Automating detection of illicit discharges in the MS4 using IoT sensors

Elizabeth Fassman-Beck, Ph.D.

Presentation to the SCCWRP Commission

March 6, 2026

SCCWRP Established 1969

BoSL Water Monitoring and Control

OC Public Works

Continuous:

- Wastewater cross-connections

Transient:

- Spills/dumps
- Irrigation

What are illicit discharges?

NPDES MS4 Requirement:

- Minimum Control Measure (MCM)
- Illicit discharge detection and elimination (IDDE)

How do we know when there is a discharge?

Best case scenarios:

- Direct agency observation
- Community hotline or web reporting (if witnessed)
- Dry-weather monitoring

Current Dry Weather Monitoring Program North Orange County, CA

- 30 outfalls targeted, April-September
  - 3 site visits per day, Mon-Fri (during business hours)
  - Each outfall sampled 5 times per dry season
  - Combination of field tests &offsite lab analyses
- Lab results can take 3-4 weeks to receive
- Results exceeding thresholds trigger source ID
- ~$244K/year to implement this program
  - Additional costs for Permittees to conduct source ID work

COUNTY OF ORANGE CALIFORNIA

OC Public Works

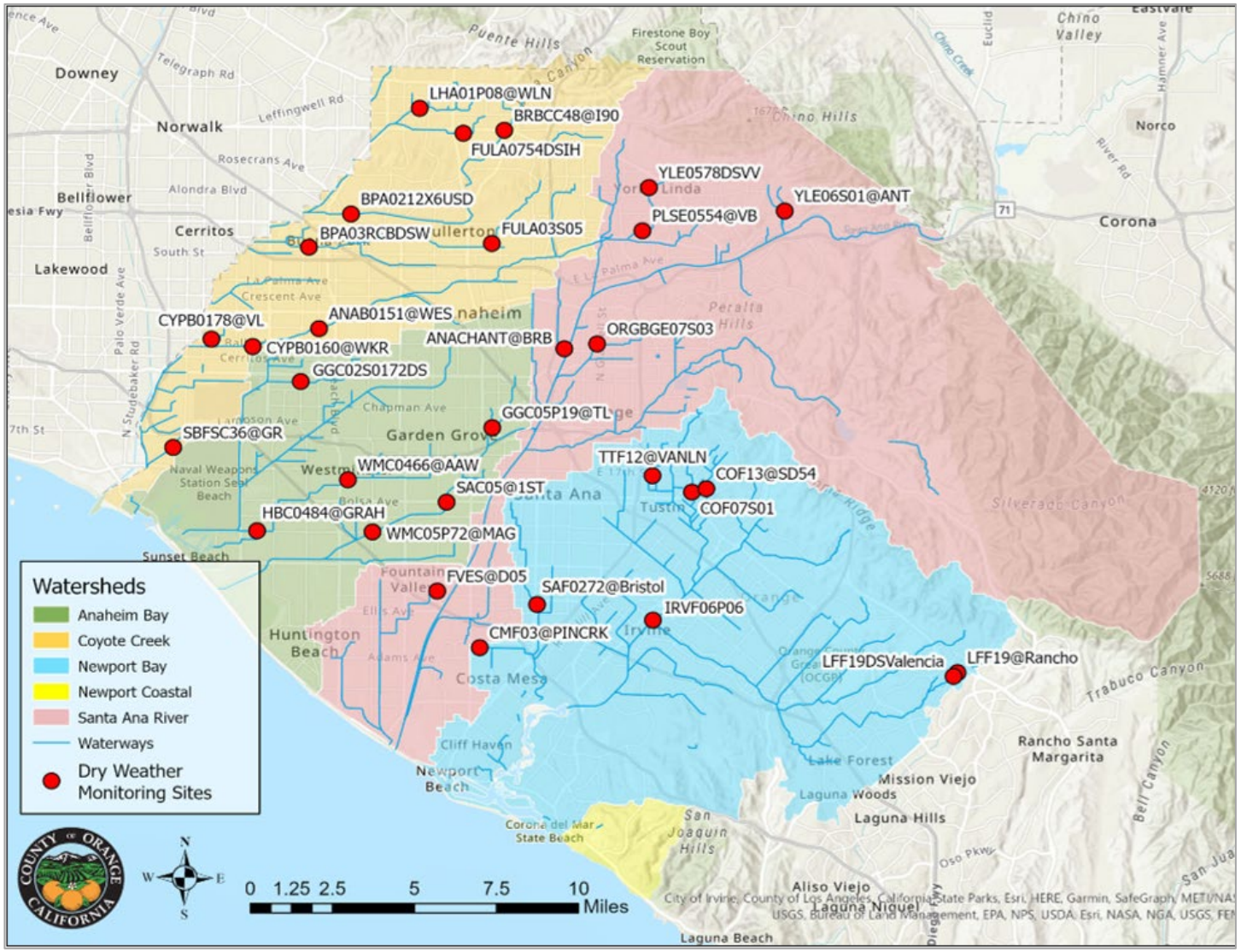
Research Objective:

Improve detection of transient discharges occurring in real-time

How to monitor the whole network?

Internet-of-Things (IoT) Sensors

Continuous, Distributed Monitoring in Real-Time



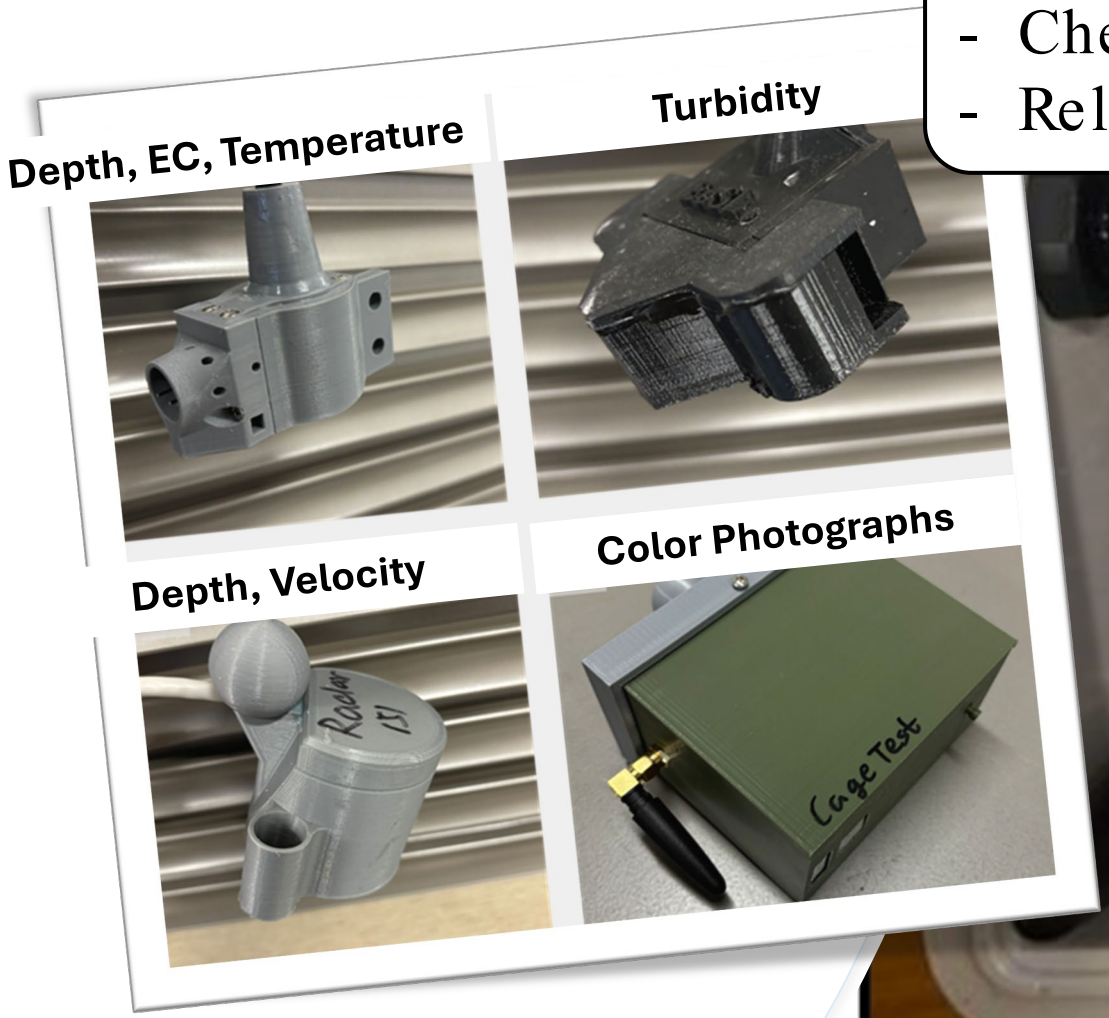
COUNTY OF ORANGE CALIFORNIA

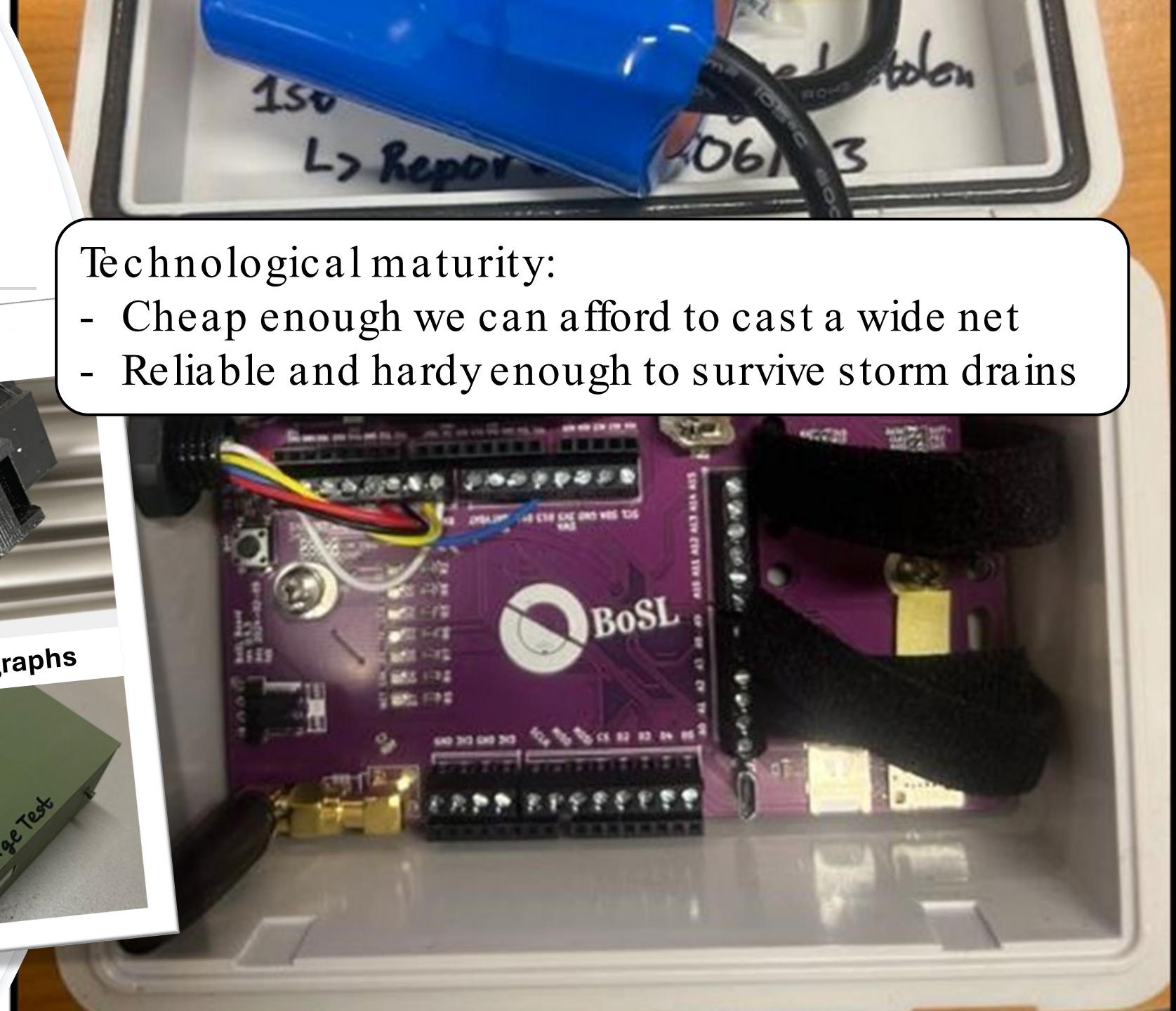
OC Public Works

Why now?

BoSL
Water Monitoring and Control

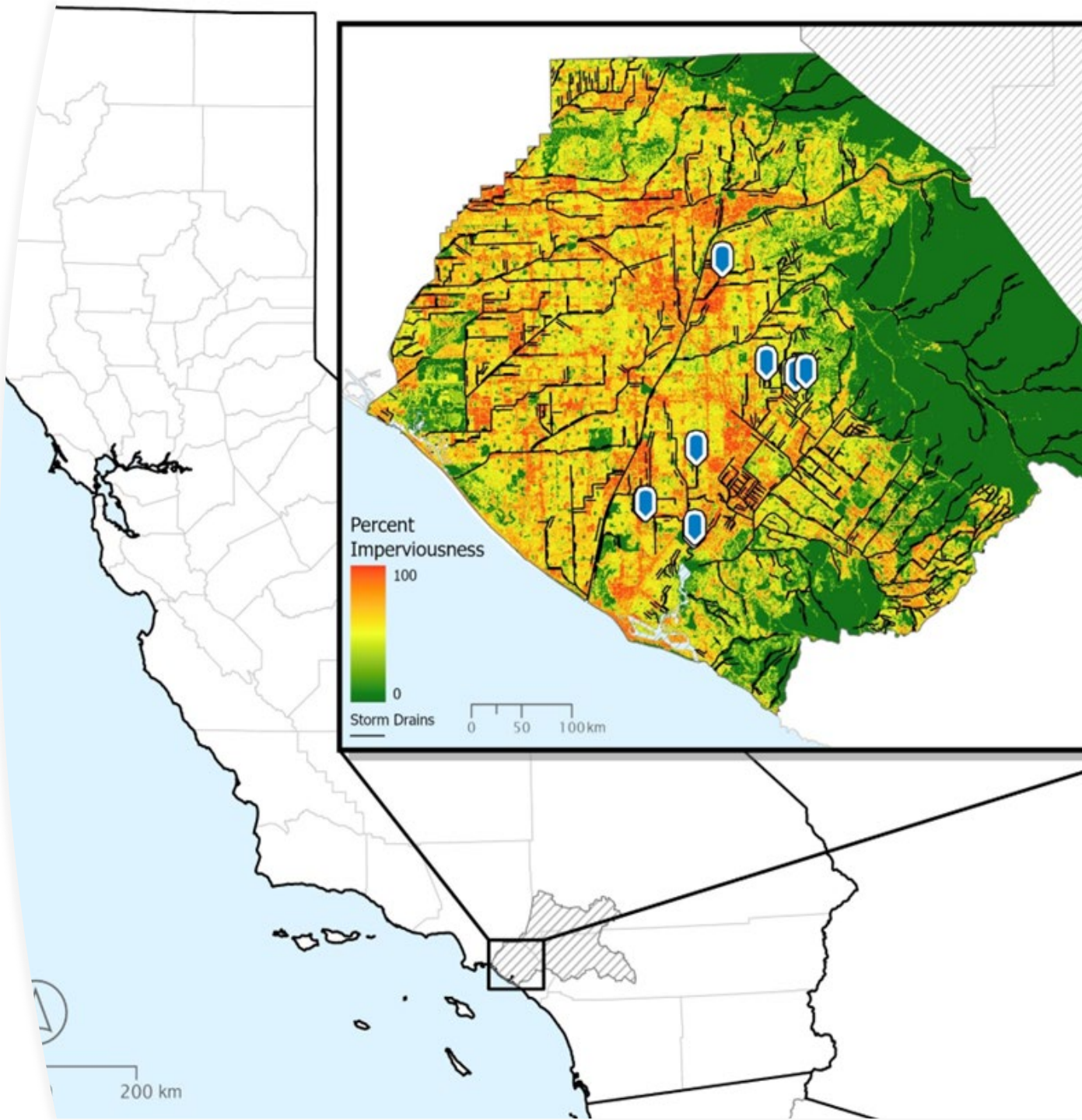
Technological maturity:
- Cheap enough we can afford to cast a wide net
- Reliable and hardy enough to survive storm drains

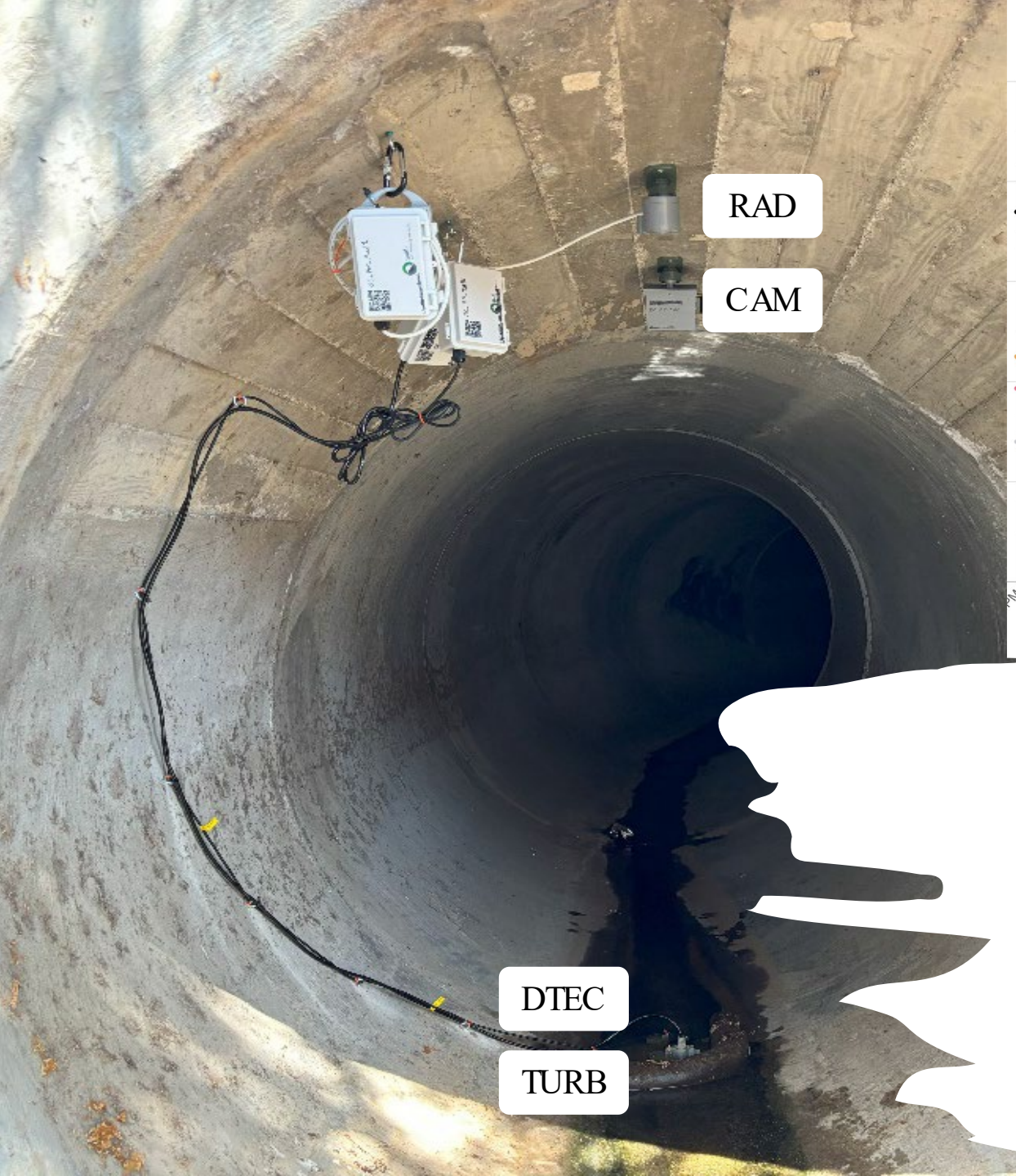


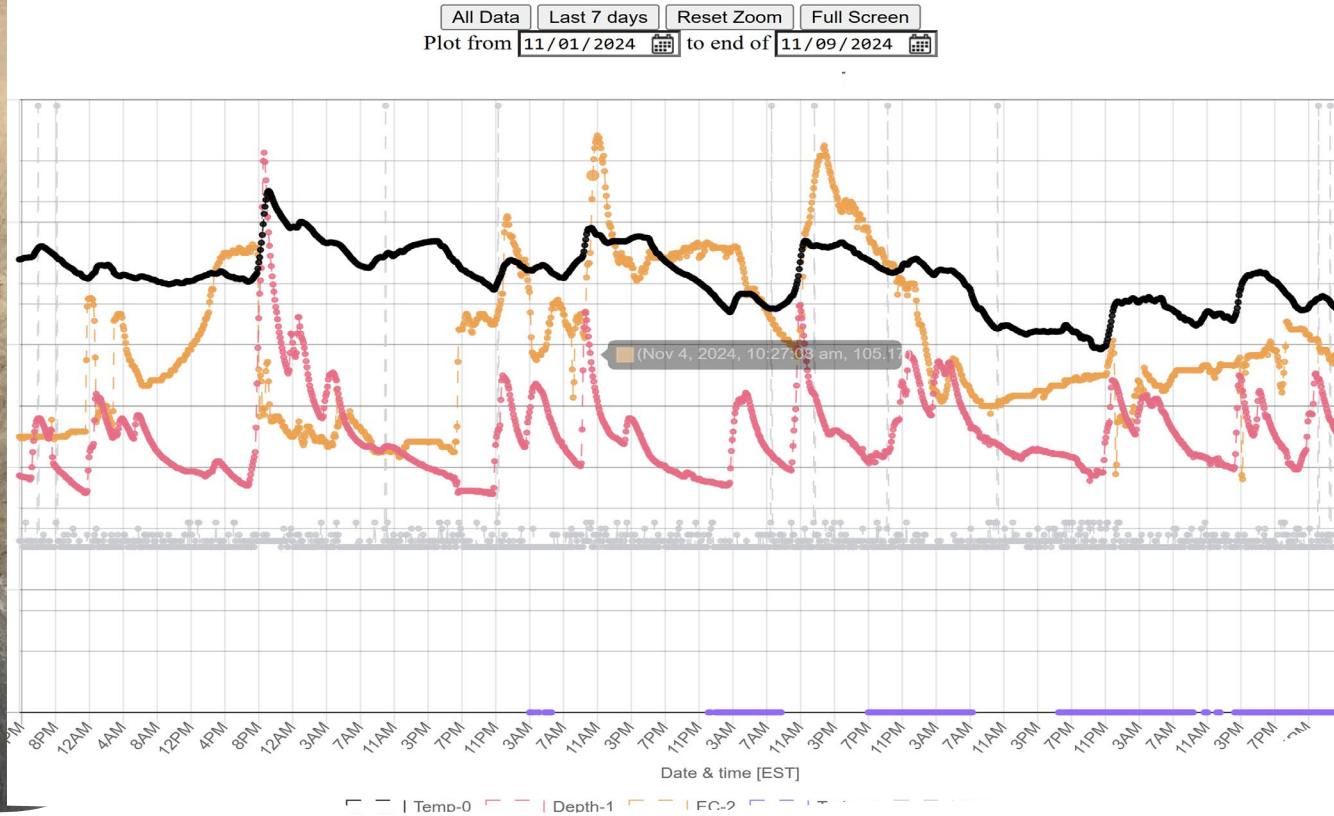


Pilot study - Orange County Public Works (OCPW)

- Instrumented 10 sites with IoT sensors
- Created visualization dashboard
- Integrated an automated anomaly detection algorithm
- Tested alarms with All-Hands Week (2024) and full dry season by OCPW (2025)





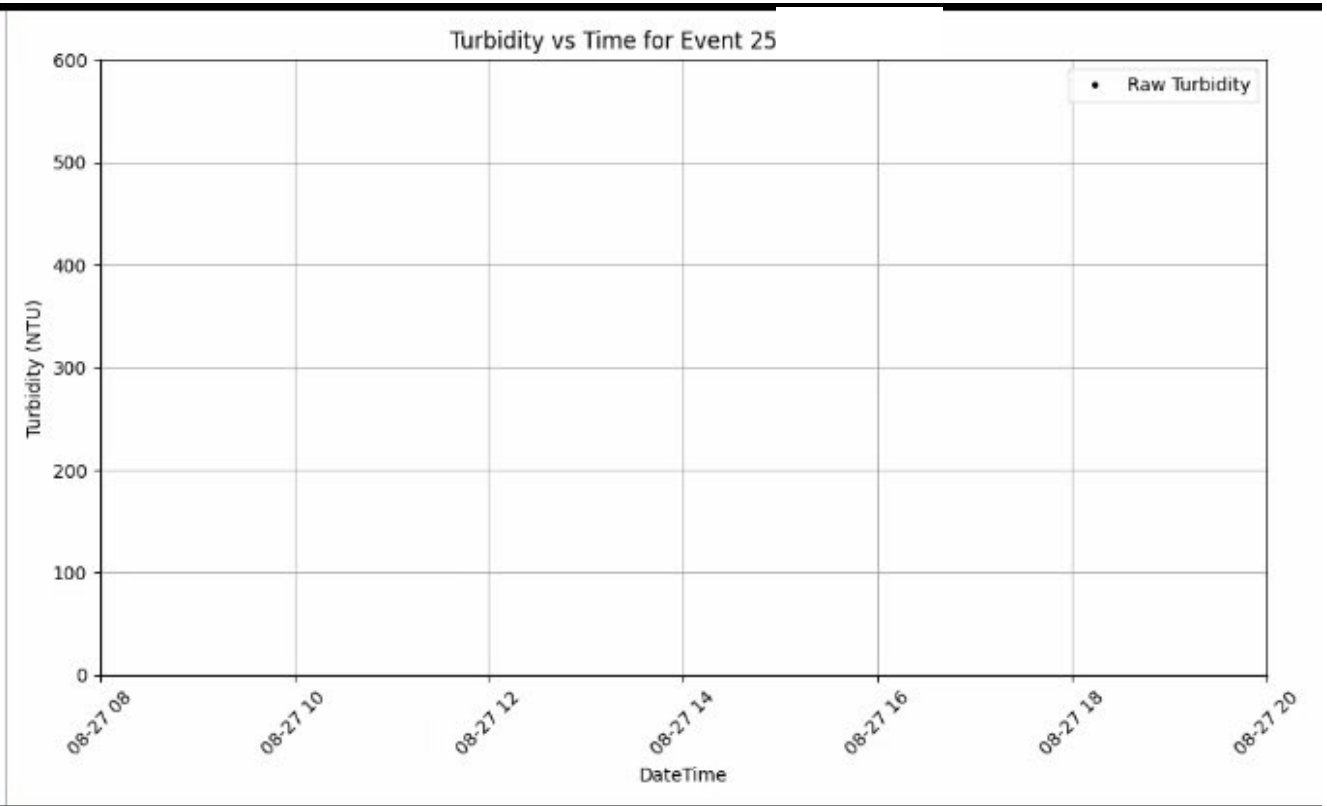


Distributed Network Monitoring

Needs Real-Time Sensing

How does it work?

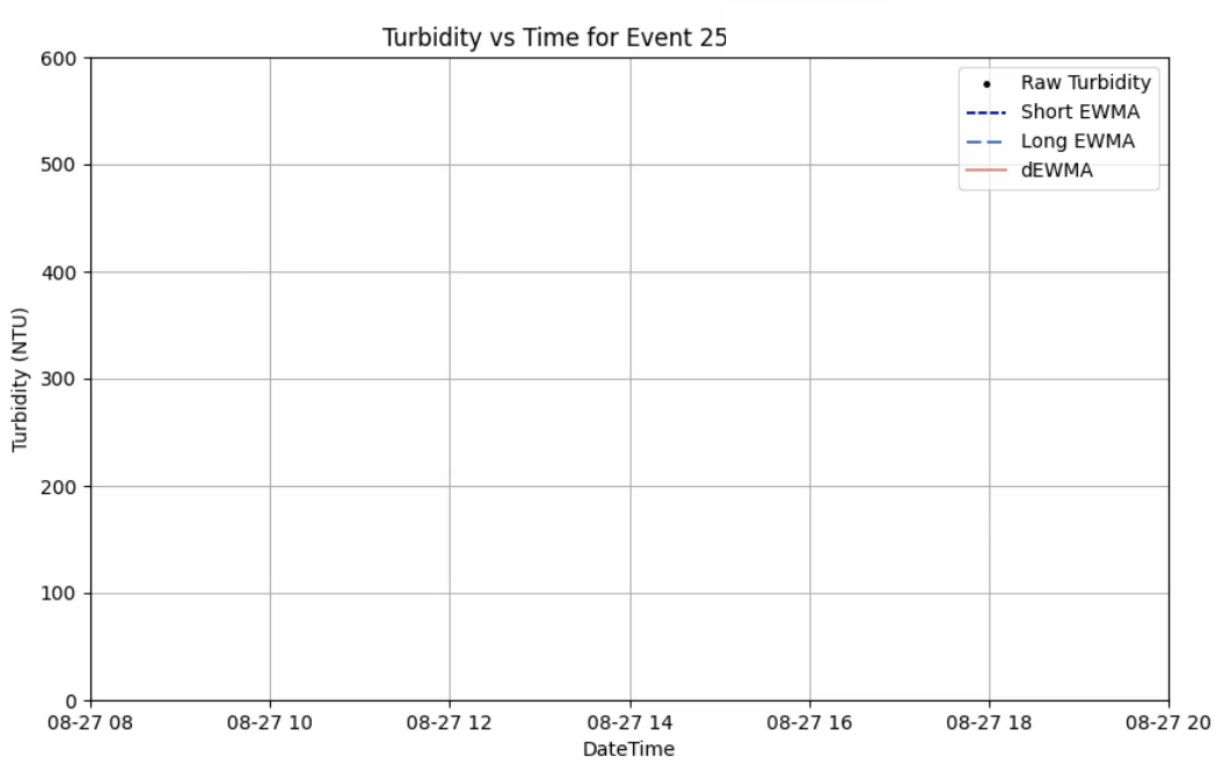
Data transmitted live to web dashboard



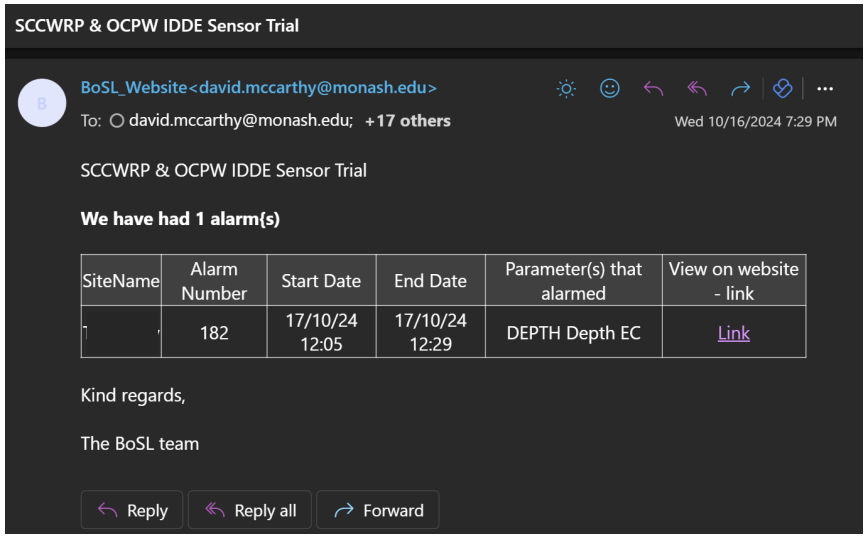
CAM

TURB

Real-Time Sensing → Automated Detection Algorithm



Alarm → Email Alert



SCCWRP & OCPW IDDE Sensor Trial

BoSL_Website<david.mccarthy@monash.edu>

To: david.mccarthy@monash.edu; **+17 others**

Wed 10/16/2024 7:29 PM

SCCWRP & OCPW IDDE Sensor Trial

We have had 1 alarm(s)

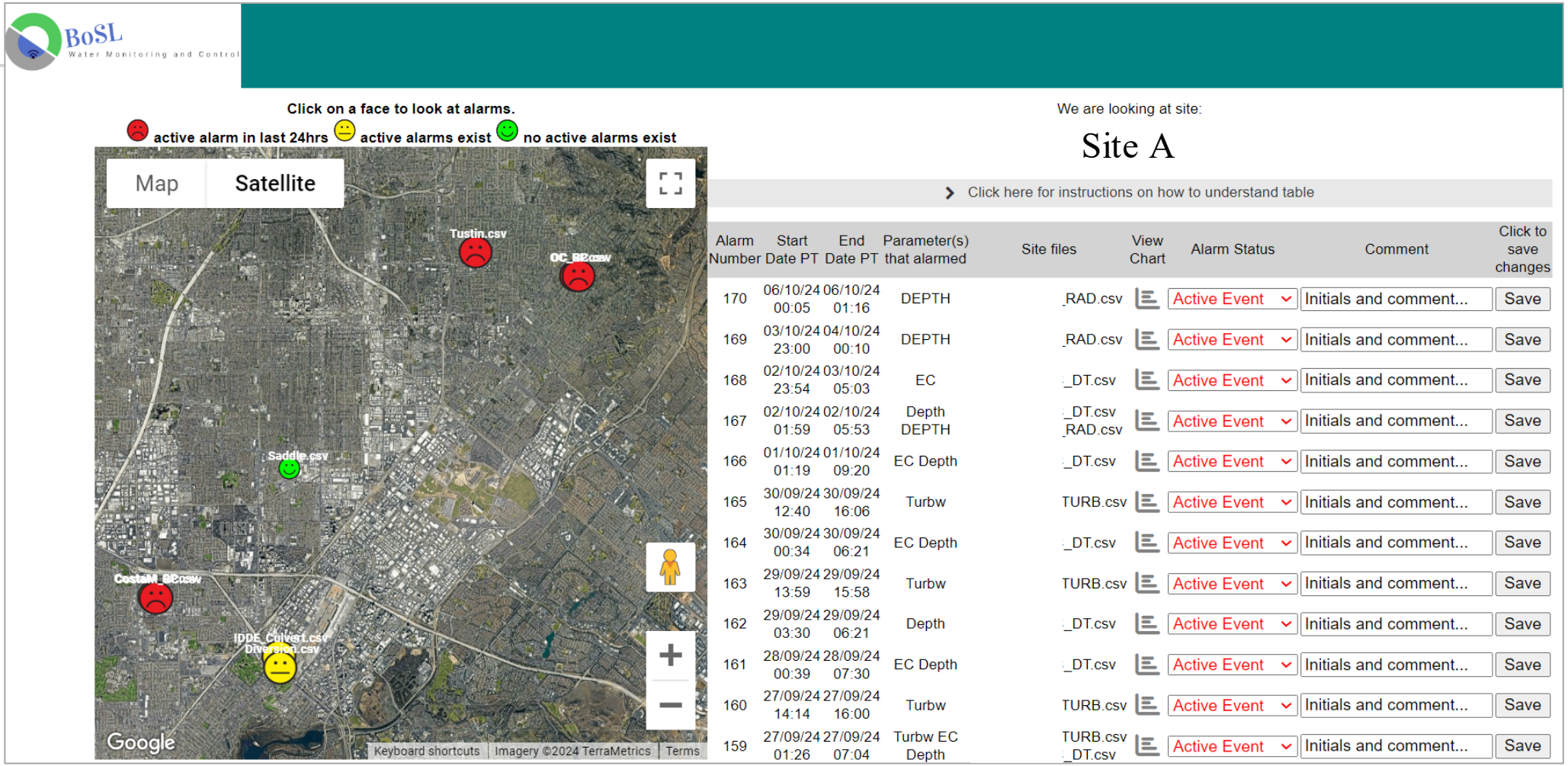
SiteName	Alarm Number	Start Date	End Date	Parameter(s) that alarmed	View on website - link
[redacted]	182	17/10/24 12:05	17/10/24 12:29	DEPTH Depth EC	Link

Kind regards,

The BoSL team

Reply Reply all Forward

Email Alert → Check Dashboard

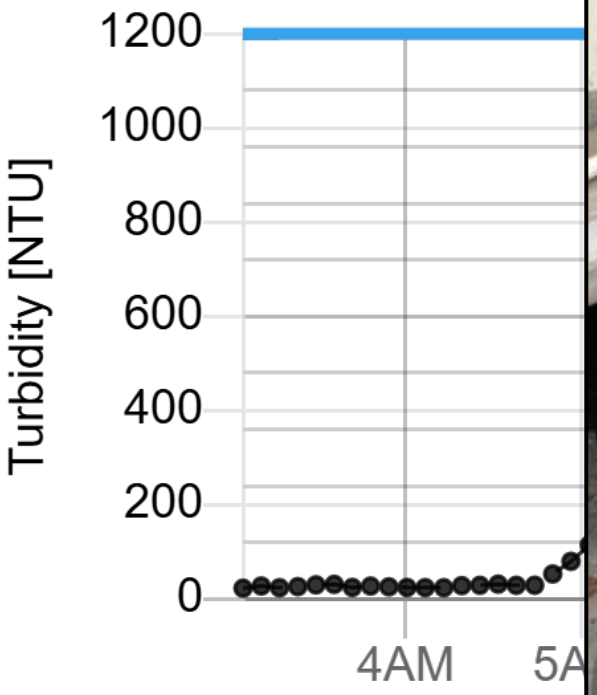


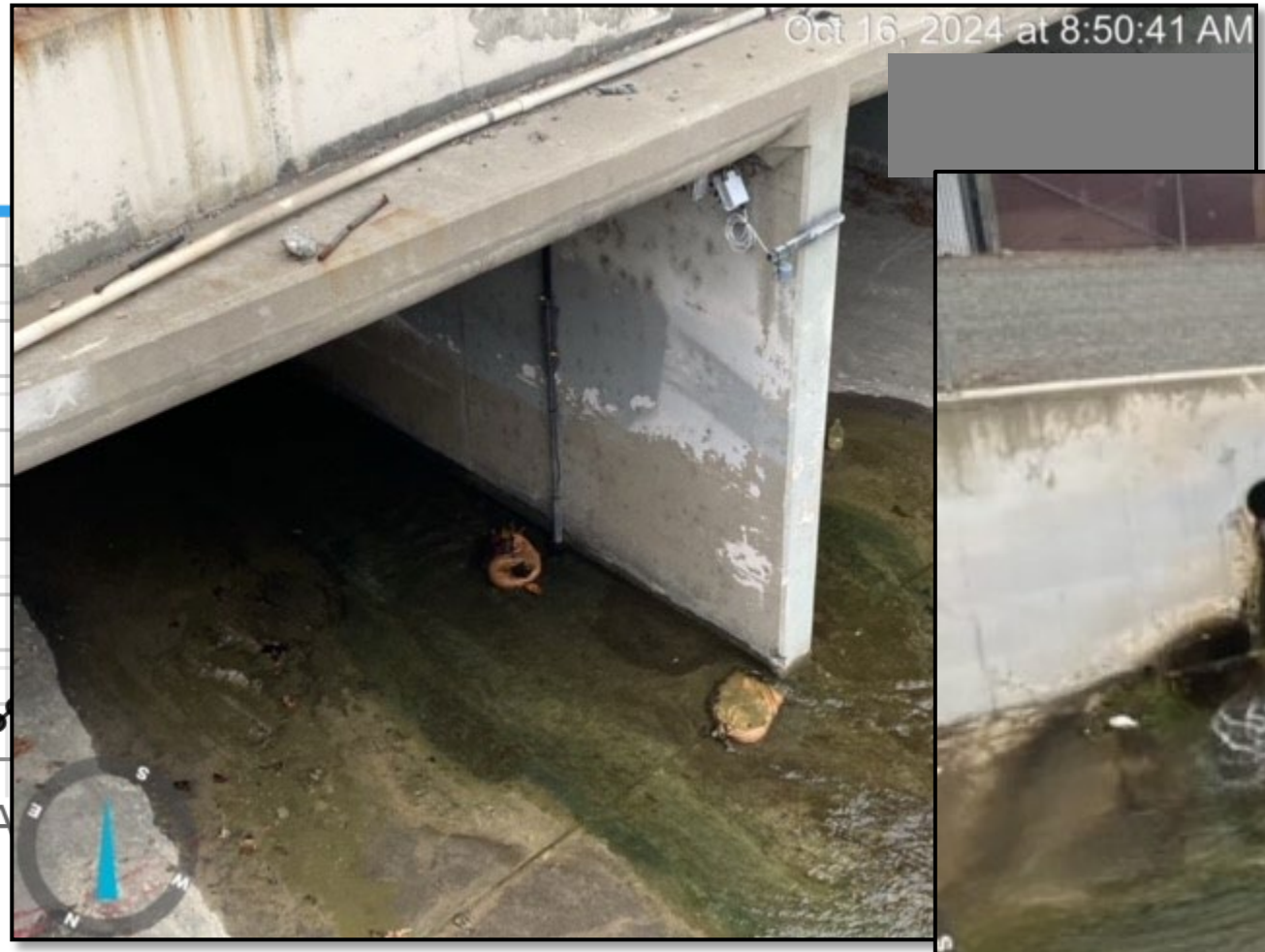
Alarm Number	Start Date PT	End Date PT	Parameter(s) that alarmed	Site files	View Chart	Alarm Status	Comment	Click to save changes
170	06/10/24 00:05	06/10/24 01:16	DEPTH	_RAD.csv		Active Event	Initials and comment...	Save
169	03/10/24 23:00	04/10/24 00:10	DEPTH	_RAD.csv		Active Event	Initials and comment...	Save
168	02/10/24 23:54	03/10/24 05:03	EC	_DT.csv		Active Event	Initials and comment...	Save
167	02/10/24 01:59	02/10/24 05:53	Depth DEPTH	_DT.csv _RAD.csv		Active Event	Initials and comment...	Save
166	01/10/24 01:19	01/10/24 09:20	EC Depth	_DT.csv		Active Event	Initials and comment...	Save
165	30/09/24 12:40	30/09/24 16:06	Turbw	TURB.csv		Active Event	Initials and comment...	Save
164	30/09/24 00:34	30/09/24 06:21	EC Depth	_DT.csv		Active Event	Initials and comment...	Save
163	29/09/24 13:59	29/09/24 15:58	Turbw	TURB.csv		Active Event	Initials and comment...	Save
162	29/09/24 03:30	29/09/24 06:21	Depth	_DT.csv		Active Event	Initials and comment...	Save
161	28/09/24 00:39	28/09/24 07:30	EC Depth	_DT.csv		Active Event	Initials and comment...	Save
160	27/09/24 14:14	27/09/24 16:00	Turbw	TURB.csv		Active Event	Initials and comment...	Save
159	27/09/24 01:26	27/09/24 07:04	Turbw EC Depth	TURB.csv _DT.csv		Active Event	Initials and comment...	Save

Rapid Response

OCPW All-Hands Week (Oct 9 – 16, 2024)

- Example: Alarm on Oct 16, 2024
  - Confirmed by municipal partner.
  - **Discharge source found upstream.**



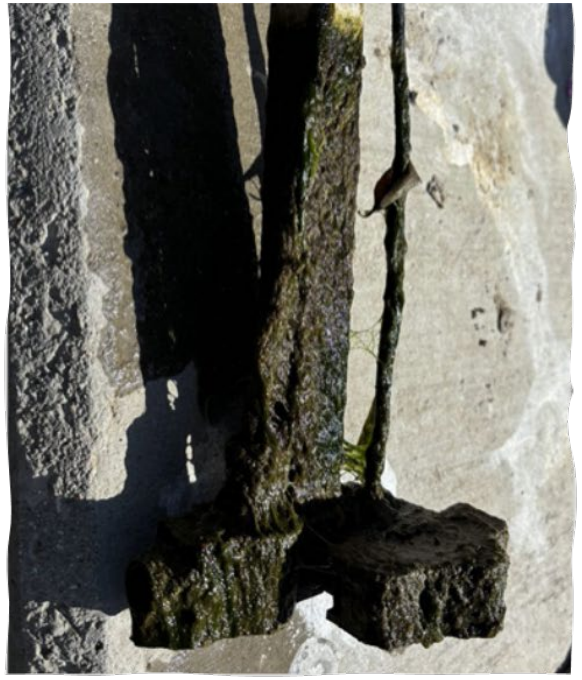


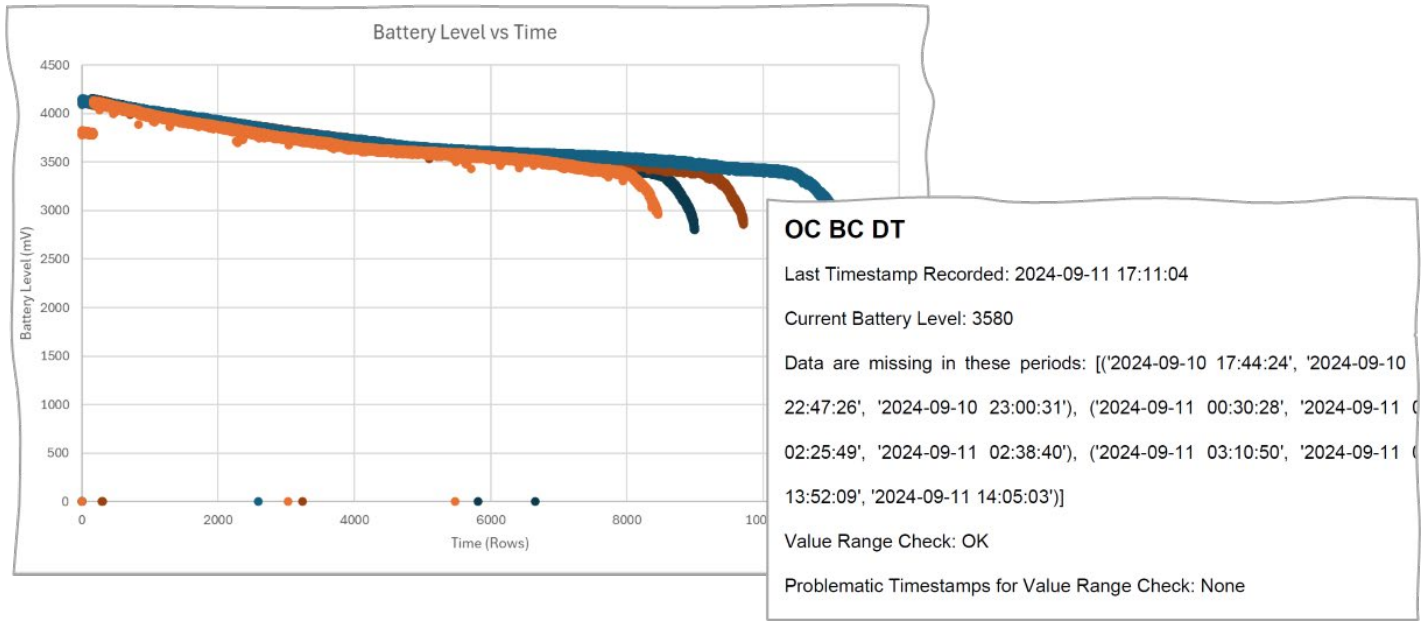
How did we do?

Effort	2024 All-Hands Week	2025 Dry Season
# Stations monitored	10→8	5
# Alarms during business hours with manual follow-up	9	8
# Discharges confirmed with sources confirmed (not nec. illicit)	6	3

Cost?

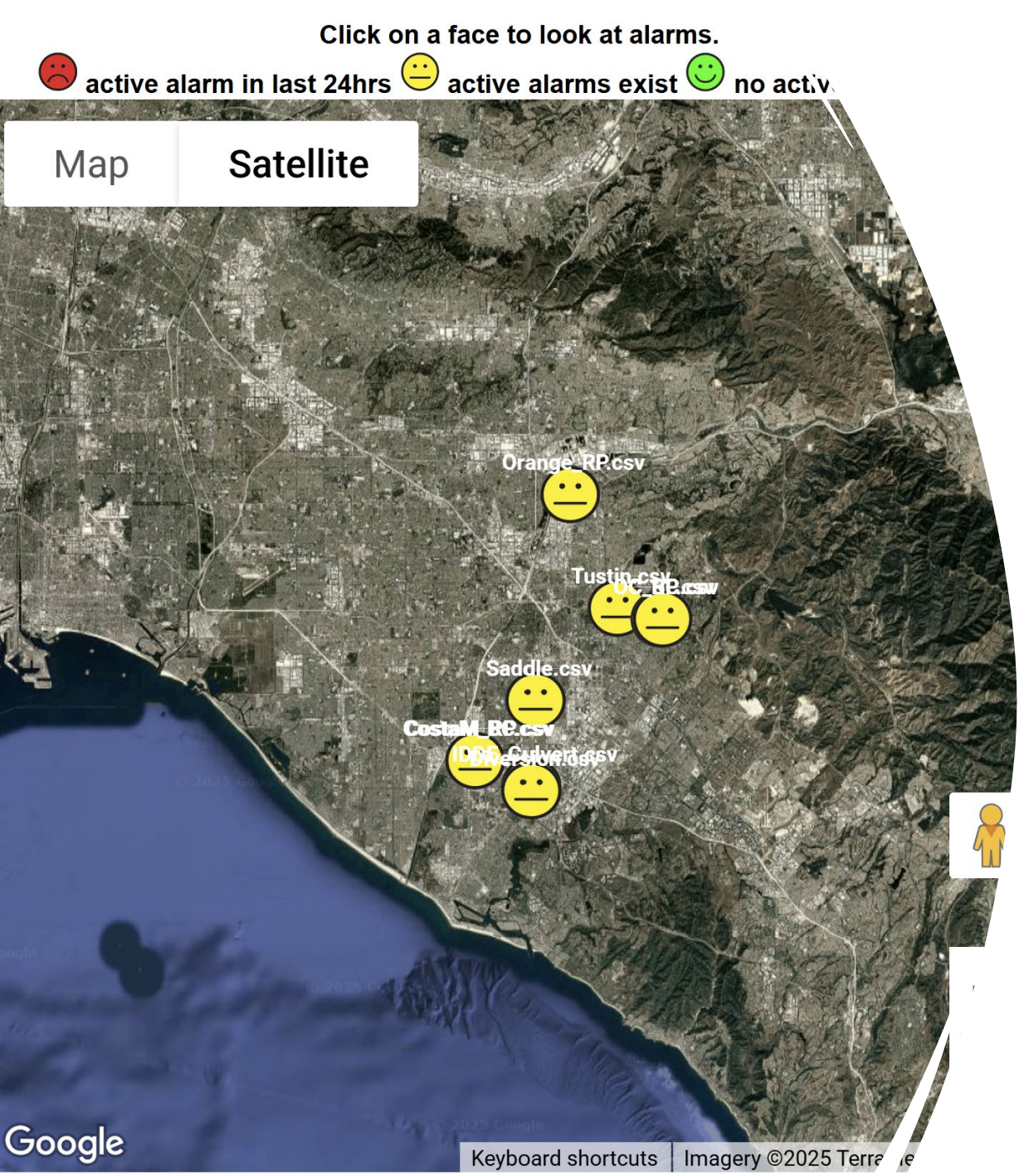
- Manual dry weather program: ~$244K annually for 30 outfalls
- Smart Sensor trial 2025: ~$122K for 5 outfalls
  - Hardware
  - Labor
- Hardware (sensors): ~$800/outfall
  - for all parameters &accessories
    - depth, velocity, electrical conductivity, temperature, turbidity
    - camera





Other program elements

- Automated notifications to track sensor "health"
  - minimize data losses and sensor maintenance visits
- Maintaining sensors
  - tracked calibration, battery demand, other operational elements
- Developed training materials &hosted workshop for Orange County staff
  - configuring and maintaining instrumentation and basic data management
- Provided back-up for Orange County staff in 2nd round deployment



Next steps for IDDE?

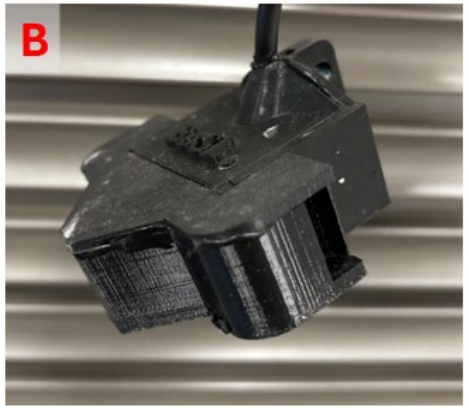
Implementation

- Working with OCIT on setting up information management in-house
- Developing a plan for rolling out on a broader scale

Research

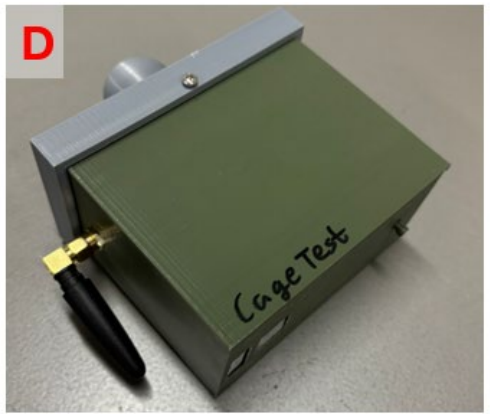
- Advancing algorithm for multi-parameter alarming
- Developing two-way communication with sensors

DTEC
Depth, Temp.,
Electrical conductivity



TURB
Turbidity

RAD
Non-contact
Depth
Velocity



CAM
Camera

New opportunities for IoT sensors?

BoSL
Water Monitoring and Control

- We are the largest test case for our partners at BoSL.
- How/where else might continuous, real-time monitoring advance water quality management?

- Current capability: water depth, velocity, turbidity, electrical conductivity, temperature, photos
- In development sensors: in-line ammonia, non-contact multi-spectral

Questions?


SCCWRP
Established 1969


BoSL
Water Monitoring and Control


OC Public Works