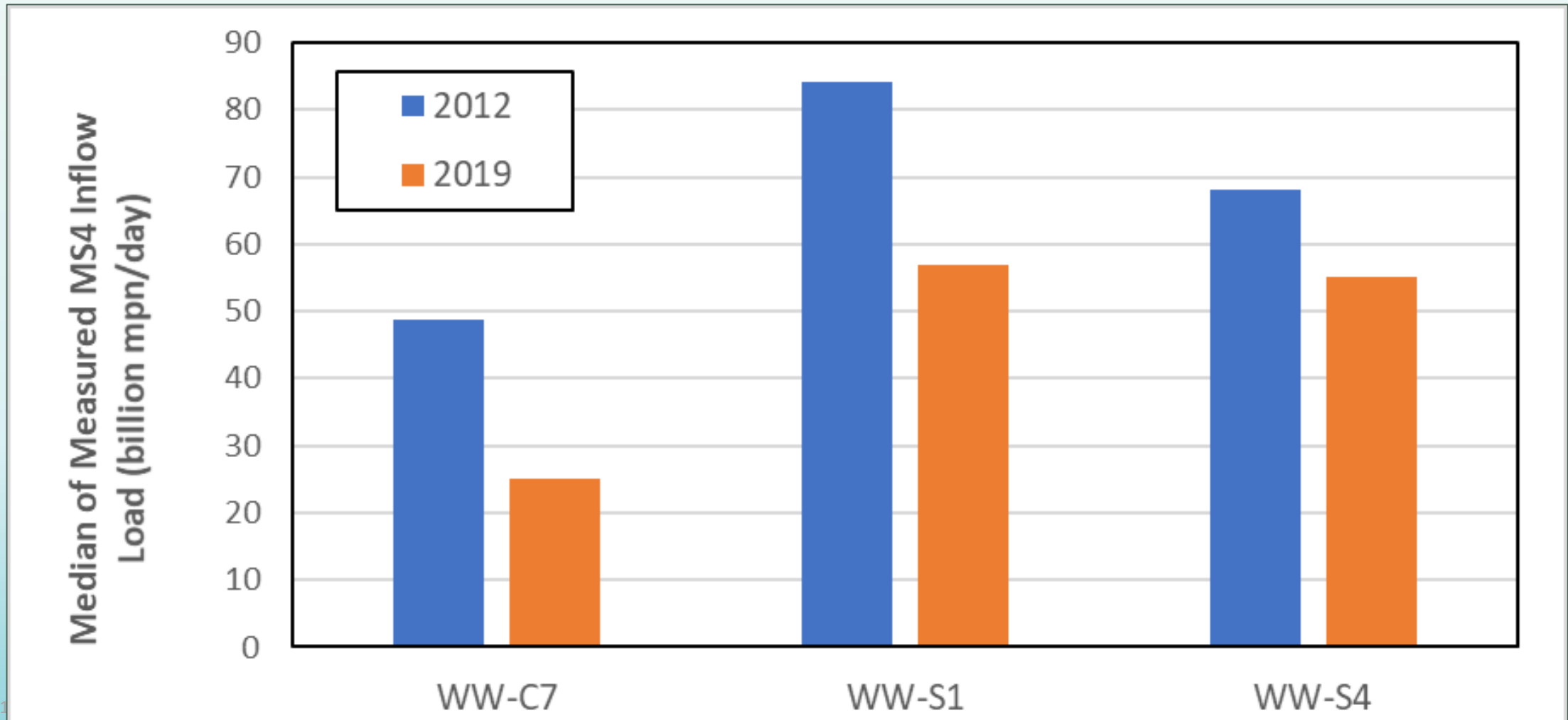
TIER 1 SITES - *E. COLI* LOADS

- Lower variability in load than flow and concentration
- Average of six events to be used in prioritization



TIER 1 SITE LOADS – 2012 VS. 2019 DRY SEASON

- *E. coli* load from Tier 1 outfalls as a whole to impaired waters is declining



WEEKLY VARIABILITY IN *E. COLI* LOAD AMONG TIER 1 SITES

- Tier 1 MS4 outfalls with the highest *E. coli* load vary week to week in all of the impaired waters

Compliance Site	7/31/2019	8/7/2019	8/14/2019	8/21/2019	8/28/2019	9/4/2019
WW-C7	BRSC	CHINOCRK	CCCH	CHINOCRK	CHINOCRK	CHINOCRK
WW-S1	SNCH	SNCH	MCSD	MCSD	MCSD	MCSD
WW-S4	SSCH	SSCH	ANZA	DAY	ANZA	SSCH

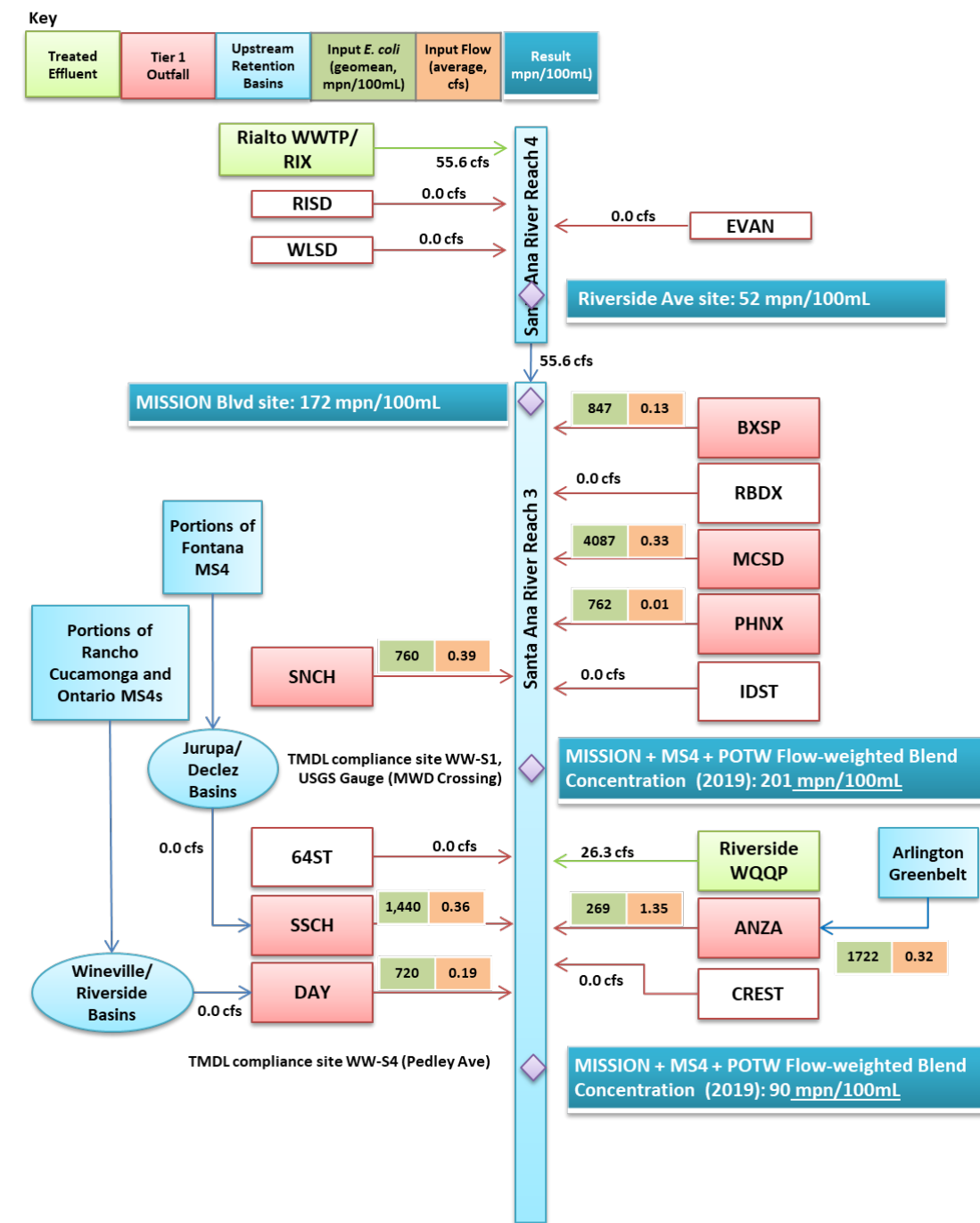
PRELIMINARY RESULTS

- Source Contribution Analysis



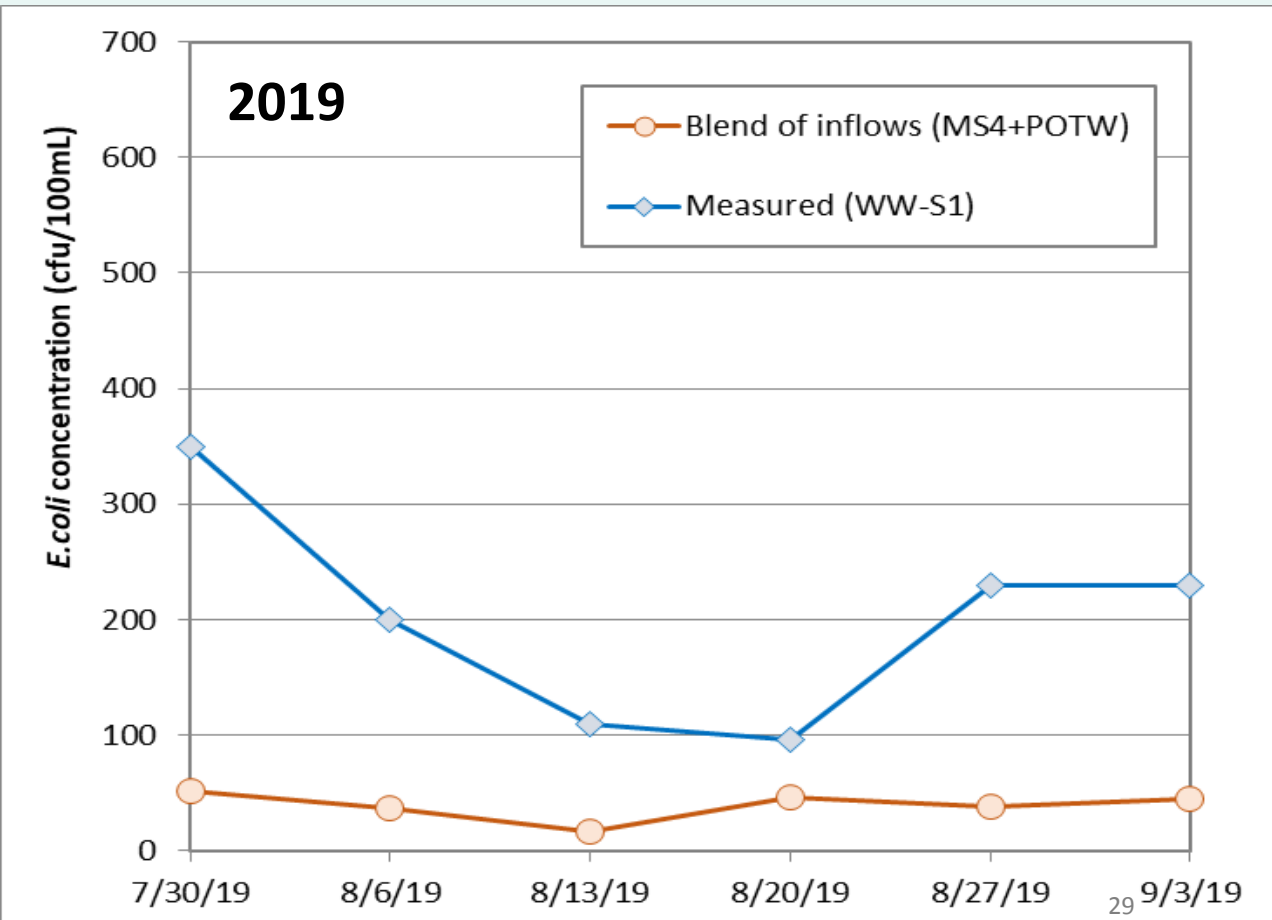
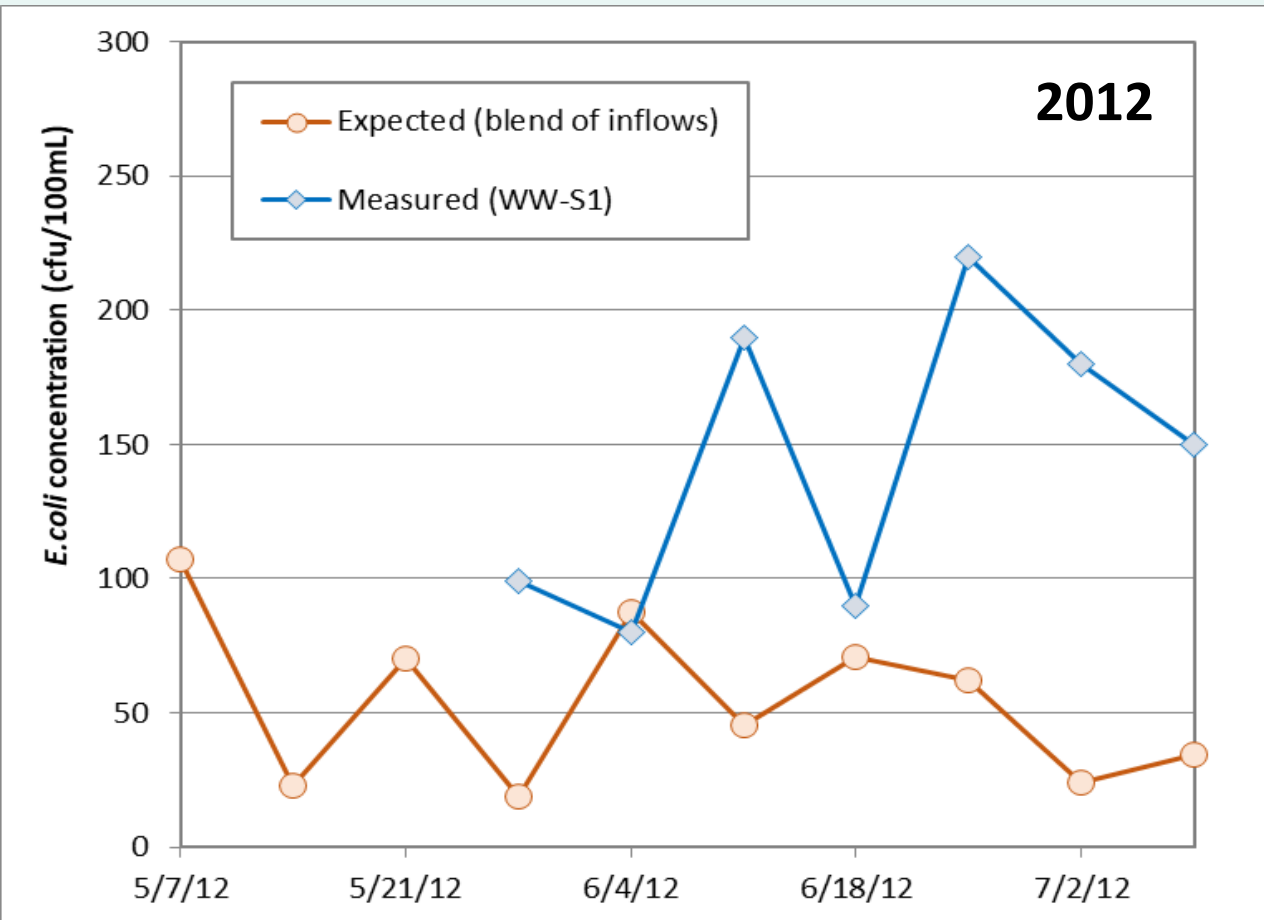
SOURCE CONTRIBUTION ANALYSIS TASK

- Source contribution analysis compares MS4 + POTW inflows with downstream monitoring sites
 - Completed in 2010, 2013, and 2016
 - Updated for 2019
- Difference between upstream inflows and downstream conditions from new sources and natural decay



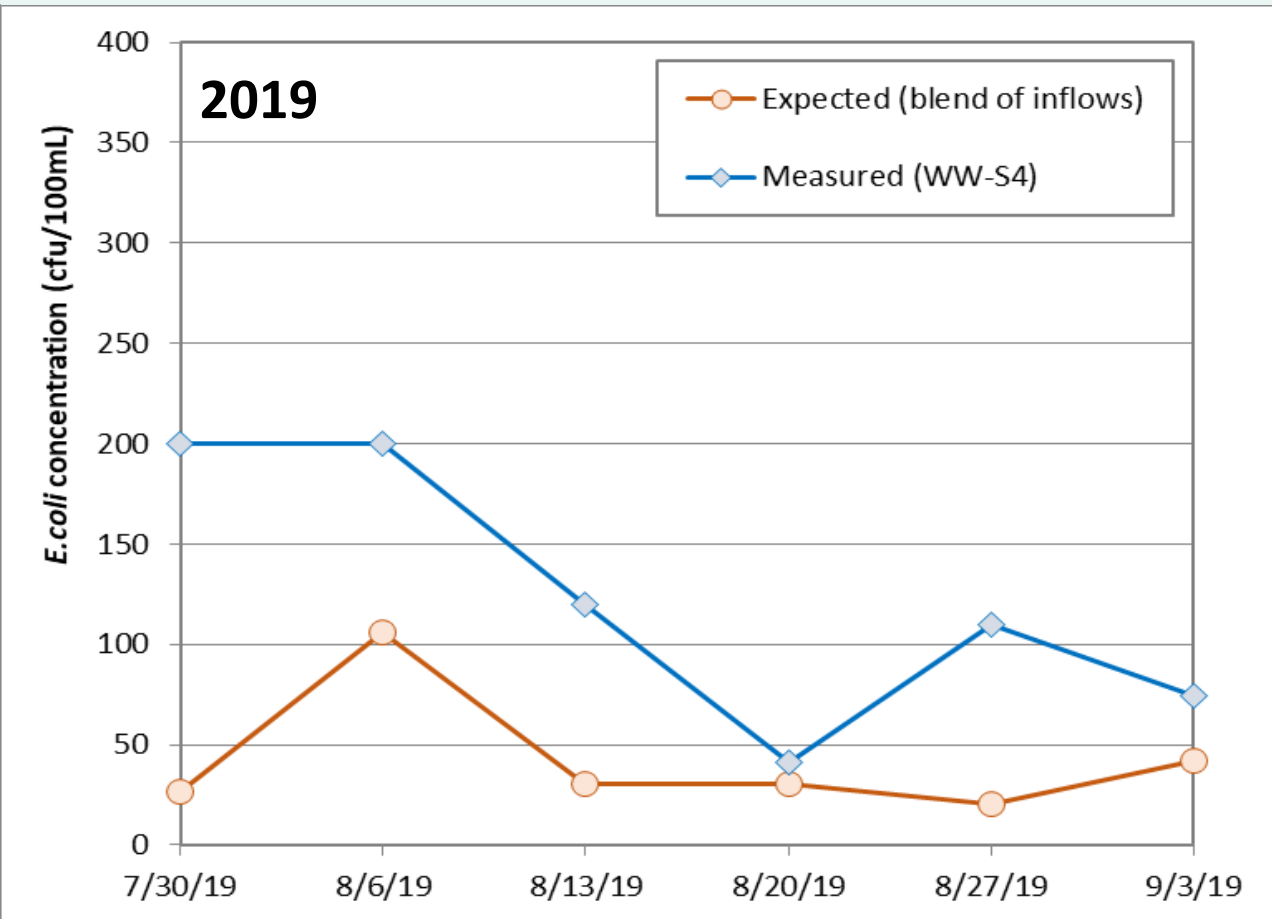
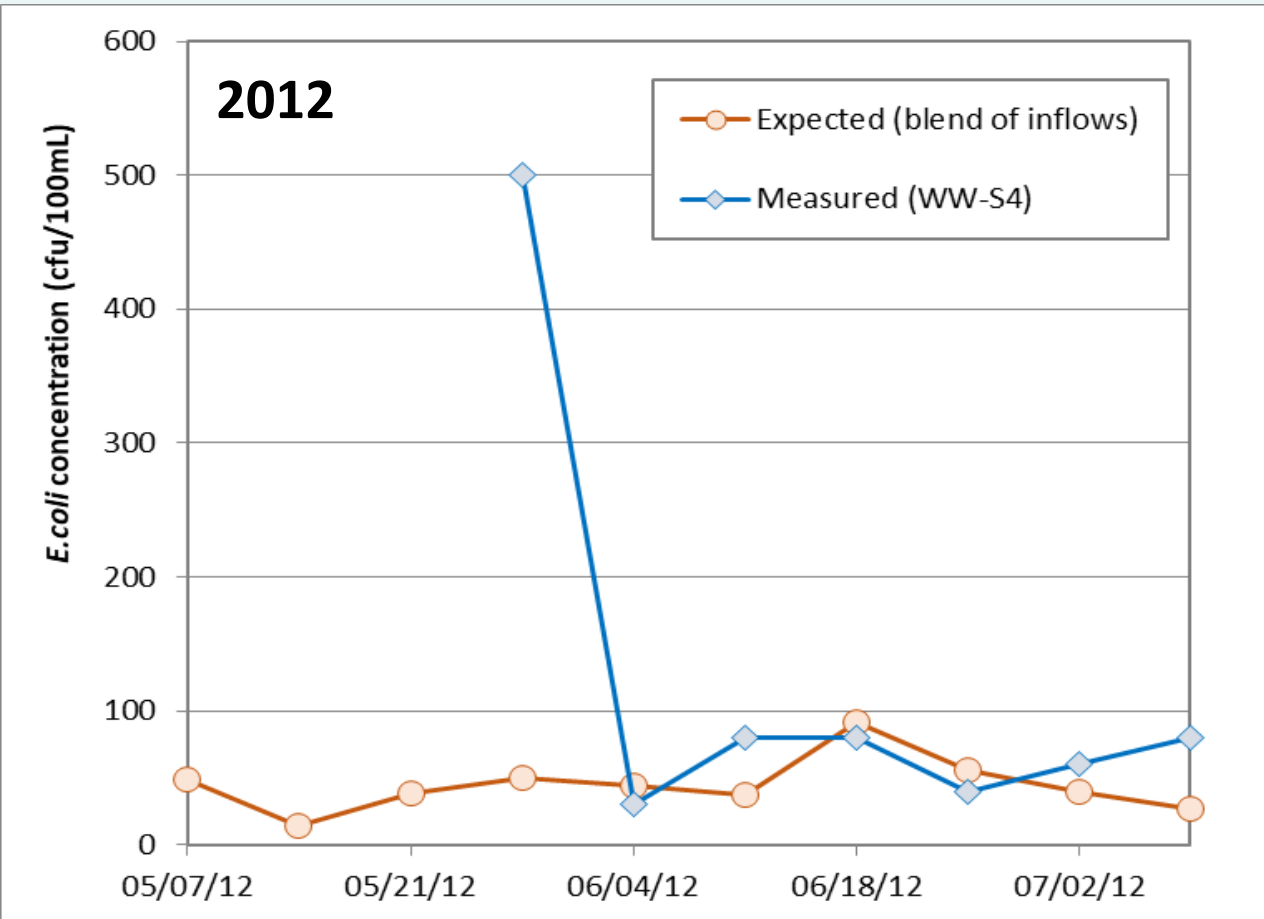
WEEKLY BALANCE – SANTA ANA RIVER AT MWD CROSSING

- Results suggest persistent non-MS4 source of *E. coli*
- Similar blend of inflows between 2012 and 2019 despite 50% decline in effluent



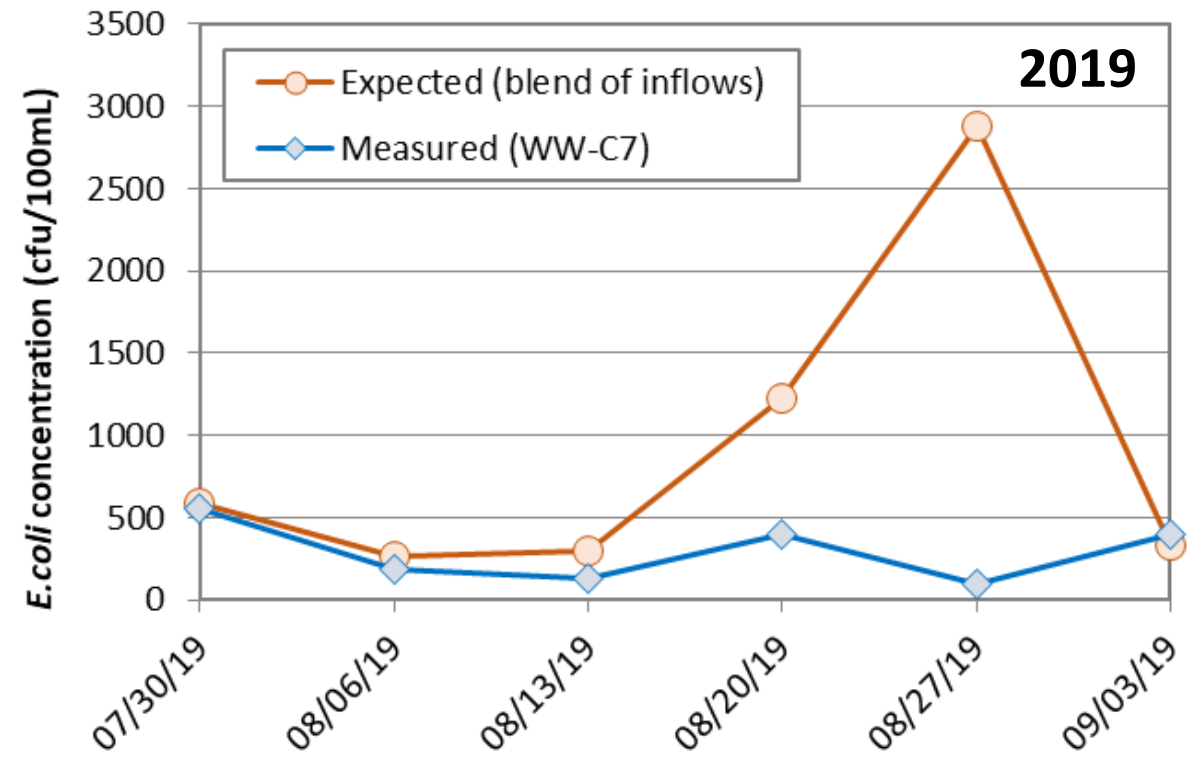
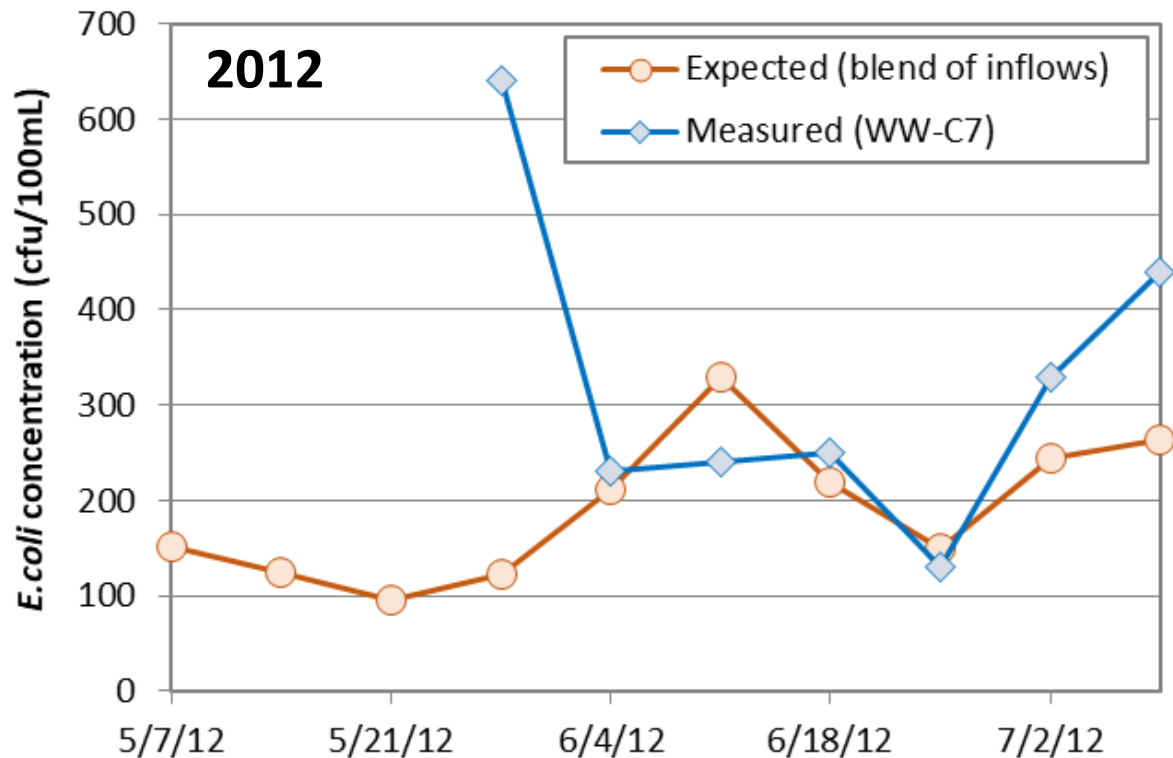
WEEKLY BALANCE – SANTA ANA RIVER AT PEDLEY AVENUE

- Results suggest persistent non-MS4 source of *E. coli*
- Similar blend of inflows between 2012 and 2019 despite 50% decline in effluent



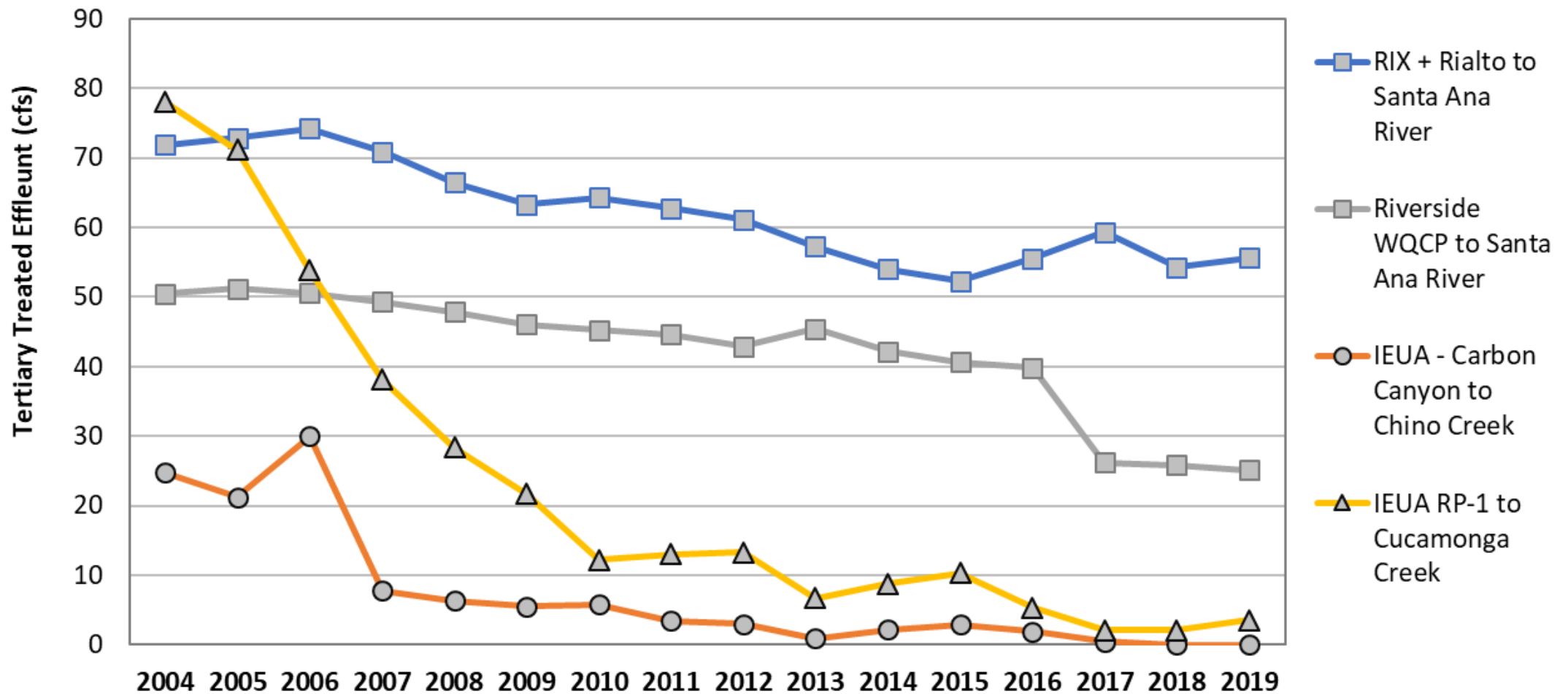
WEEKLY BALANCE – CHINO CREEK

- Chino Creek results suggest a net decay from inflows to downstream (i.e., non-MS4 sources may be negligible)
- Measured concentration at WW-C7 close to 2012 levels, but higher than expected bacteria from blend of inflows with zero POTW effluent in 2019 dry season

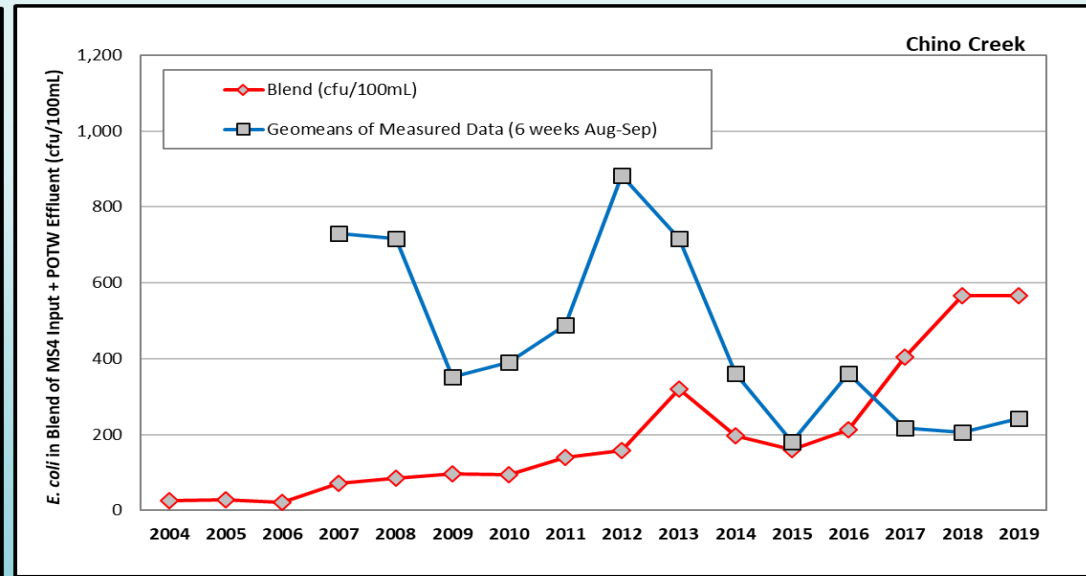
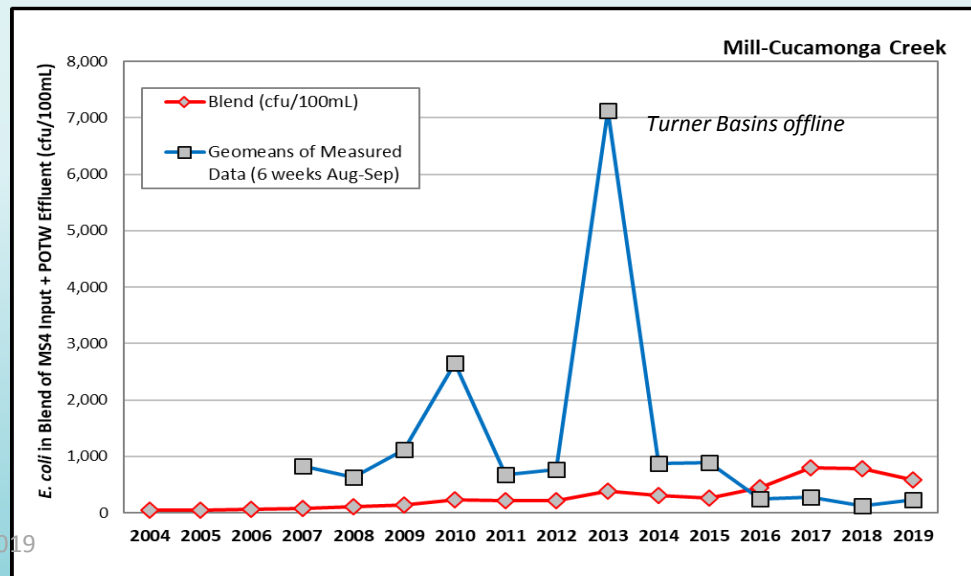
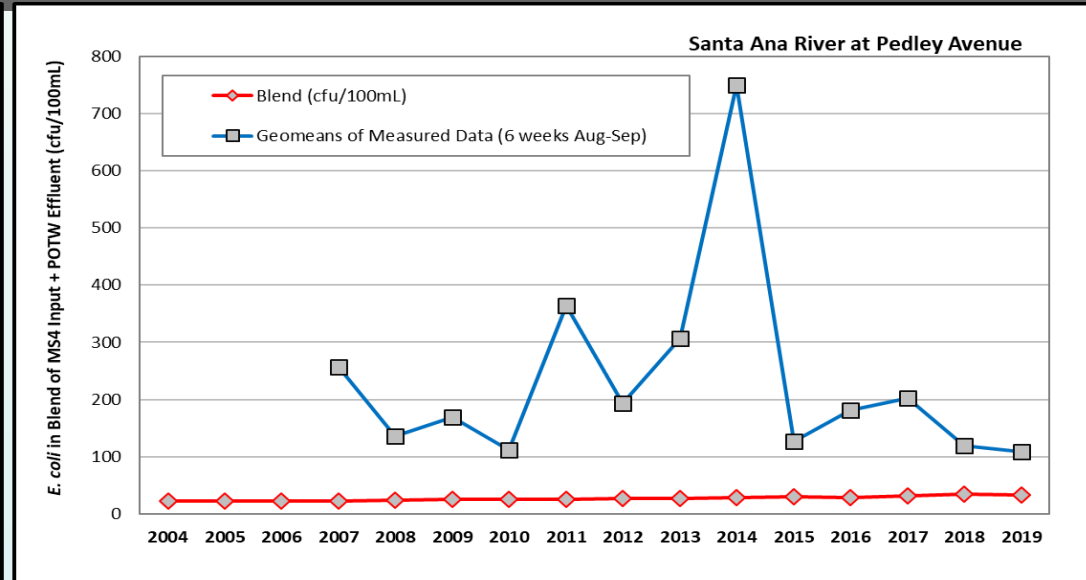
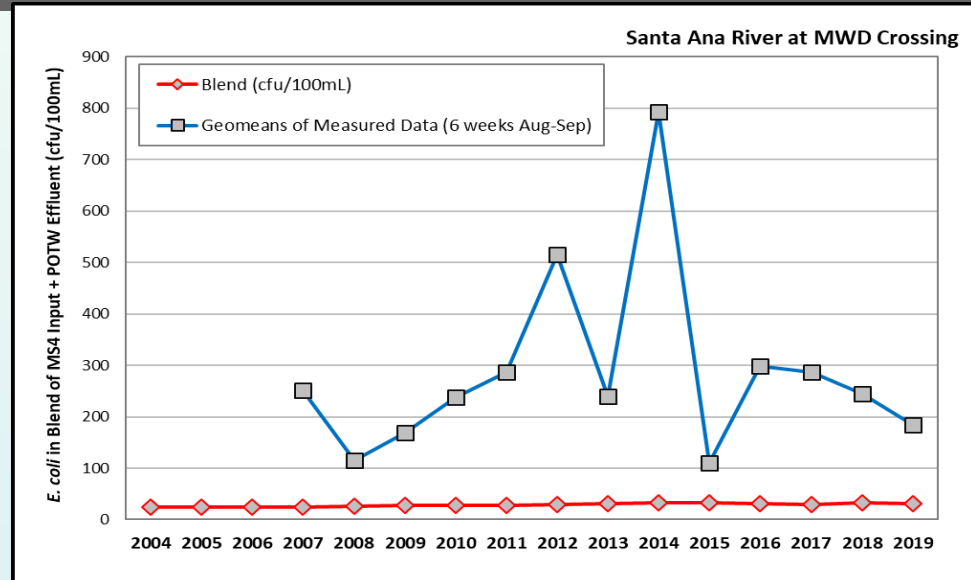


DECLINING POTW EFFLUENT DISCHARGES

- Challenge of declining POTW discharges



SOURCE CONTRIBUTION ANALYSIS FINDINGS



PRELIMINARY RESULTS

- Santa Ana River Findings



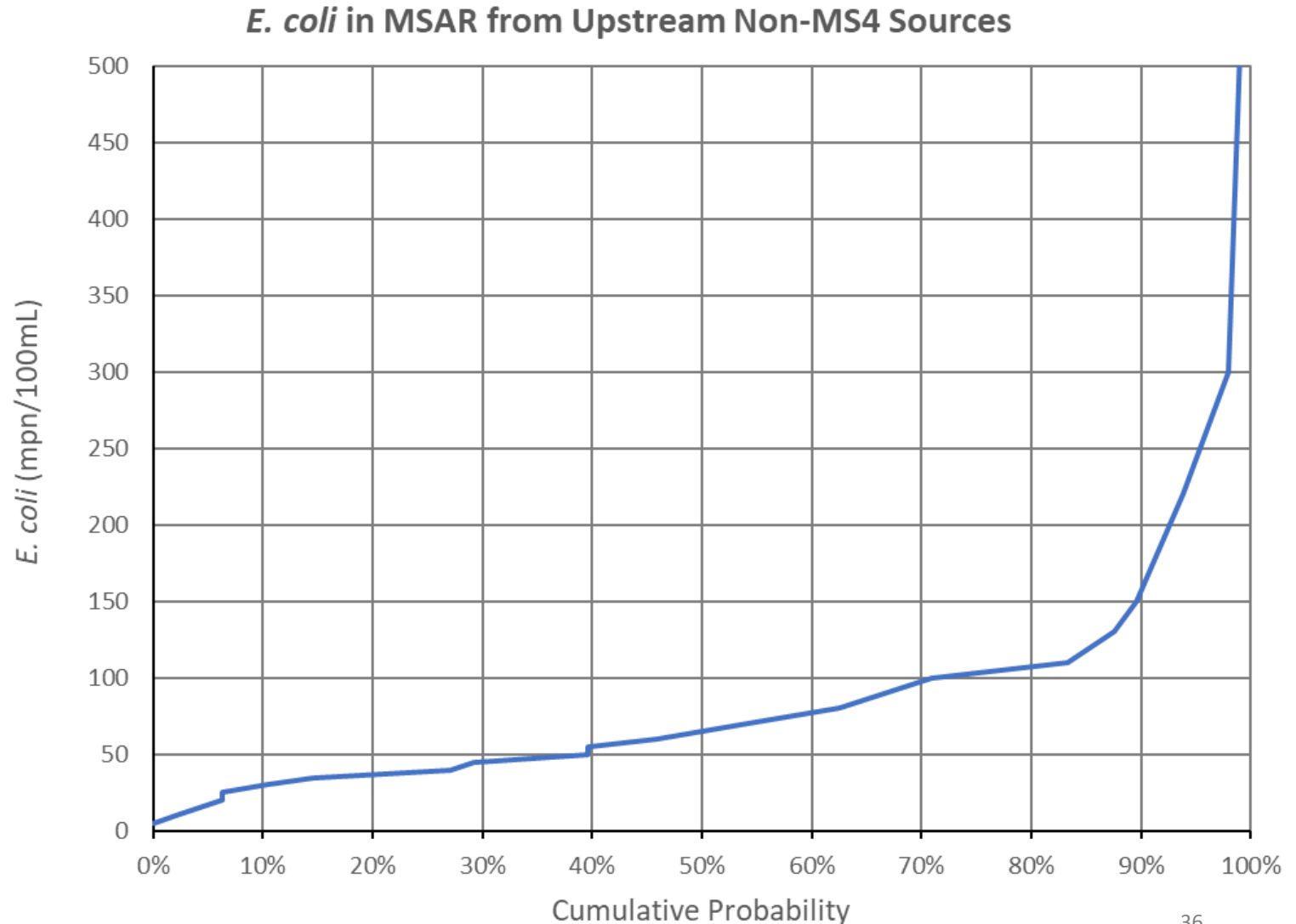
ROLE OF NON-MS4 SOURCES

- Unique opportunity in Santa Ana River Reach 4 to quantify non-MS4 *E. coli* sources to MSAR during dry weather
- Two sites sampled upstream of any MS4 contributions



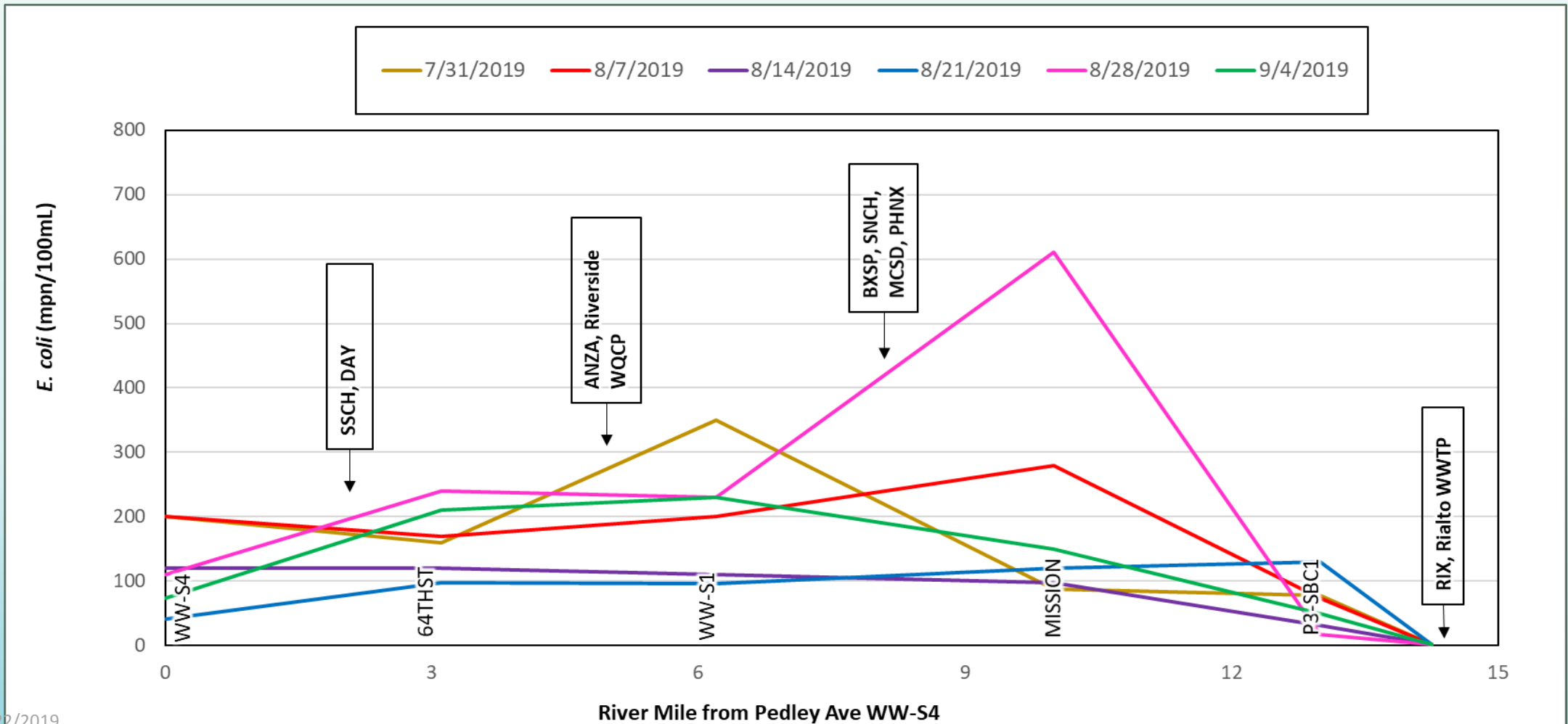
ROLE OF NON-MS4 SOURCES

- Unique opportunity in Santa Ana River Reach 4 to quantify contribution of non-MS4 *E. coli* sources to MSAR during dry weather conditions
- Median load to Mission Bridge site ~200 billion MPN/day
- Median total MS4 load to entire MSAR ~100 billion MPN/day



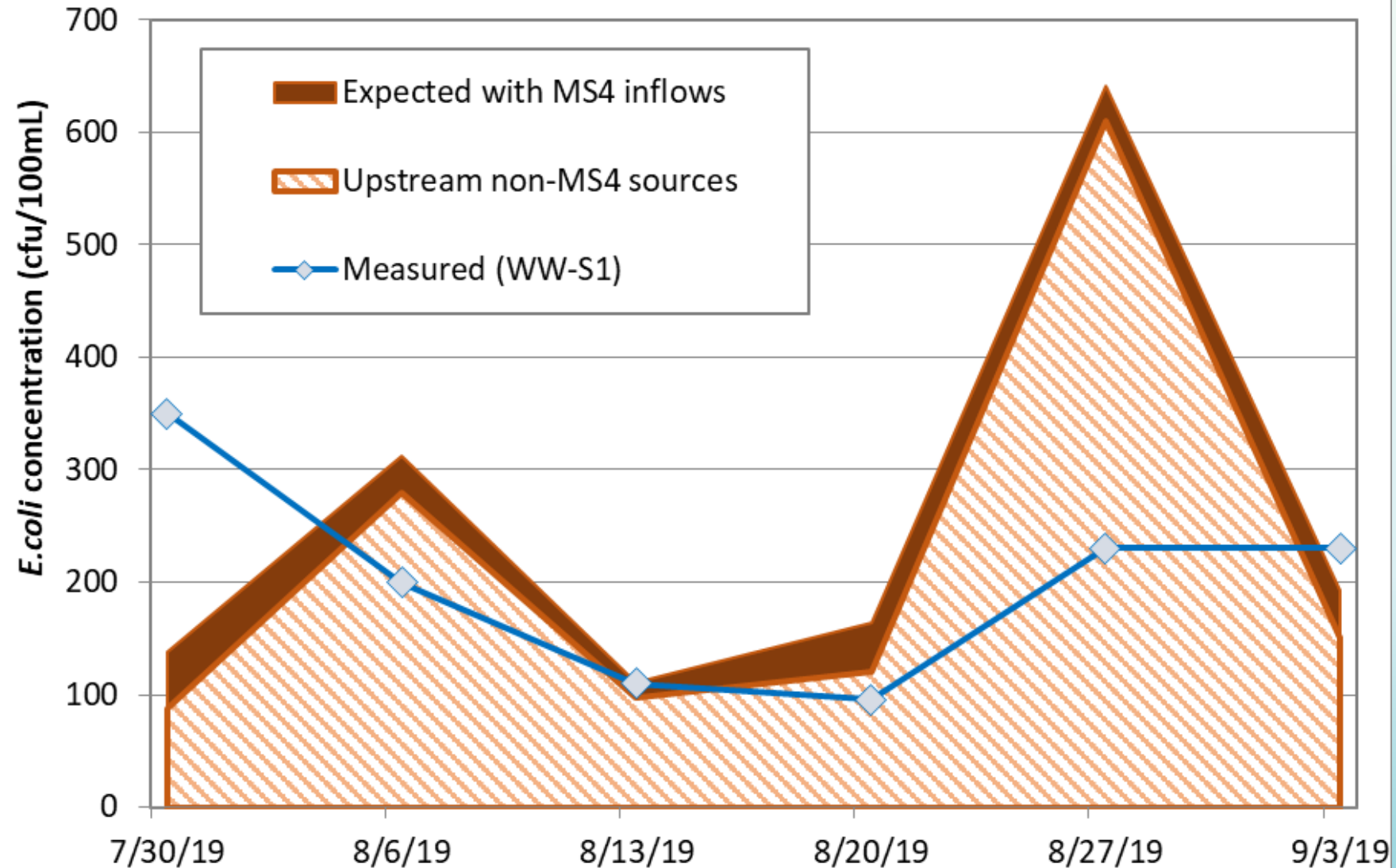
DEMONSTRATION THROUGH LONGITUDINAL PROFILES

- What role do non-MS4 sources (abv. Mission Avenue) play in expected blend of inflow calculation?



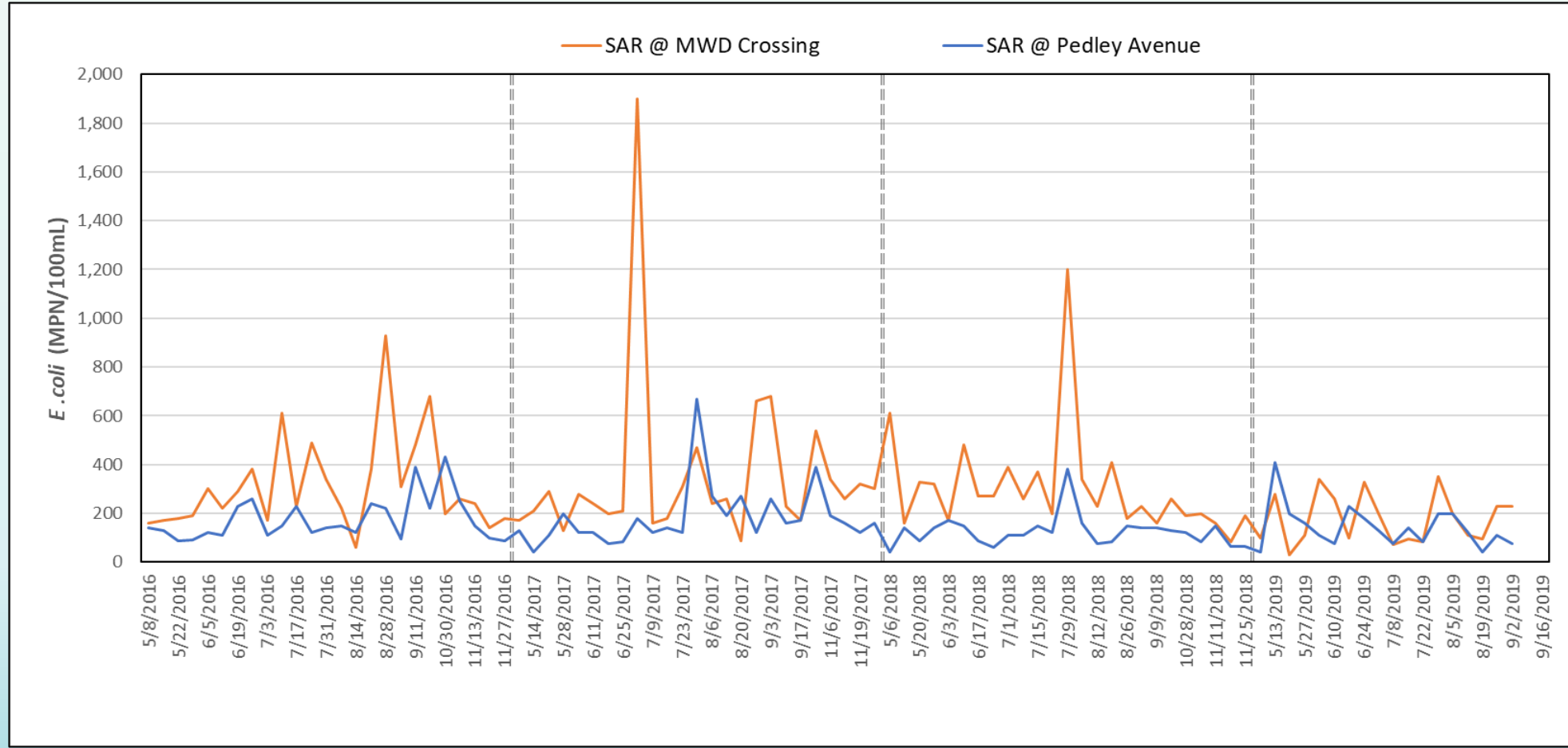
WEEKLY BALANCE – SANTA ANA RIVER AT MWD CROSSING

- River water quality is insensitive to temporal variability in MS4 loads



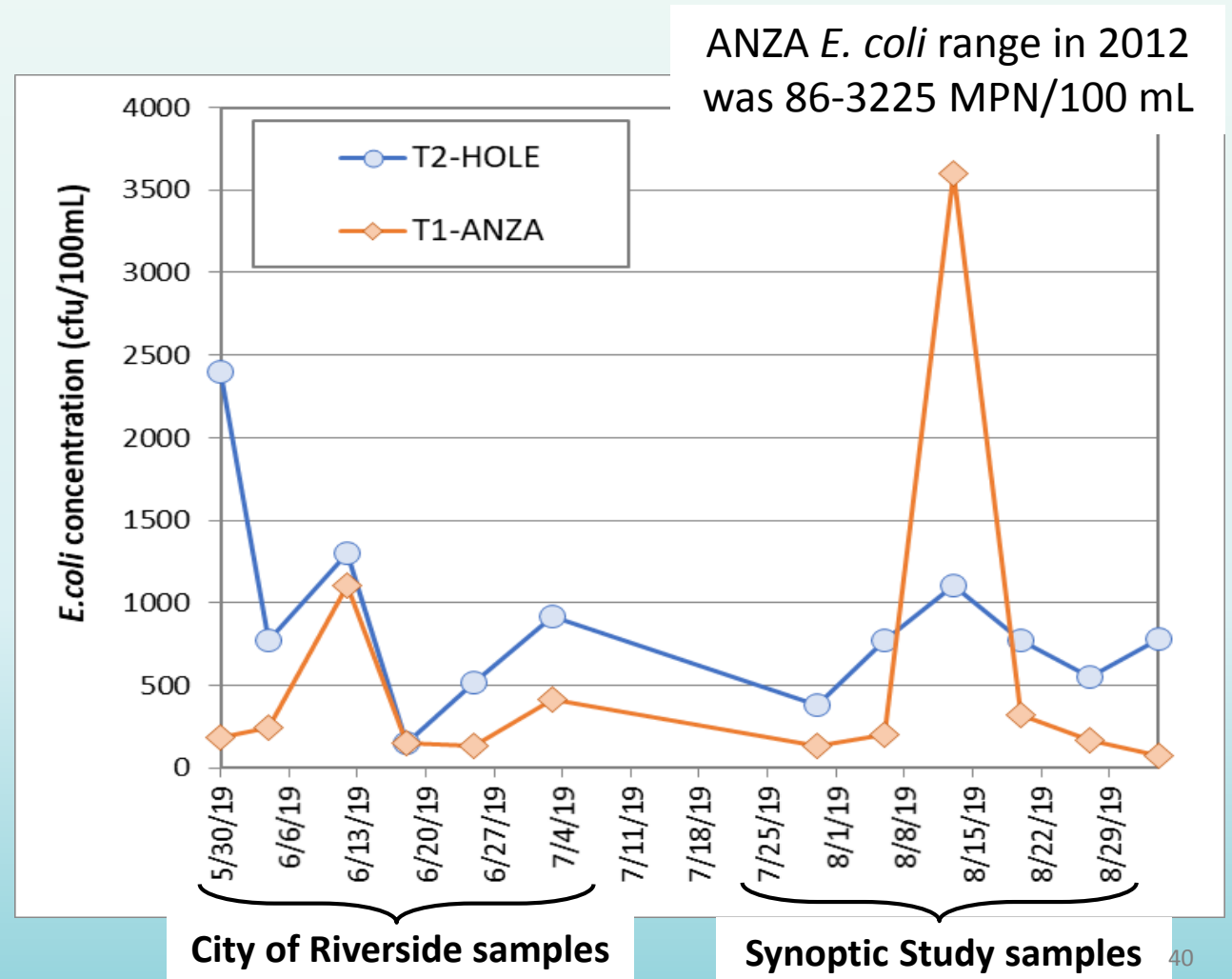
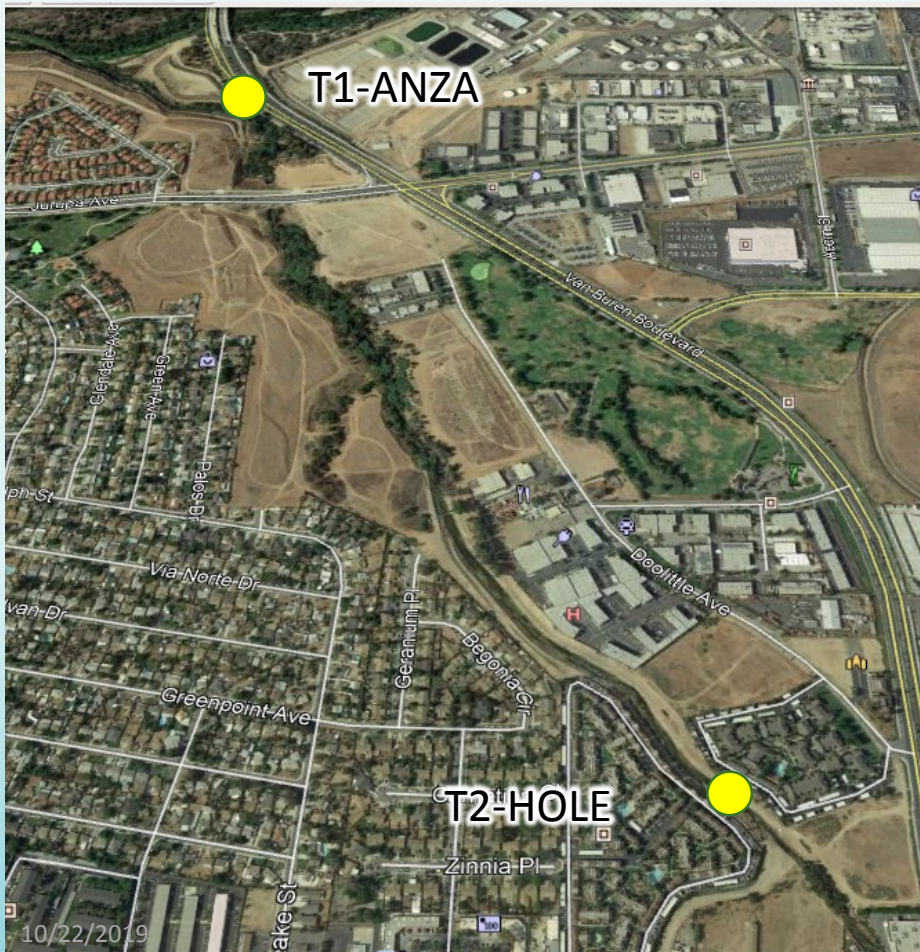
CHANGES BETWEEN MWD CROSSING AND PEDLEY AVENUE COMPLIANCE SITES

- Downstream site generally lower *E. coli* concentration
- Riverside Regional WQCP effluent dilution effect greater than influence of new MS4 inflows and non-MS4 sources



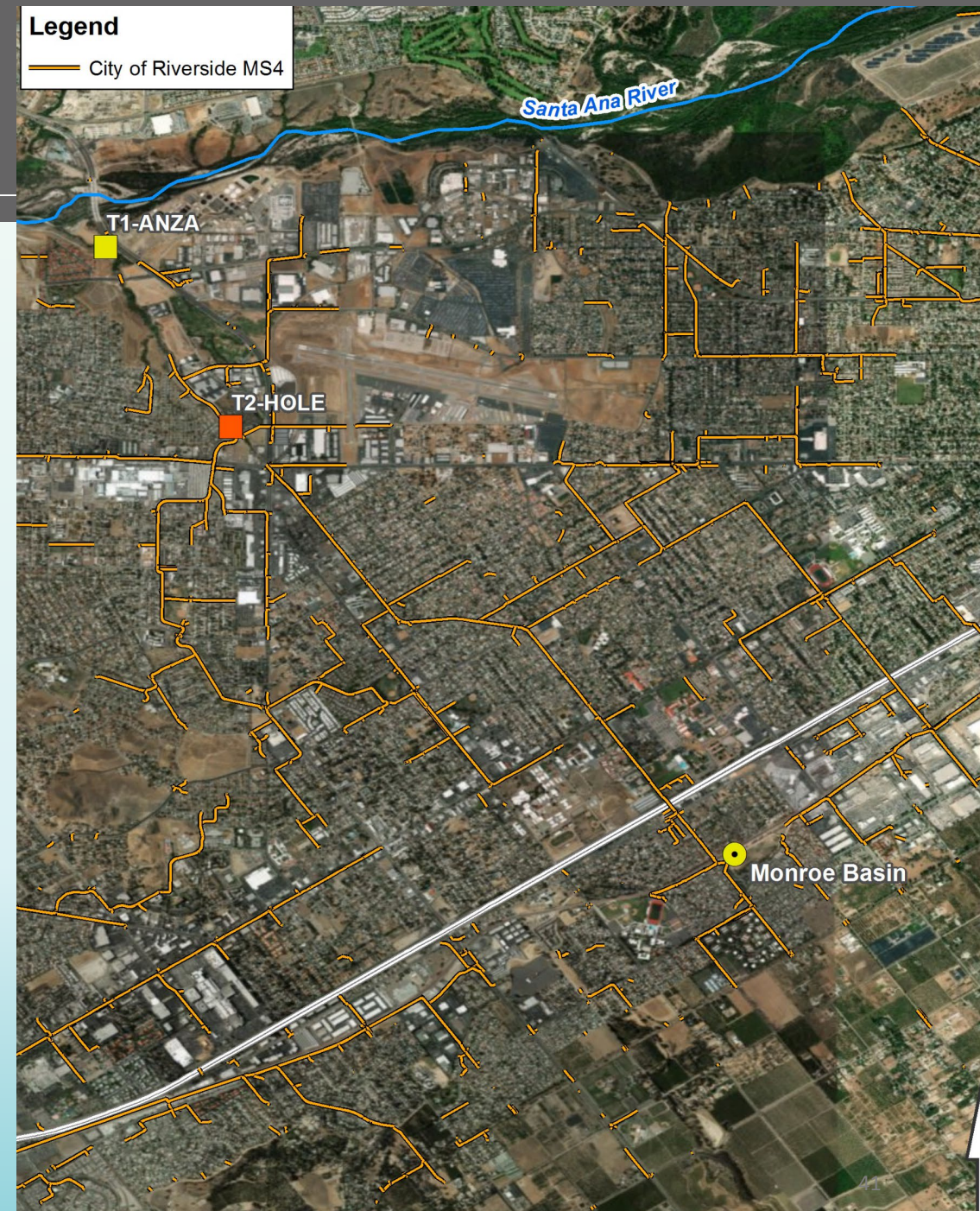
ANZA DRAIN SUBWATERSHED - TIER 2 RESULTS

- Samples upstream of Hole Lake generally higher than downstream (homeless encampment cleanup on 8/21/19)



ANZA DRAIN SUBWATERSHED - TIER 2 RESULTS

- Monroe Basin outflow *E.coli* load ~12 billion MPN/day (Arlington Greenbelt Study 2018)
- *E.coli* load ~7 billion MPN/day estimated at Tier 1 site ANZA Drain (2019)
- Flow from Arlington Greenbelt is important to Anza loads



PRELIMINARY RESULTS

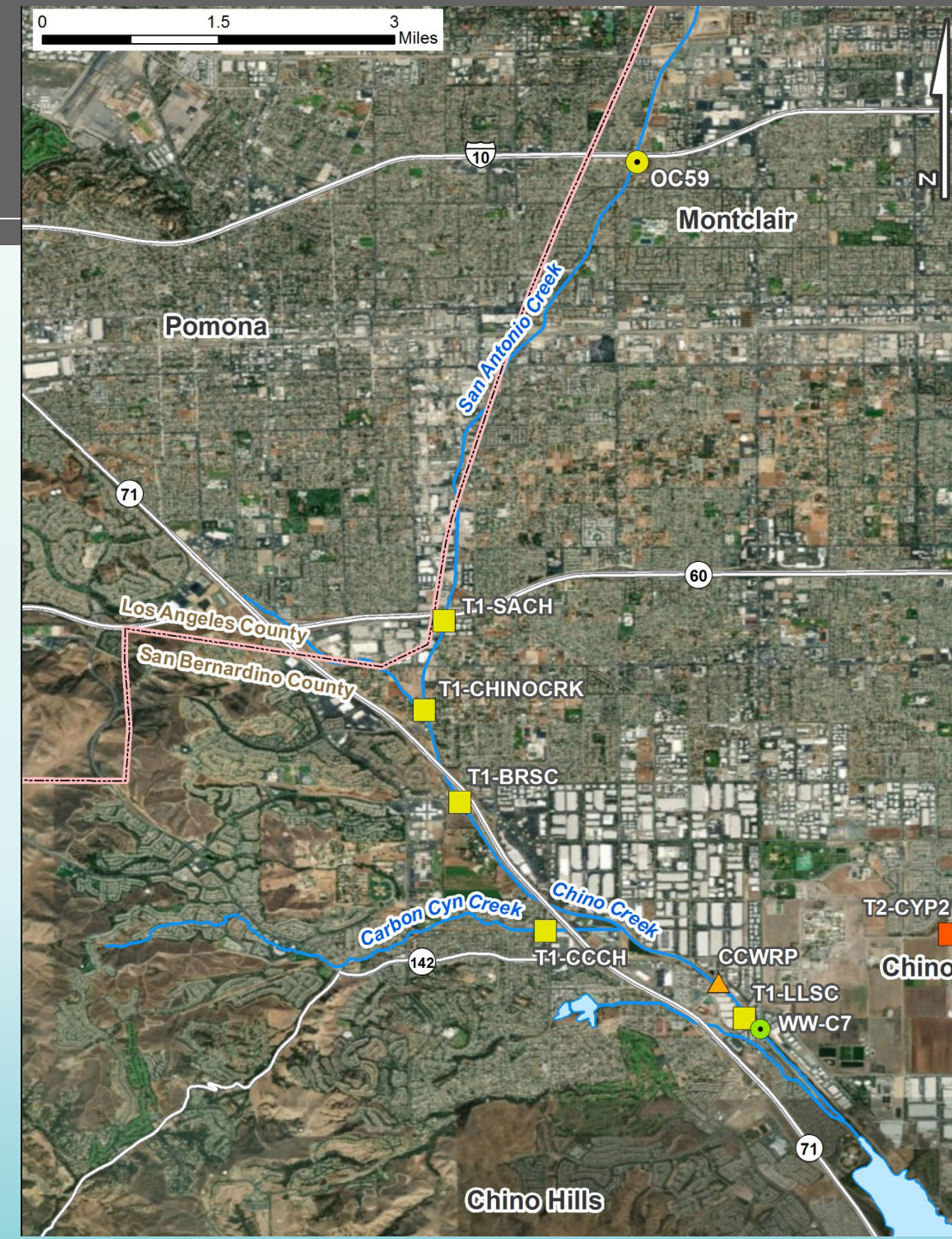
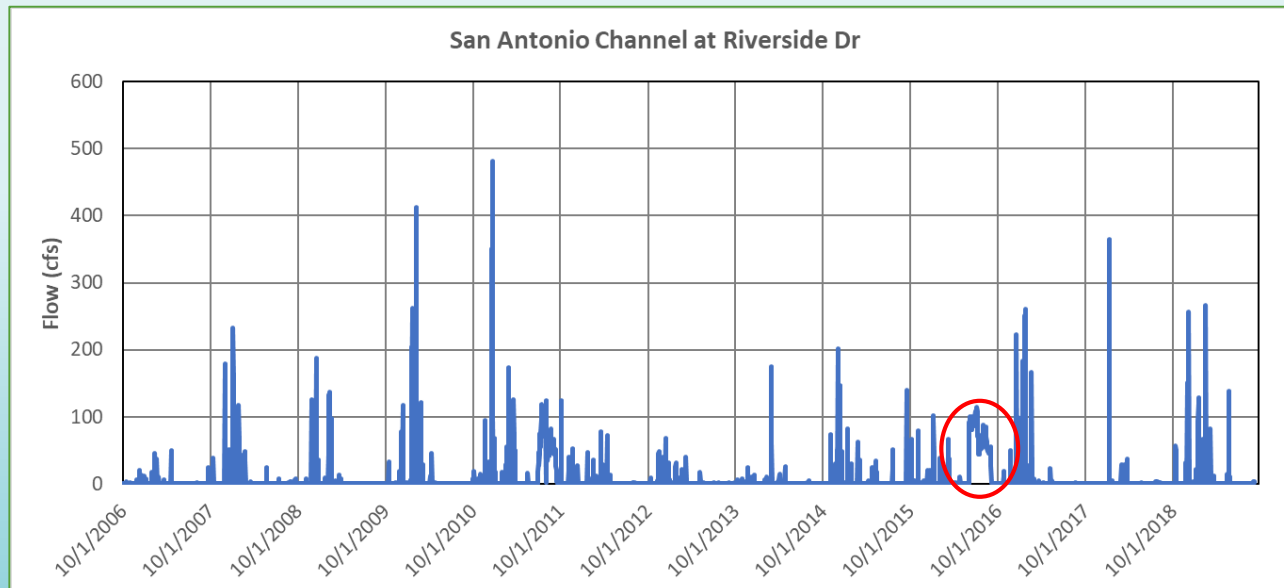
- Chino Creek Findings



CHANNEL RESUSPENSION IS A KEY FACTOR

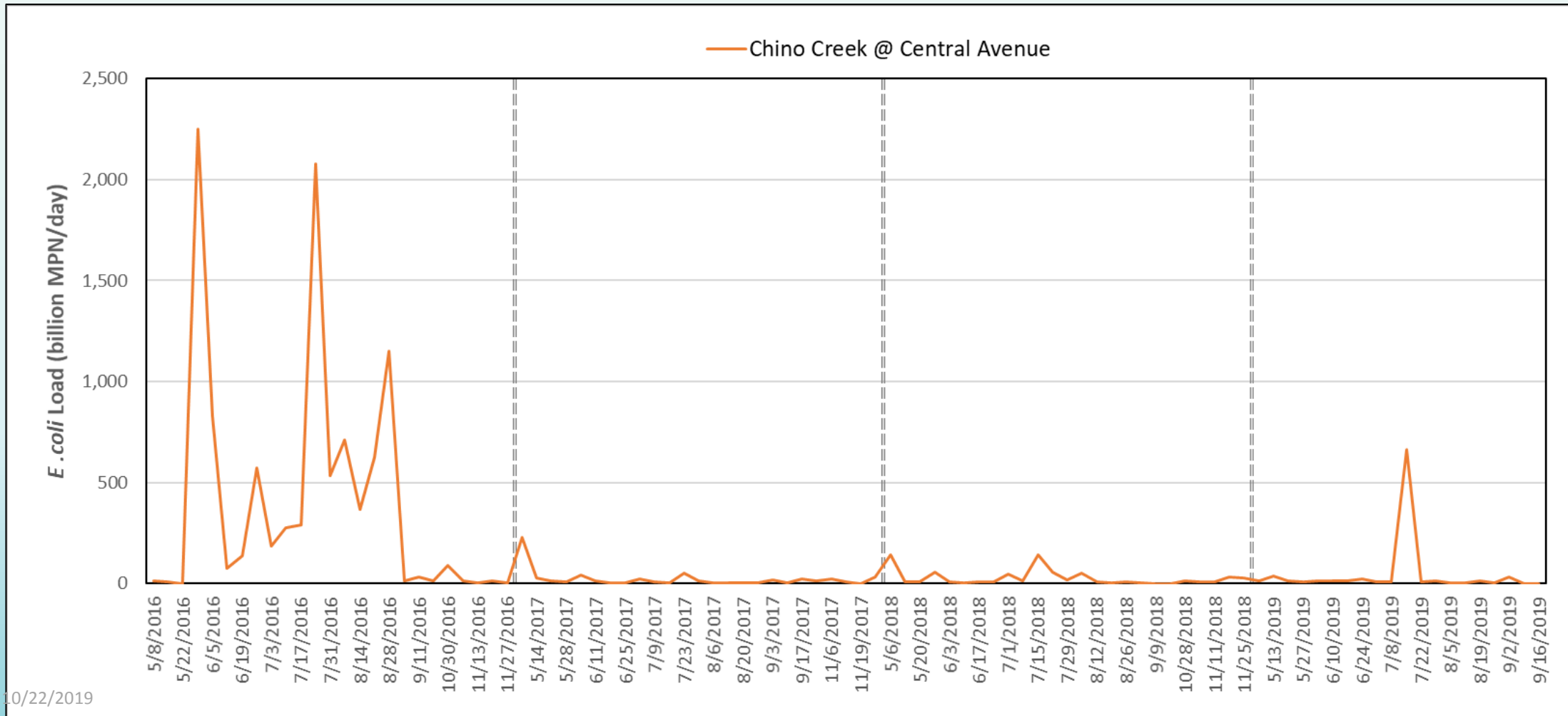
- San Bernardino County Flood Control District special study conducted in 2016 during Metropolitan Water District water turnout

Type	Period	Volume (AF)	Average Flow (cfs)
MWD turnout at OC59	6/1/16 - 9/1/16	12,780	73



CHANNEL RESUSPENSION IS A KEY FACTOR

- Revisit 2016 dry season longitudinal survey during MWD turnout



CHANNEL RESUSPENSION IS A KEY FACTOR

- Mass balance for average conditions in July to September 2016 during MWD turnout in San Antonio Channel (T1-SACH)
- 95% of load unaccounted for



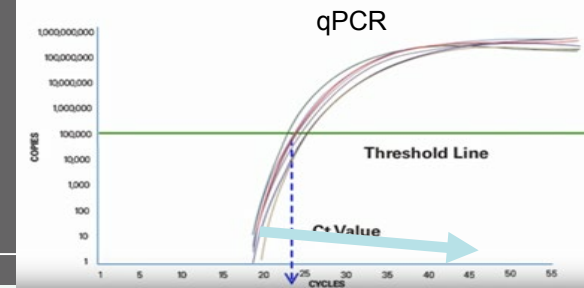
Site	Flow (cfs)	Concentration (MPN/100 mL)	Load (Billion MPN/day)
Downstream			
WW-C7	66.8	298	487.6
Inflows			
OC59	73.4	2	3.6
SACH	73.4	9	16.6
CHINOCRK	0.5	256	3.3
BRSC	0.1	1205	3.8
CCCH	0.5	65	0.7
LLSC	0.003	522	0.03
Other non-MS4 source (btw SACH and WW-C7)			463.0

MSAR SYNOPSIS STUDY

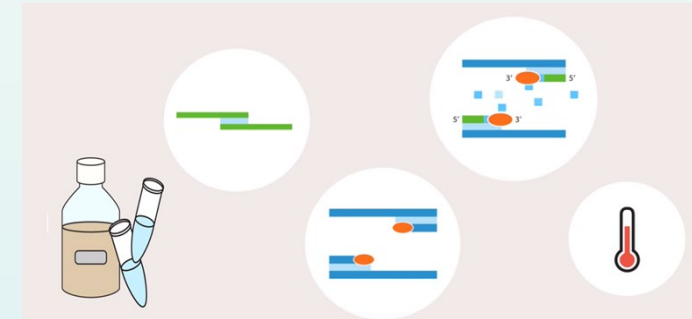
- *Bacteroides* Analysis



BACTEROIDES ANALYSIS USING QPCR



- Orange County Public Health Laboratory (OCPHL) to perform qPCR testing for *Bacteroides*, HF183 Human marker (EPA method 1696)
- OCPHL Update
 - Approximately, 174 grab water samples have been filtered by OCPHL
 - For greater resolution & sensitivity, 200+ mL of water filtered
 - Filters are stored frozen
 - DNA extraction & qPCR analysis is underway
 - All controls & standards are run with each sample
- qPCR Data
 - Results will be provided as Non-Detect/Detect; positive samples will determine DNA copy number/reaction that will be converted to DNA copy number/200 mL (or per filtered volume)
 - Any samples with uncertainty can be re-run using qPCR/droplet digital PCR (ddPCR)



BACTEROIDES - QPCR PRELIMINARY RESULTS FOR WEEK OF JULY 29

Site Category	Site ID	Site Description	Result (DL=10 copies/2 µL)	Quantity (DNA copies/reaction)
Compliance Sites	WW-C7	Chino Creek at Central Ave	ND	--
	WW-M6	Mill-Cucamonga Creek	ND	--
	WW-S1	SAR at Pedley Avenue	ND	--
	WW-S4	SAR at MWD Crossing	ND	--
Mainstem SAR	64THST	SAR at 64th St	ND	1.08
	MISSION	SAR at Mission Blvd	ND	--
	P3-SBC1	SAR Reach 4 abv S. Riverside Ave Bridge	ND	--
POTW	CCWRP	IEUA Carbon Canyon Water Recycling Plant effluent	ND	--
	Rialto WWTP	Rialto WWTP effluent	ND	--
	Riverside RWQCP	Riverside Regional Water Quality Control Plant effluent	ND	--
	RIX	Rapid Infiltration and Extraction Facility effluent	ND	--
	RP-1	IEUA Regional Water Recycling Plant No. 1 effluent	ND	--

BACTEROIDES - QPCR PRELIMINARY RESULTS FOR WEEK OF JULY 29

Site Category	Site ID	Site Description	Result (DL=10 copies/2 µL)	Quantity (DNA copies/reaction)
Tier 1	T1-ANZA	Anza Drain	ND	--
	T1-BRSC	Boys Republic South Channel	ND	1.2
	T1-BXSP	Box Springs Channel	ND	8.07
	T1-CCCH	Carbon Canyon Creek Channel	ND	--
	T1-CHINOCRK	Chino Creek upstream of San Antonio Channel	ND	3.77
	T1-CUCAMONGA	Cucamonga Creek at Hellman	ND	--
	T1-CYP	Cypress Channel	Dry	--
	T1-DAY	Day Creek	ND	--
	T1-LLSC	Lake Los Serranos Channel	ND	--
	T1-MCSD	Magnolia Center Storm Drain	Detected	279.19
	T1-PHNX	Phoenix Storm Drain	ND	--
	T1-SACH	San Antonio Channel	ND	--
	T1-SNCH	Sunnyslope Channel	ND	5.63
	T1-SSCH	San Sevaine Channel	ND	--
Tier 2	T2-CYP2	Cypress Channel upstream of CIM's ag fields	ND	--
	T2-HOLE	Anza Drain upstream of Hole Lake	ND	--

MSAR SYNOPSIS STUDY

- Next Steps



SYNOPTIC STUDY REPORT PREPARATION

Study Plan Schedule

- Continue to receive/review *Bacteroides* data (remainder expected by end of October)
- Complete all data analyses
- Prepare draft TMDL Triennial Report for Task Force review

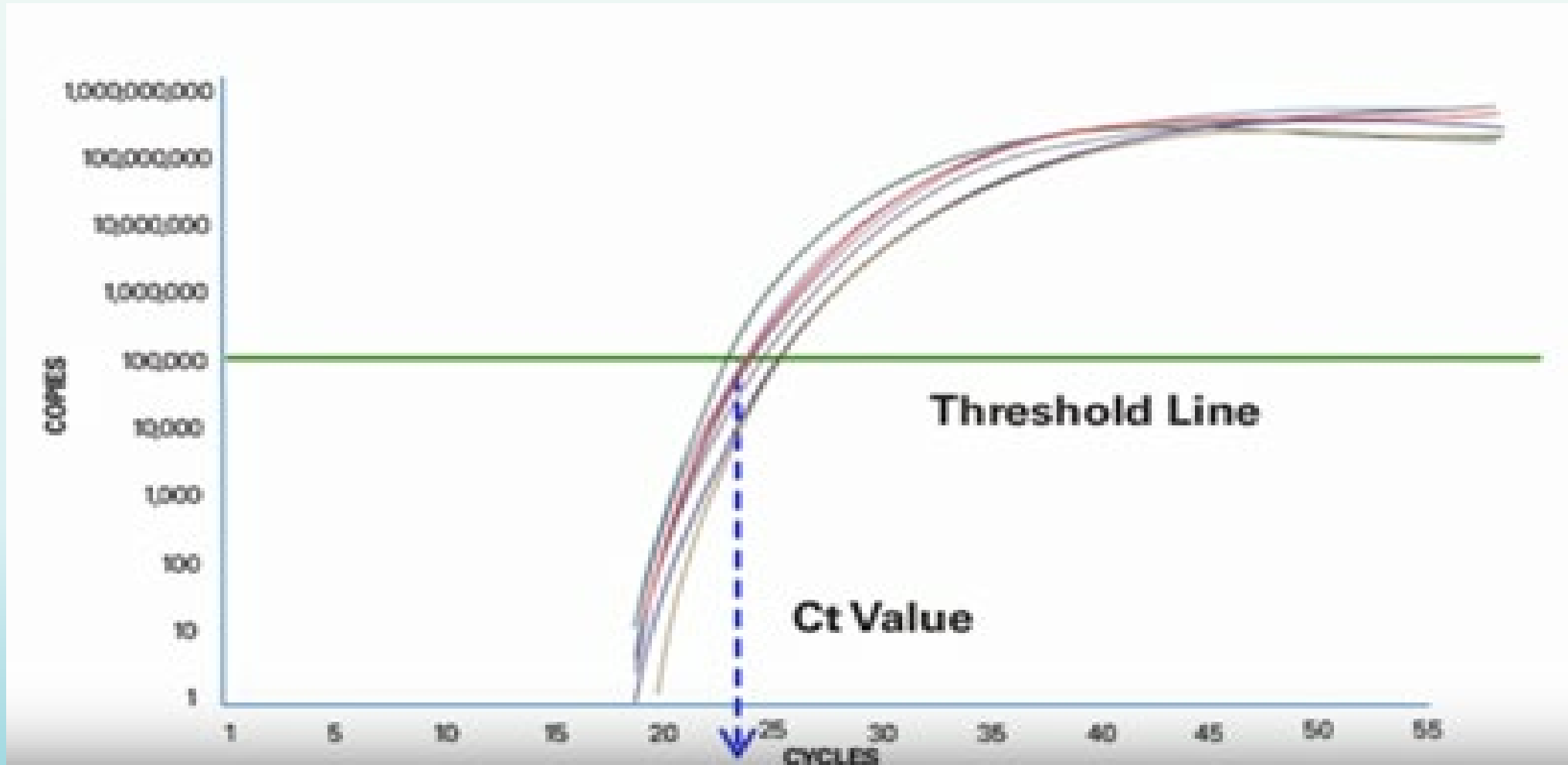
Task	Complete By
Final Study Plan, QAPP and Final Cost Estimates	July 15, 2019
Data Collection	Week of July 29 through the week of September 2, 2019
Progress Report with Presentation to Task Force	October 15, 2019
Draft TMDL Triennial Report	November 15, 2019
Final TMDL Triennial Report	January 15, 2020
Submit Final Report to Santa Ana Water Board	February 15, 2020

A wide river flows through a lush green landscape. The banks are covered in dense vegetation, including tall grasses and shrubs. The water is a murky brown color, and the sky is a clear, bright blue. The word "Discussion" is overlaid in the center of the image.

Discussion

2019. 8. 21 11:47

QPCR EXPLANATION



QPCR EXPLANATION

