



# UPDATE ON DISSOLVED OXYGEN MODELING OF UPPER OYSTER CREEK

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# Topics to be covered:

## **Study Area**

Modeling Area

## **Background**

Purpose of Modeling

## **Modeling System**

LSPC, WASP

## **Flow verification, Calibration, Validation**

Flow, Water temperature, Water Quality parameters  
(ISS, CBOD, NH4-N, NO3-N, Org\_N, Total\_N,  
Total\_P, PO4\_P, Org\_P, Chlo A, and DO)

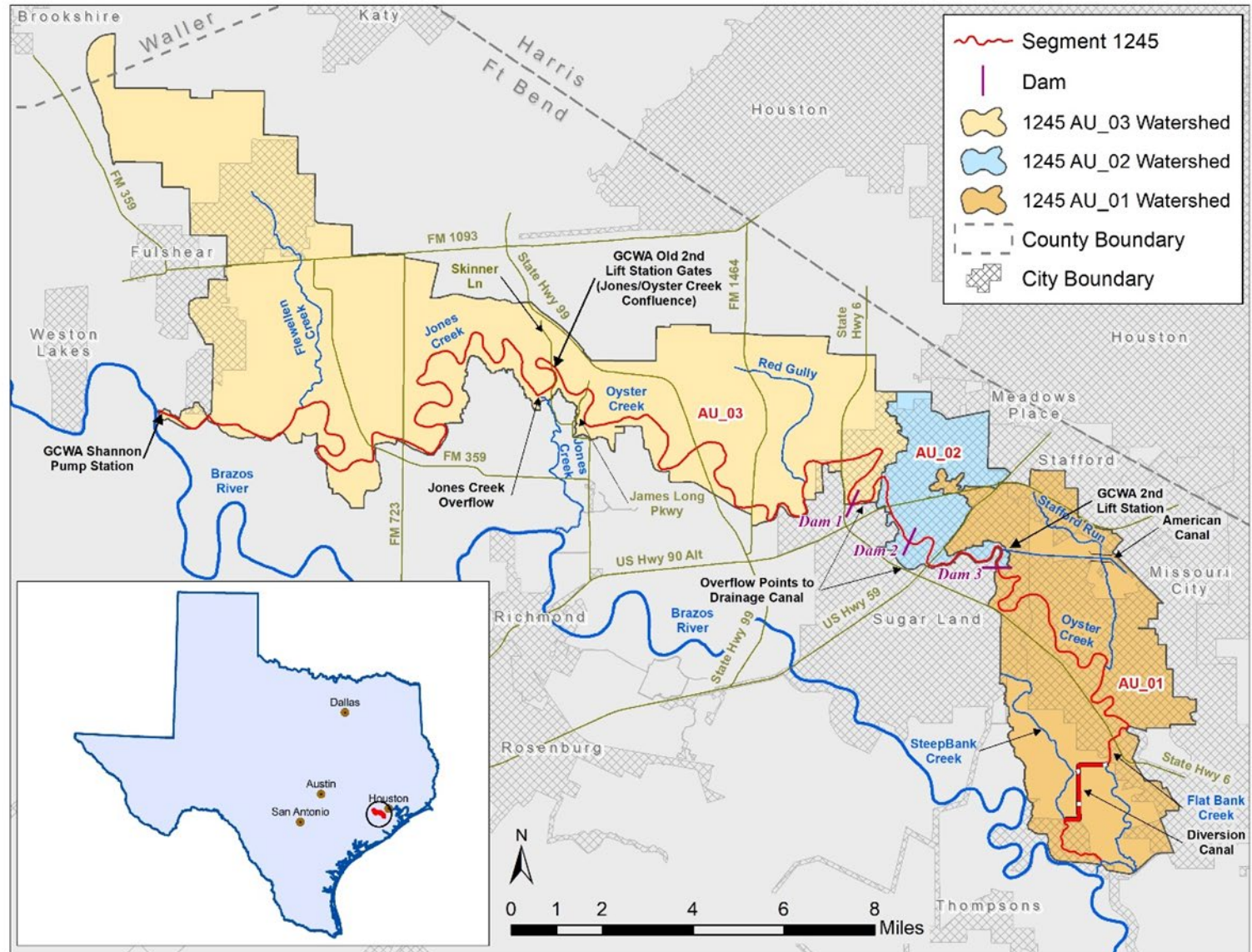
## **Project status**

Timeline



# Study Area

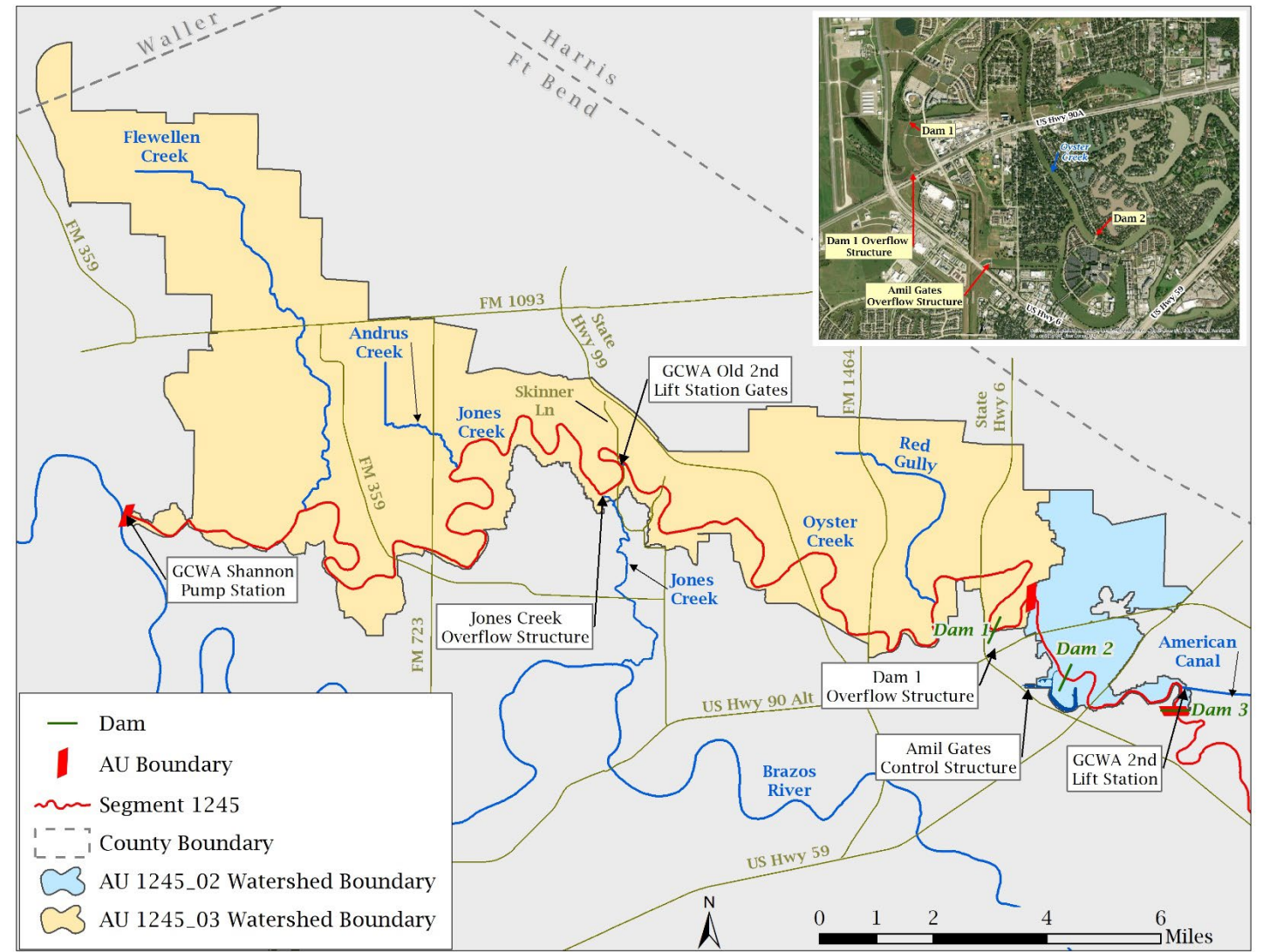
Upper Oyster Creek includes,  
Portion of Jones Creek  
Oyster Creek  
Flatt Bank Creek  
Flatt Bank Creek Diversion  
Canal  
Steep Bank Creek  
AU 1245\_03 and AU 1245\_02





# Control Structures on UOC

- Three Dams
- Control Gates – GCWA Old Second Lift Station
- Jones Creek Overflow Control Structure
- Amil Gates





# TMDL

## Total Maximum Daily Load

- Determines the maximum amount (load) of pollutant that a water body can receive and still keep water quality standards
- Allocates this load to broad categories of sources in the watershed
- Adopted by the TCEQ; Approved by the EPA

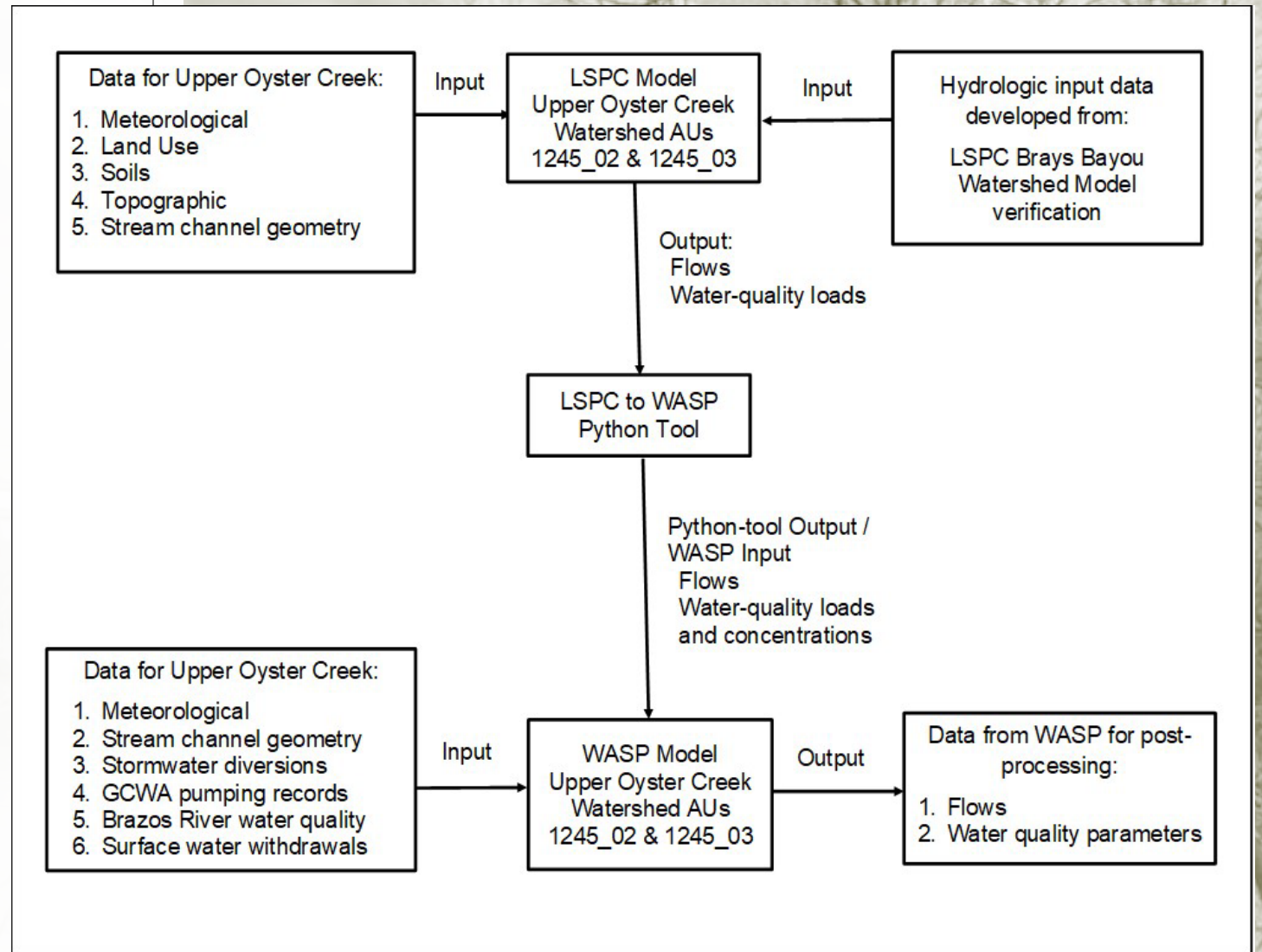


How much is too much?



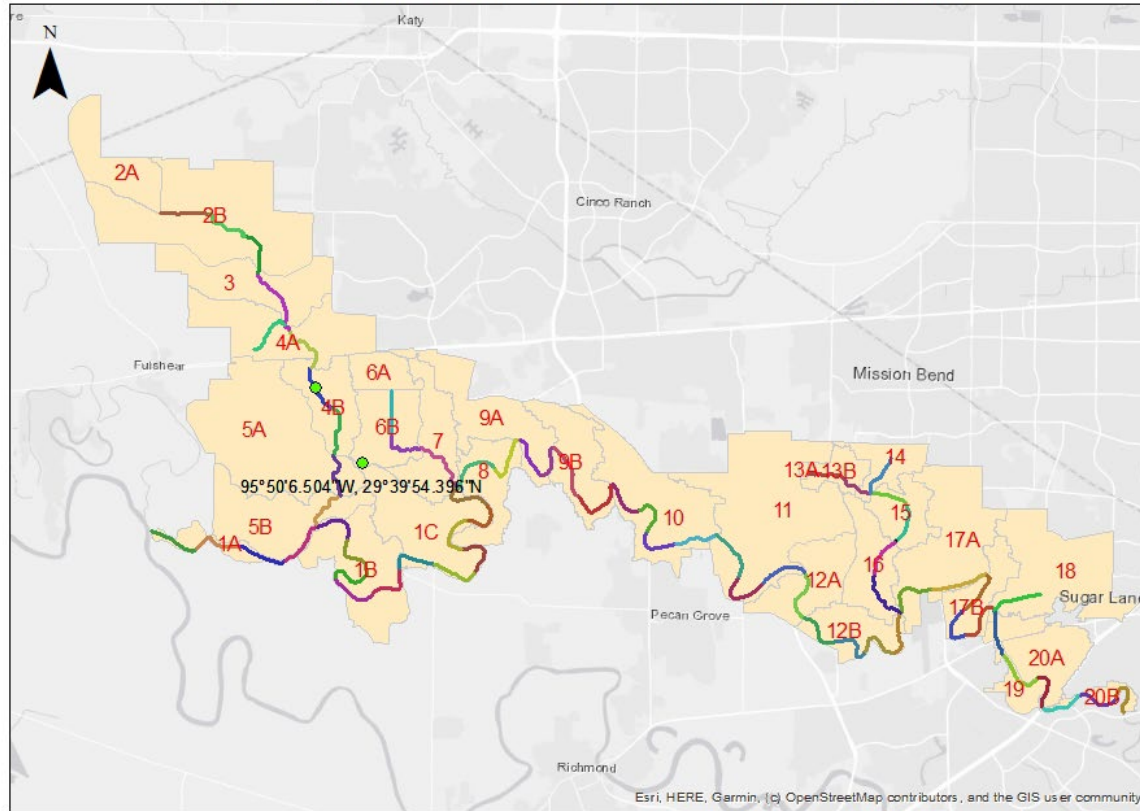
# Modeling System

- Hydrologic Simulation Program FORTRAN (HSPF)
- Loading Simulation Program in C++ (LSPC) – Watershed Model
- Water Quality Analysis Simulation Program (WASP) – Water Quality Model



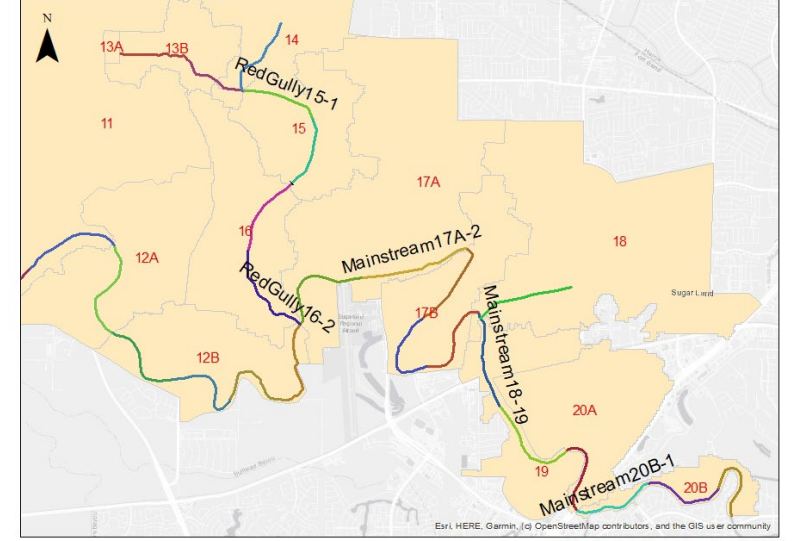
# WASP - Segmentation

Upper Oyster Creek - Subbasins and Segments



Author: Cynthuja Partheeban, June 29 2023

Upper Oyster Creek - Subbasins and Segments



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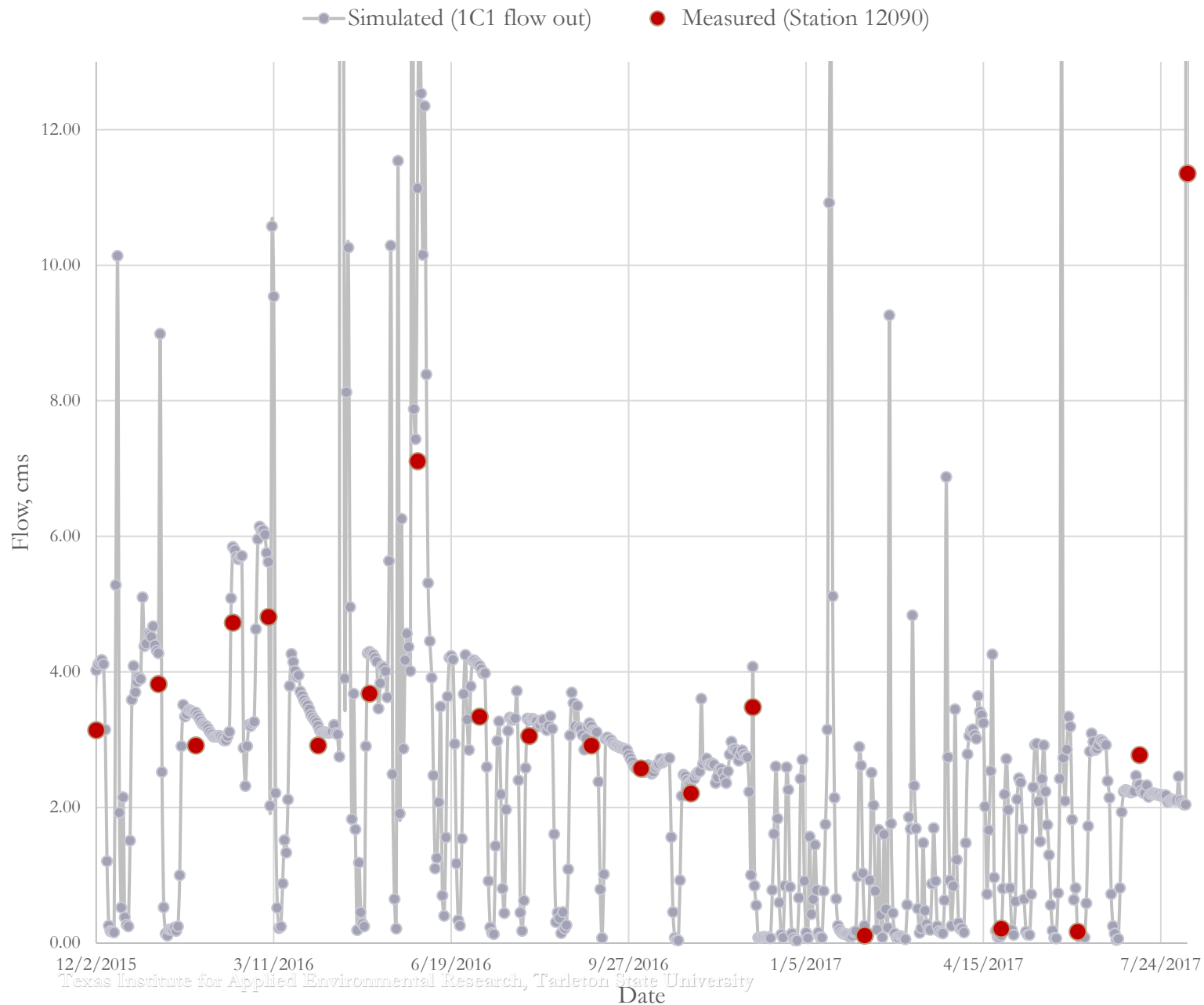
- **Segments - 65**
  - Upper Oyster Creek – Mainstream – 45 segments (44 main and 1 tributary)
  - Flewellen Creek – 9 segments (8 main and 1 tributary)
  - Andrus Creek – 3 segments
  - Red Gully - 7 (6 main and 1 tributary)
- **Average length 1489 m**

Model State Variable Activation

	System Type	System Name	Particulate Transport	Mass Balance	
1	PHYTO	Phytoplankton 3	Solids 1	<input type="checkbox"/>	1
2	PHYTO	Phytoplankton 2	Solids 1	<input type="checkbox"/>	1
3	PHYTO	Phytoplankton 1	Solids 1	<input type="checkbox"/>	1
4	SOLID	Clay (mg/l)	Solids 1	<input type="checkbox"/>	1
5	SOLID	Silt (mg/l)	Solids 1	<input type="checkbox"/>	1
6	SOLID	Sand (mg/l)	Solids 1	<input type="checkbox"/>	1
7	DET-P	Particulate Organic Phosphorus 1	Solids 1	<input type="checkbox"/>	1
8	DET-N	Particulate Organic Nitrogen 1	Solids 1	<input type="checkbox"/>	1
9	DET-C	Particulate Organic Carbon 1	Solids 1	<input type="checkbox"/>	1
10	DISOX	Dissolved Oxygen 1	Solids 1	<input type="checkbox"/>	1
11	CBODU	CBOD (ultimate) 1	Solids 1	<input type="checkbox"/>	1
12	ORG-P	Diss Organic Phosphorus 1	Solids 1	<input type="checkbox"/>	1
13	D-DIP	Inorganic Phosphorus 1	Solids 1	<input type="checkbox"/>	1
14	ORG-N	Diss Organic Nitrogen 1	Solids 1	<input type="checkbox"/>	1
15	NO3O2	Nitrate Nitrogen 1	Solids 1	<input type="checkbox"/>	1
16	NH-34	Ammonia Nitrogen 1	Solids 1	<input type="checkbox"/>	1
17	WTEMP	WTEMP	Solids 1	<input checked="" type="checkbox"/>	1

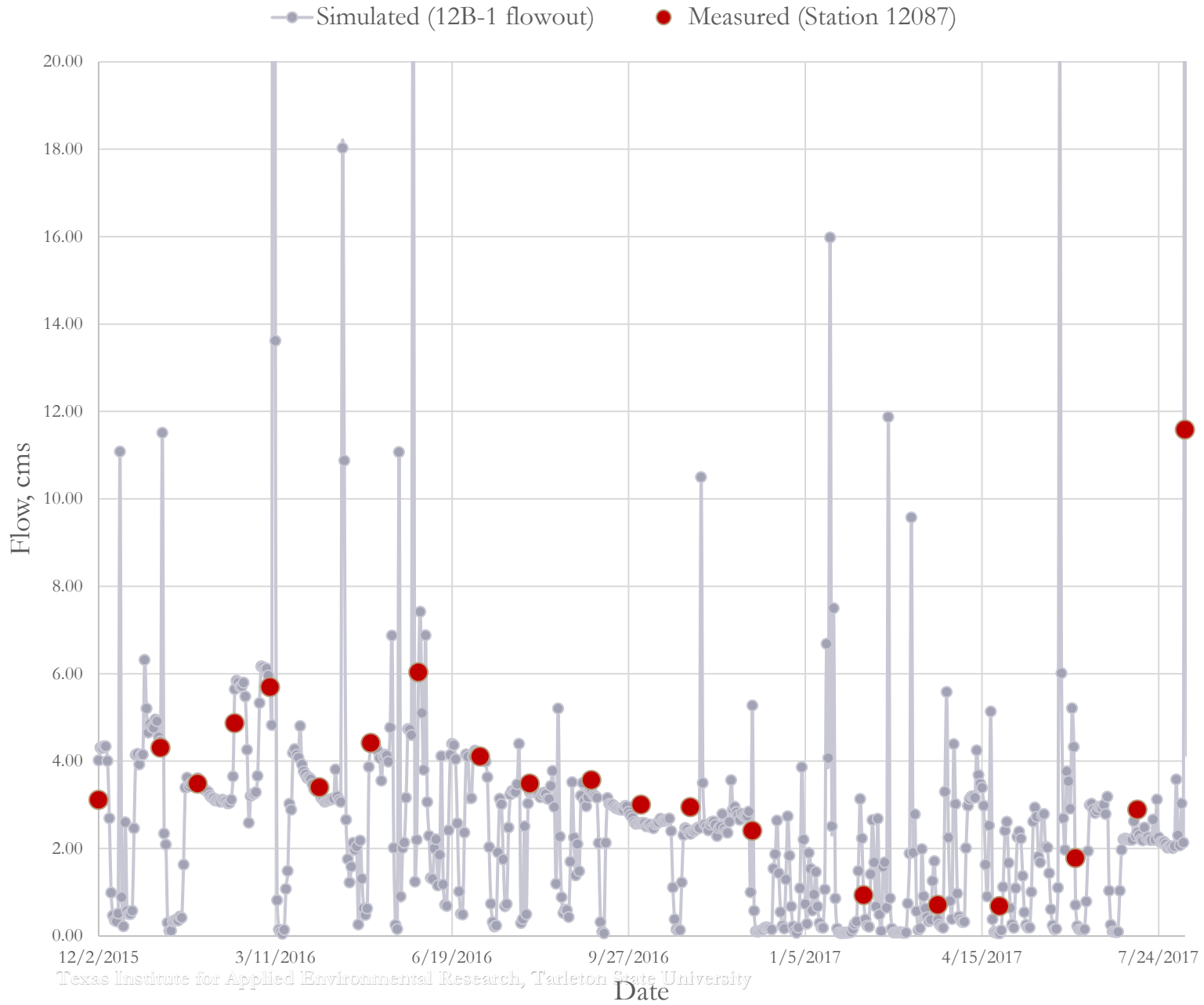
# WASP Model State Variables





# Flow Verification

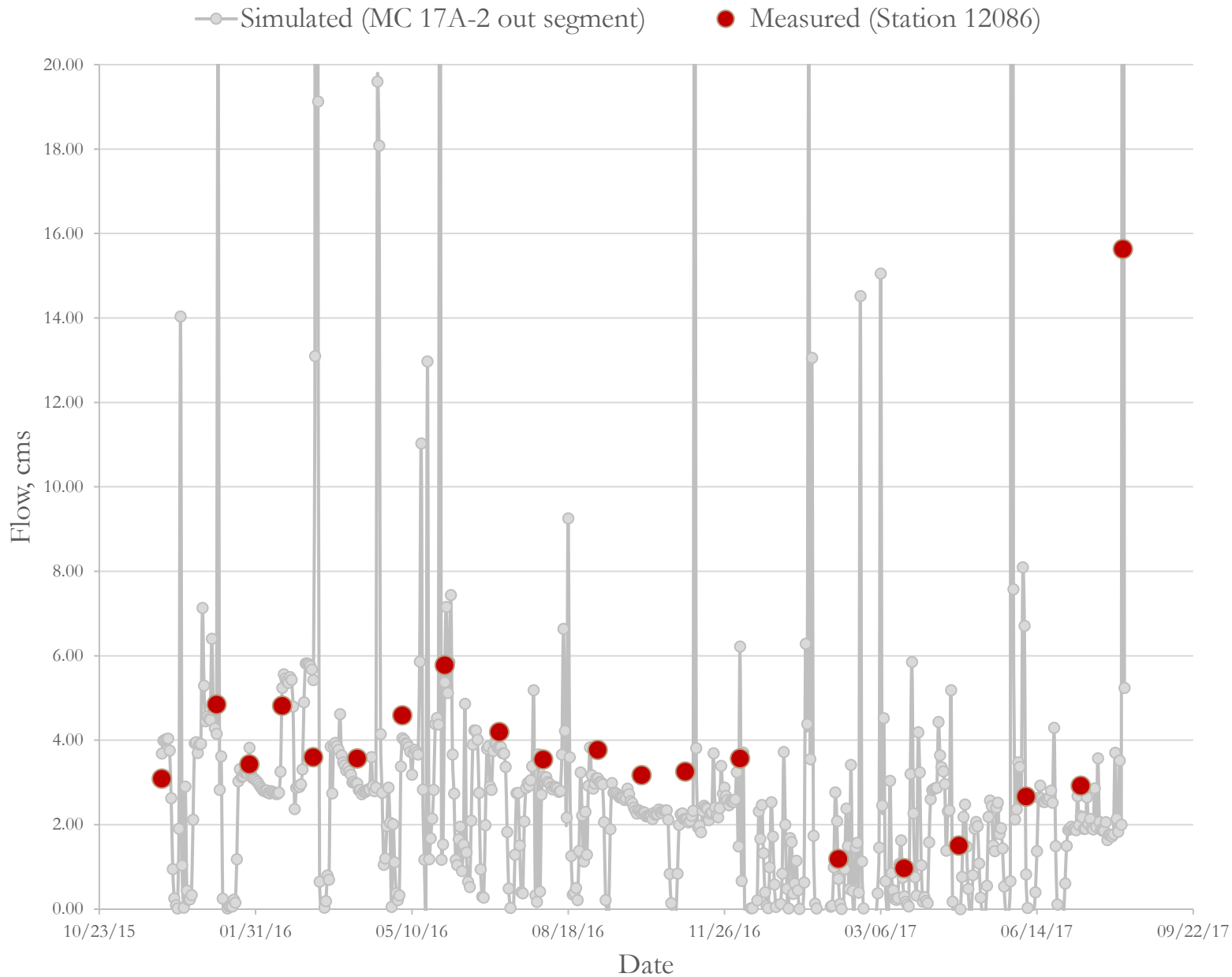
Segment 1C1 flow against  
Station 12090



# Flow Verification

Segment 12B- flow out against Station 12087

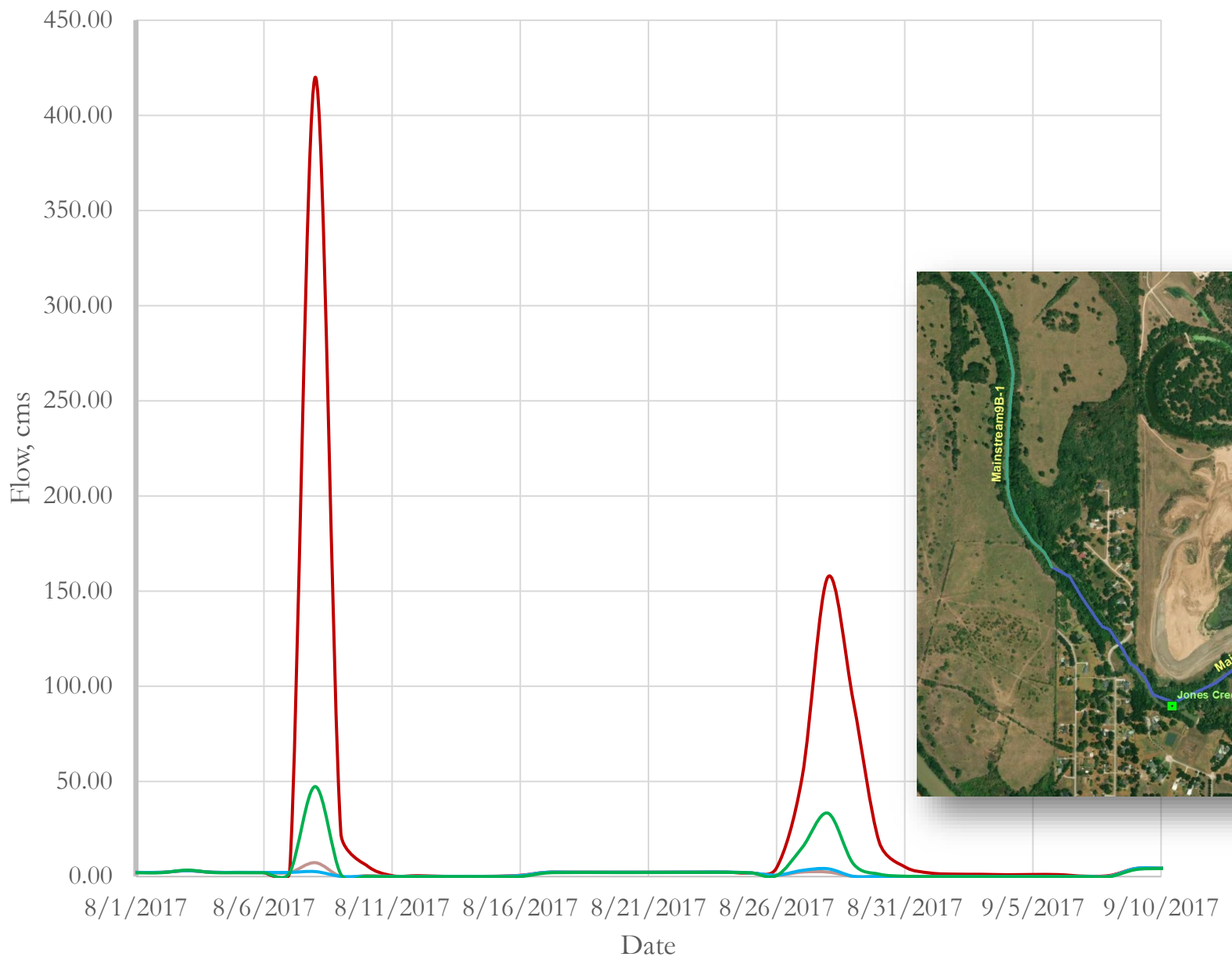




# Flow Verification

17A -2 flow out against Station 12086

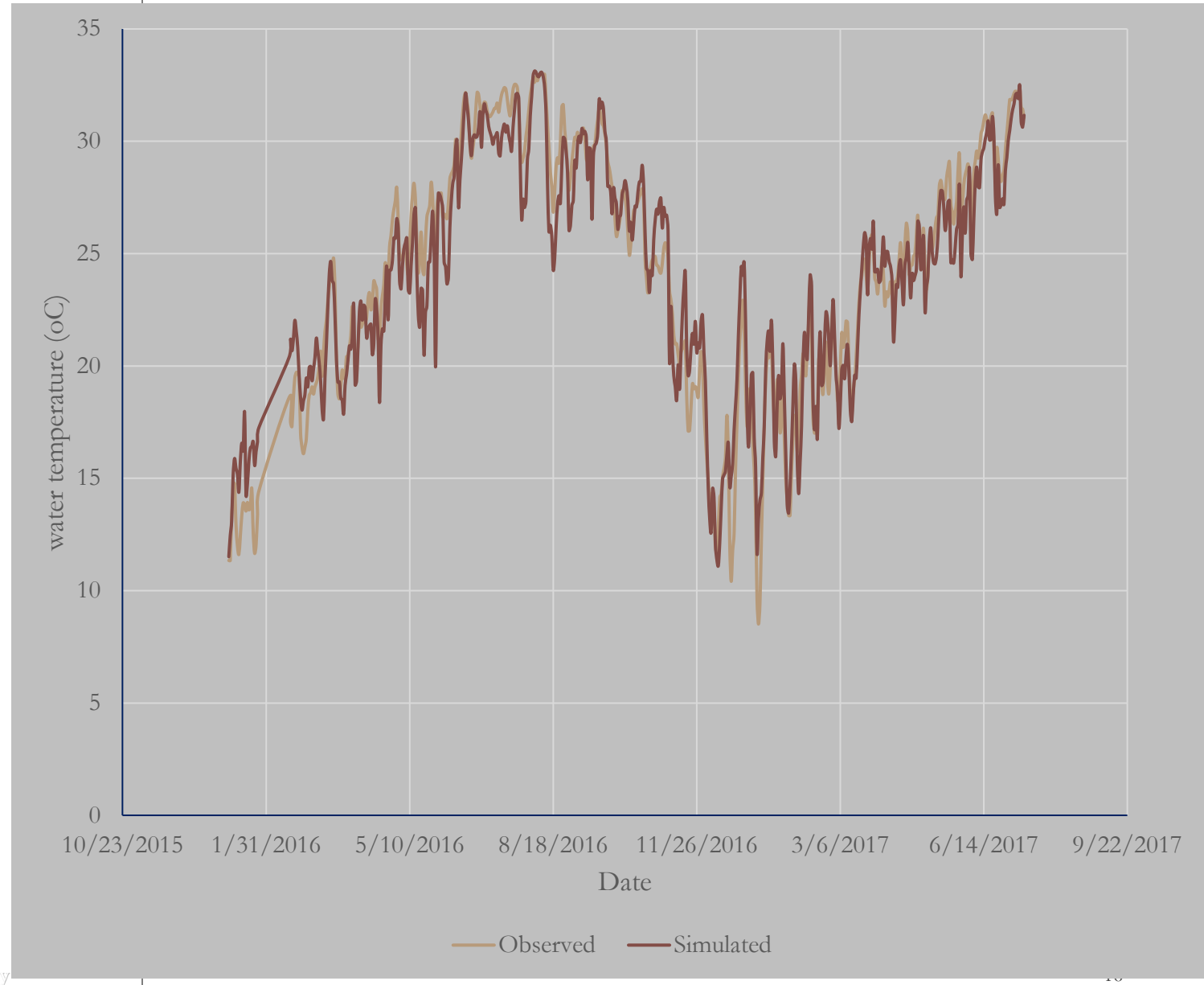
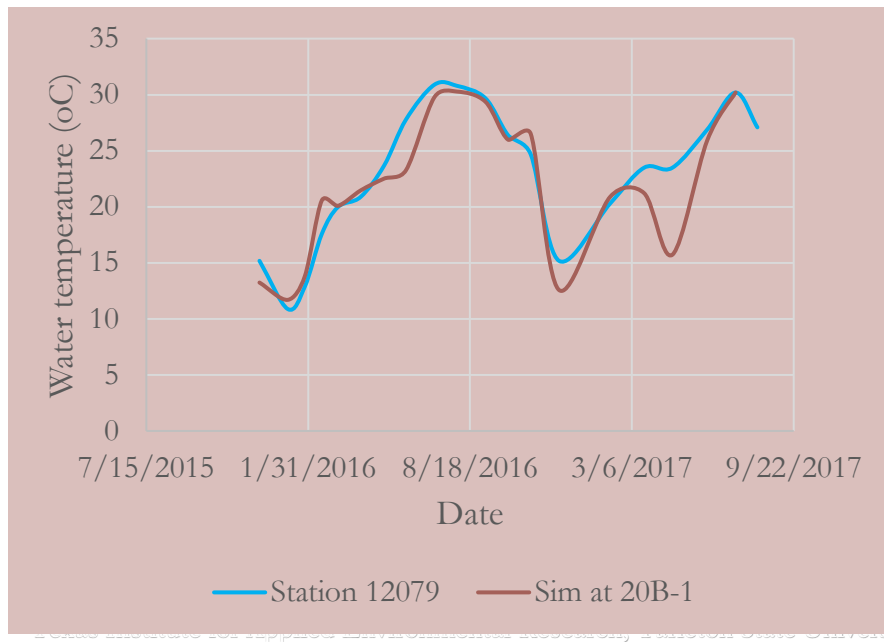
# Simulation of flows upstream and downstream of Jones Creek Overflow Structure





# Calibration – Water temperature

- **NSE = 0.92**
- **Equilibrium Option**





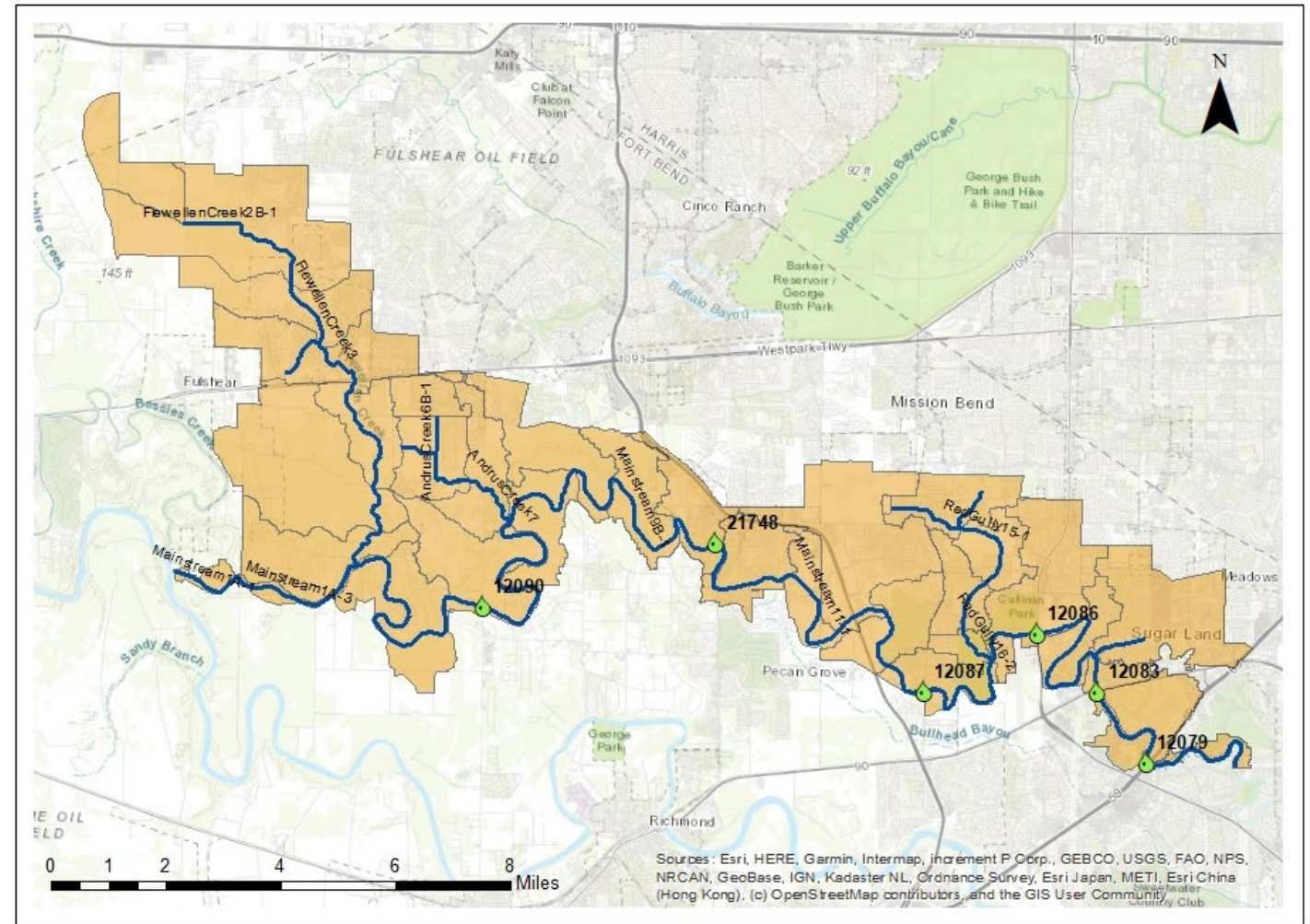
## Calibration – Water Quality Parameters

- Inorganic Suspended Solids (ISS)
- Carbonaceous Biochemical Oxygen Demand (CBOD)
- Organic Nitrogen, Organic Phosphorus
- Ammonium Nitrogen, Nitrate Nitrogen, Total nitrogen
- Phosphate Phosphorus, Total Phosphorus
- Chlorophyll-a (CHLA)
- Dissolved oxygen



# Calibration – Water Quality

- 20 sampling events and 6 sampling station (4 additional sampling stations for 2 sampling events)
- Sept 2016 – Aug 2017 – 10 sampling events for calibration
- Dec 2016 – Aug 2016 – 10 sampling events for validation
- RMSE, PBIAS are used to measure the calibration
- Time series plot for visual evaluation

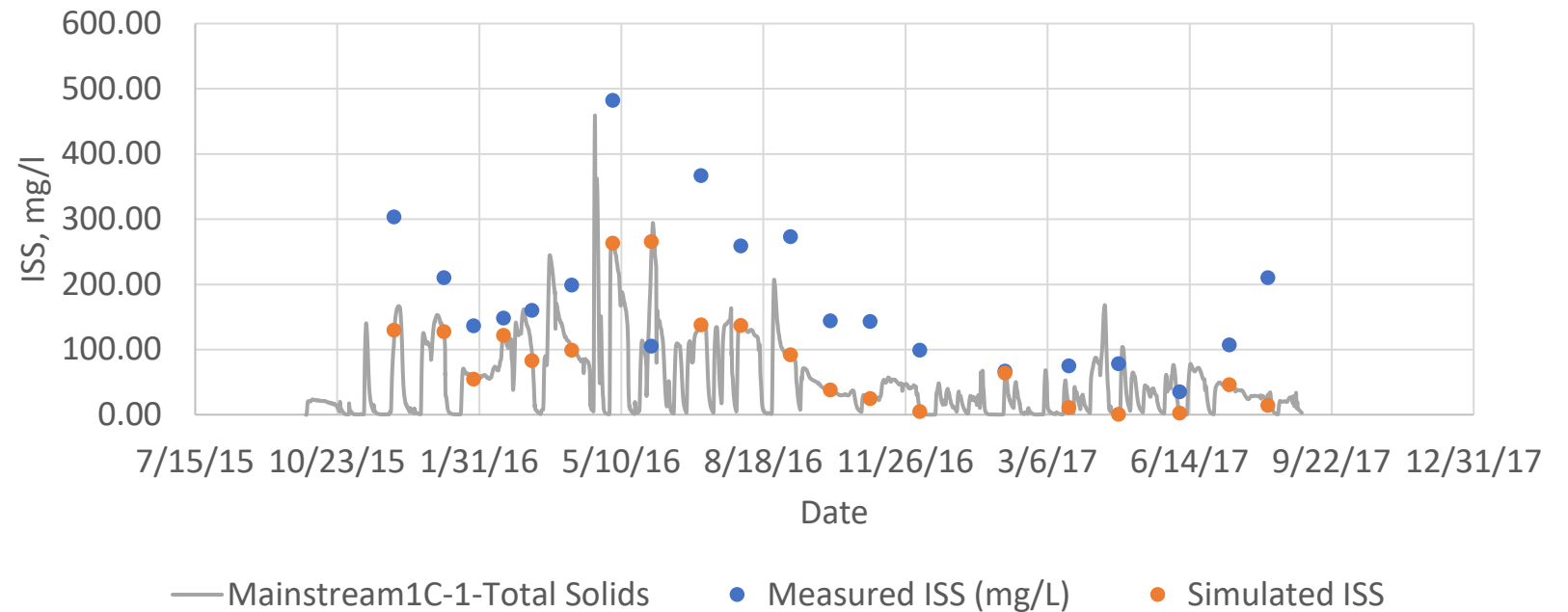




# Calibration for ISS

- $ISS = TSS - VSS$
- Three categories:, Colloid, Clay, Silt + Sand
- Solid settling velocity in segment 0.4, 2.0, and 20.0 m/d for colloid, clay and silt + sand respectively
- Other calibration parameters: Particle diameter

Station 12090 / Seg 1C-1

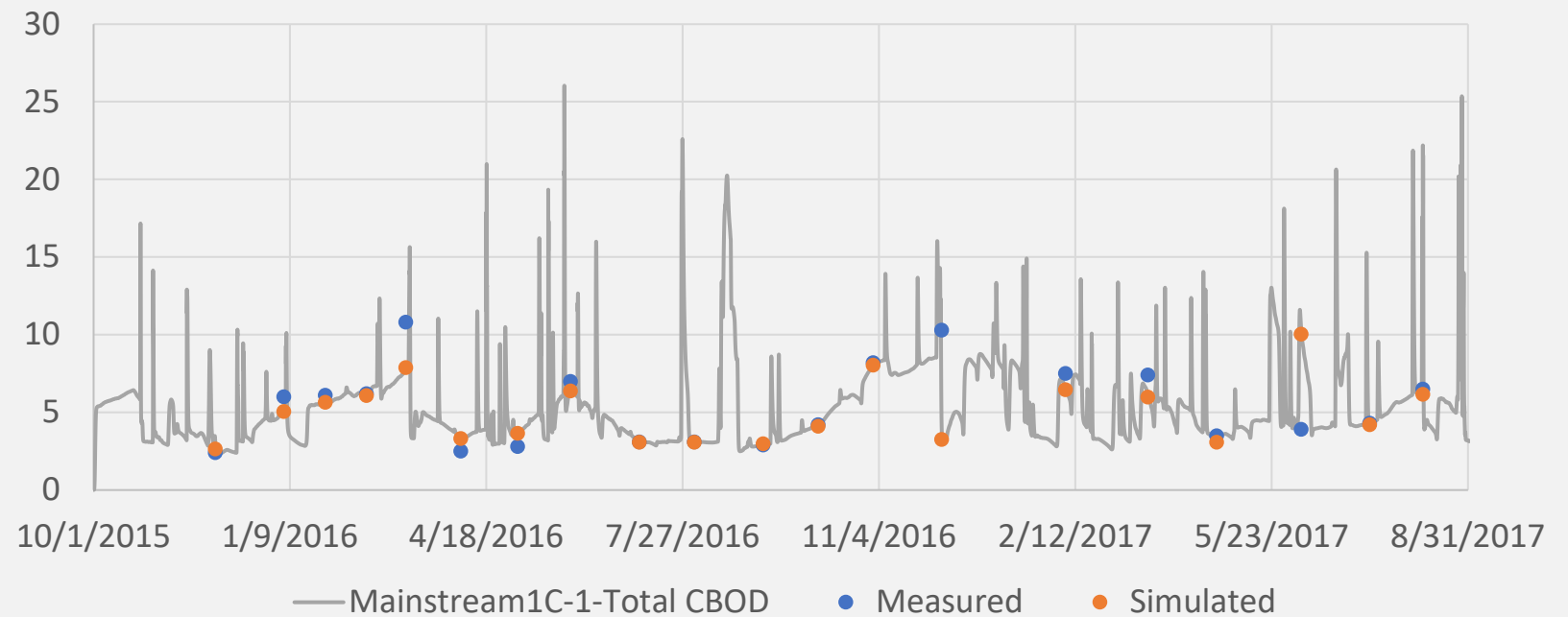




# Calibration for CBOD

- Measurement of how much oxygen is depleted in water by biological organisms when organic material breaks down
- CBOD decay rate 0.02 – 1
- CBOD decay temperature coefficient 1.047
- Segment CBOD decay rate scale factor

Station 12090 / Seg 1C-1

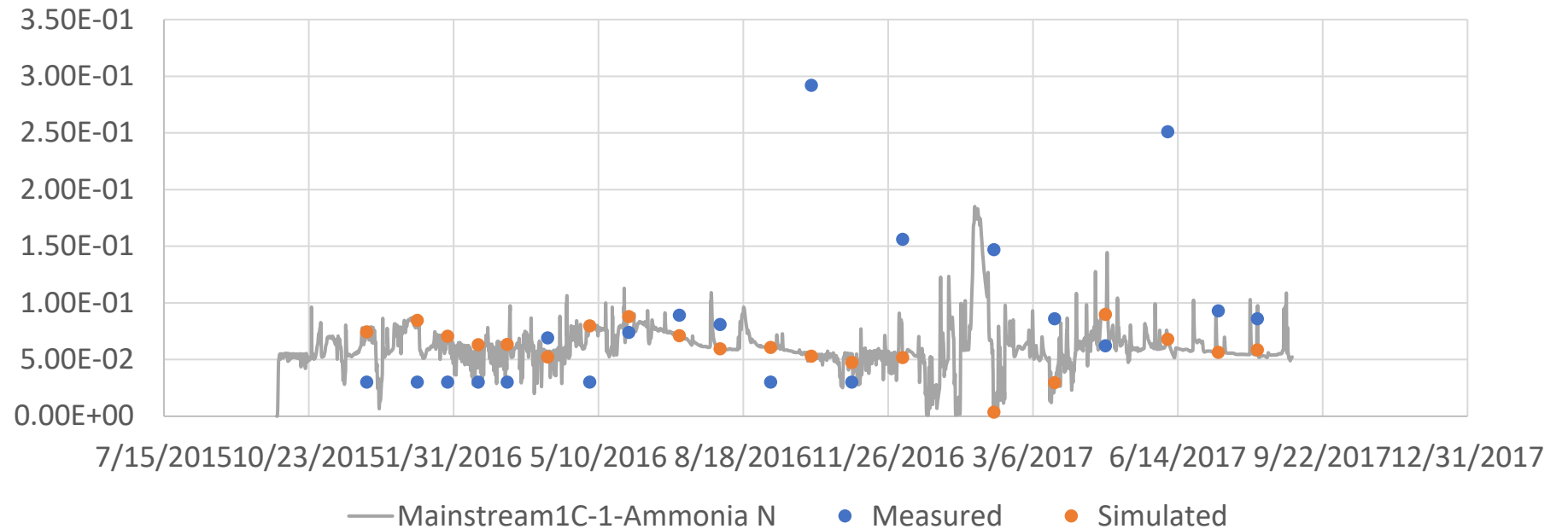


# Calibration for nitrogen

- NH<sub>4</sub> -N, NO<sub>3</sub> - N, organic N, and total N



Station 12090 / Seg 1C-1

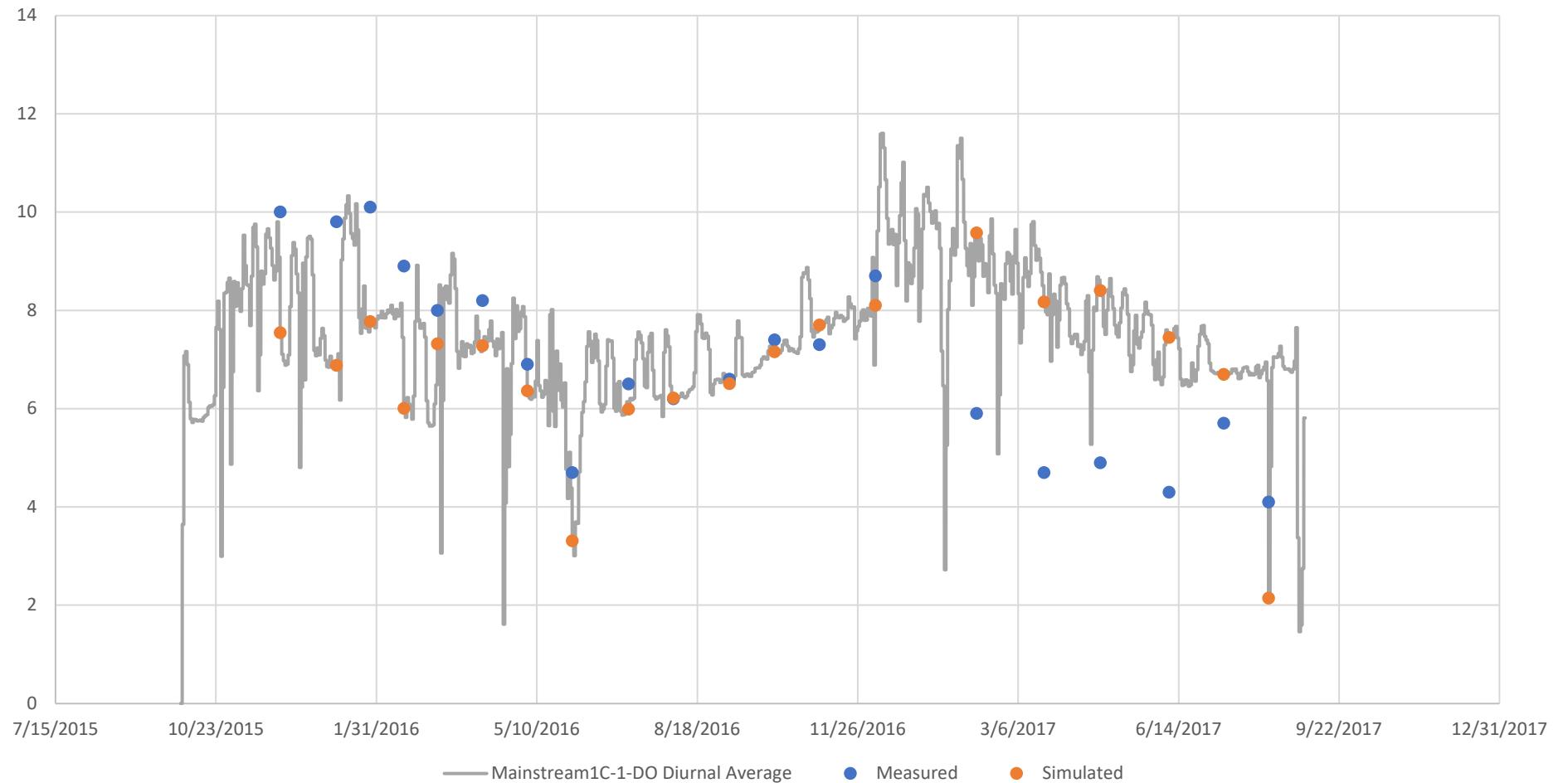




# Calibration for DO

- **Minimum reaeration velocity 0.6 m/day**
- **Sediment Oxygen demand**

Station 12090 / Seg 1C-1





# Calibration for Chlo-A

- **Three algal groups:**
  1. **Diatoms – Cool season functional group**
  2. **Green algae – mild – season functional group**
  3. **Blue green algae – warm season functional group**
- **Calibration parameters:**
  - Max growth rate constant 3/day
  - Optimal temp for growth chla3 - 20°C, chla2 – 18°C, chla1 – 15°C





# Calibration statistics results

Work in progress...

Date	ISS				CBOD				NH4-N				NO3-N				Total-N			
	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation
9/6/2016	16.61	Meet	-65.65	Do not meet	3.43	Do not meet	40.66	Meet	0.03	Meet	-90.88	Do not meet	0.26	Meet	-30.24	Meet	0.22	Meet	-4.59	Meet
10/4/2016	51.63	Do not meet	2.23	Meet	1.38	Meet	21.84	Meet	0.10	Meet	31.77	Meet	0.19	Meet	-0.54	Meet	0.50	Meet	9.37	Meet
11/1/2016	66.13	Do not meet	-51.66	Meet	3.41	Meet	-32.50	Meet	0.03	Meet	15.65	Meet	0.61	Do not meet	302.90	Do not meet	0.50	Meet	22.77	Meet
12/6/2016	58.64	Do not meet	-74.02	Do not meet	3.60	Meet	-7.88	Meet	0.08	Meet	-62.59	Meet	0.46	Do not meet	-33.70	Meet	1.16	Do not meet	-40.87	Meet
2/7/2017	37.75	Do not meet	-31.41	Meet	5.38	Do not meet	-34.07	Meet	0.11	Meet	-84.67	Do not meet	0.96	Do not meet	19.31	Meet	0.99	Meet	-2.01	Meet
3/21/2017	40.36	Do not meet	-59.92	Do not meet	2.80	Meet	-20.45	Meet	0.07	Meet	-73.01	Do not meet	0.75	Do not meet	-15.82	Meet	0.96	Meet	-13.61	Meet
4/25/2017	59.98	Do not meet	-59.22	Do not meet	2.77	Do not meet	18.42	Meet	0.09	Meet	-72.17	Do not meet	0.68	Do not meet	-54.72	Meet	0.90	Do not meet	-12.50	Meet
6/7/2017	135.20	Do not meet	-20.46	Meet	1.40	Meet	21.30	Meet	0.13	Meet	-64.61	Meet	0.95	Do not meet	-41.34	Meet	0.51	Meet	-13.94	Meet
7/12/2017	31.97	Meet	32.98	Meet	1.69	Meet	17.82	Meet	0.10	Meet	-50.98	Meet	0.56	Do not meet	72.13	Do not meet	0.85	Do not meet	42.55	Meet
8/8/2017	152.79	Do not meet	-89.70	Do not meet	0.81	Meet	-89.70	Do not meet	0.08	Meet	-89.70	Do not meet	0.33	Do not meet	-89.70	Do not meet	1.17	Do not meet	-89.70	Do not meet

# Calibration statistics results

Work in progress...

Date	Org-N				Total-P				PO4-P				Org-P				Chlorophyll A			
	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation
9/6/2016	0.21	Meet	13.41	Meet	0.15	Meet	-51.07	Meet	0.04	Meet	-34.71	Meet	0.12	Meet	-60.75	Meet	7.45	Do not meet	92.89	Do not meet
10/4/2016	0.31	Meet	15.72	Meet	0.09	Meet	-33.49	Meet	0.03	Meet	-28.86	Meet	0.05	Meet	-37.07	Meet	17.04	Do not meet	89.95	Do not meet
11/1/2016	0.33	Meet	-17.21	Meet	0.10	Meet	26.44	Meet	0.12	Meet	341.49	Do not meet	0.06	Meet	-27.17	Meet	69.69	Do not meet	-95.25	Do not meet
12/6/2016	0.70	Do not meet	-43.67	Meet	0.27	Do not meet	-67.25	Meet	0.18	Meet	-73.76	Do not meet	0.10	Meet	-56.96	Meet	7.89	Do not meet	-74.44	Meet
2/7/2017	0.31	Meet	-19.34	Meet	0.22	Meet	-1.97	Meet	0.19	Meet	29.13	Meet	0.09	Meet	-30.23	Meet	12.76	Do not meet	-42.72	Meet
3/21/2017	0.61	Do not meet	-7.30	Meet	0.16	Meet	-21.16	Meet	0.13	Meet	7.94	Meet	0.13	Meet	-38.01	Meet	39.16	Do not meet	-49.73	Meet
4/25/2017	0.84	Do not meet	22.11	Meet	0.19	Meet	-32.16	Meet	0.15	Meet	-49.10	Meet	0.18	Meet	-18.21	Meet	30.54	Do not meet	75.40	Do not meet
6/7/2017	0.22	Meet	4.71	Meet	0.21	Meet	-49.92	Meet	0.11	Meet	-54.11	Meet	0.11	Meet	-45.83	Meet	9.04	Do not meet	-91.36	Do not meet
7/12/2017	0.20	Meet	17.00	Meet	0.16	Meet	24.13	Meet	0.08	Meet	29.48	Meet	0.09	Meet	19.69	Meet	17.90	Do not meet	-96.16	Do not meet
8/8/2017	0.87	Do not meet	-89.70	Do not meet	0.31	Do not meet	-89.70	Do not meet	0.18	Meet	-89.70	Do not meet	0.14	Meet	-89.70	Do not meet	13.50	Do not meet	-89.70	Do not meet

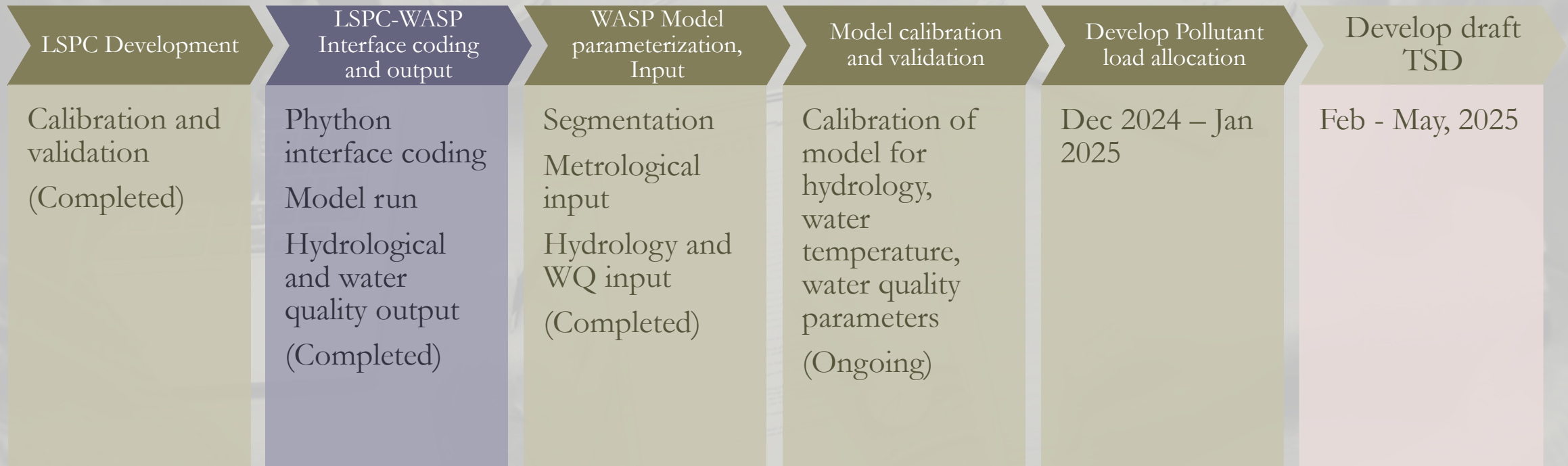


# Calibration statistics results

Work in progress...

Date	Dissolved O - inst				Dissolved O - di avg				Dissolved O - di min			
	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation	RMSE	Evaluation	PBIAS	Evaluation
9/6/2016	1.98	Meet	-31.63	Meet	1.82	Meet	-28.38	Meet	1.79	Meet	-28.42	Meet
10/4/2016	1.14	Meet	-13.39	Meet	0.92	Meet	-11.17	Meet	0.88	Meet	-12.02	Meet
11/1/2016	1.05	Meet	9.93	Meet	1.38	Meet	18.21	Meet	1.25	Meet	16.73	Meet
12/6/2016	1.85	Meet	-14.93	Meet	1.70	Meet	-11.54	Meet	2.36	Meet	-21.70	Meet
2/7/2017	2.37	Meet	30.65	Meet	3.29	Meet	41.55	Meet	3.67	Do not meet	59.39	Do not meet
3/21/2017	3.34	Do not meet	44.31	Meet	4.35	Do not meet	76.26	Do not meet	4.15	Do not meet	74.27	Do not meet
4/25/2017	5.72	Do not meet	94.59	Do not meet	6.08	Do not meet	121.47	Do not meet	4.84	Do not meet	101.68	Do not meet
6/7/2017	2.86	Do not meet	73.09	Do not meet	2.36	Do not meet	46.07	Meet	2.85	Do not meet	77.28	Do not meet
7/12/2017	2.89	Do not meet	64.42	Do not meet	2.04	Meet	33.49	Meet	2.52	Do not meet	56.14	Do not meet
8/8/2017	3.27	Do not meet	-89.70	Do not meet	1.54	Meet	-89.70	Do not meet	2.30	Do not meet	-89.70	Do not meet

# Project Status and Timeframe







THANK YOU!