Finally!! Automated, In Situ Bacteria Measurement

MS4 Case Studies using Fluidion Alert Analyzers

James Riddle, PE
Vice President
Program Director

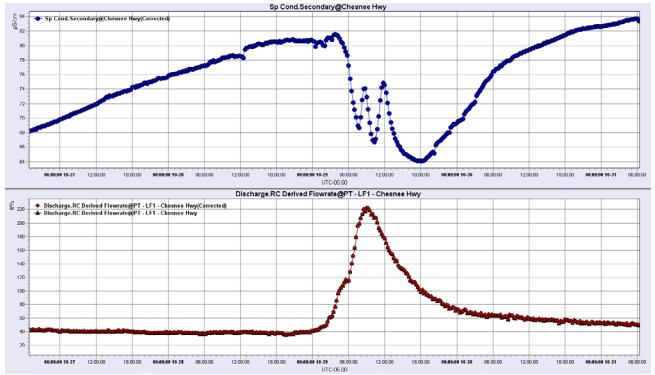
WOOLPERT
ARCHITECTURE | ENGINEERING | GEOSPATIAL

The Bacteria Conundrum

- Indicators only, not the virus or pathogen
- Multiple types of indicators (total coliforms, fecal, E Coli, enterococci)
- Highly variable parameter - spatially and temporally
- Not appropriate to assess with automated samplers (ie. Isco)
- Short holding times - bottle requires preservation solution
- Sample setup in lab – restricts sample drop off (sometimes Mon-Thurs)
- After hours setup/overtime costs
- Minimal number of certified commercial labs/available utility partners
- Dilution requirements for lab analysis (> or < results)
- Subjective results – membrane filter method
- Delays in receipt of results
- Questionable epidemiological studies used to develop standards
- Ambient water quality standards often applied to runoff
- Unreasonable TMDLs

Previous Assessment

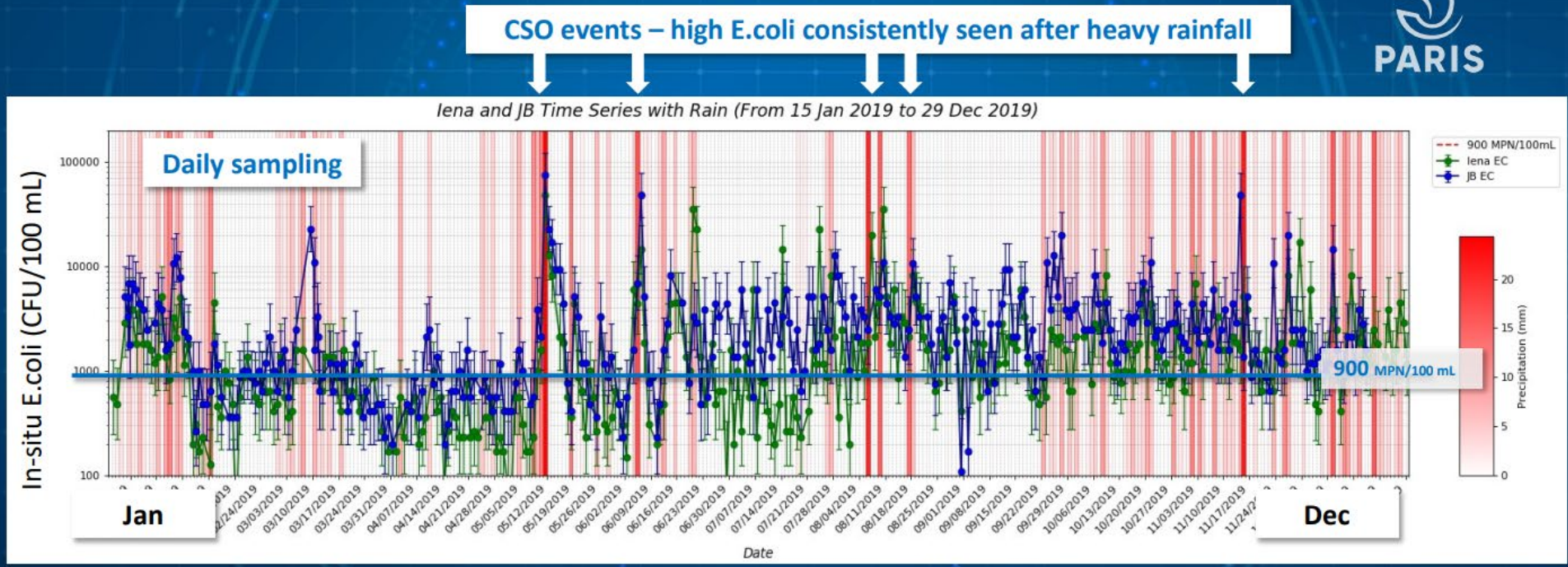
- Field observations/odors
- Indicator grab sampling
  - Fecal coliform
  - Enterococci
  - *E. coli*
- Field test kits – presence/absence or approximate
- Surrogates or tracers – optical brighteners, tryptophan, sucralose, pharmaceuticals
- Microbial source tracking



Swimming in Paris: A vision becoming a reality

- 2017 - Villette basin becomes first-ever approved Paris open-water swim site
- 2024 - Olympic Games to host aquatic events in open-water (Seine River)
- 2025 - Open-water swimming areas to be opened to the public

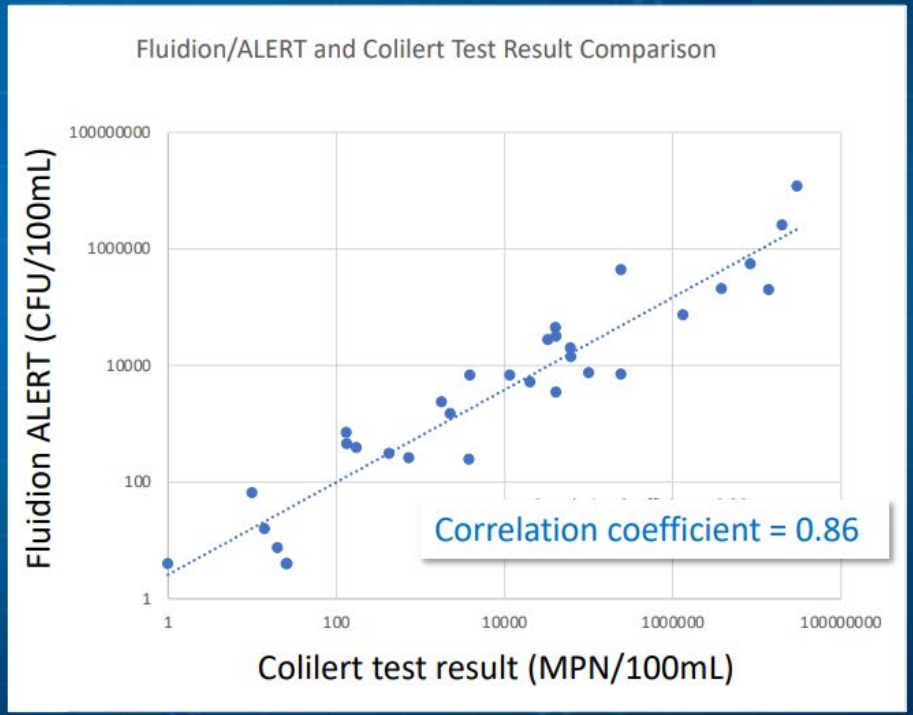
High-frequency data captures CSO events over the course of the year (2019, Paris)



Tijuana River: Evaluating impact of illegal sewage dumping

- Excellent agreement with EPA-approved lab method over 8 LOG units
- Evaluated and validated by the San Diego RWQCB, investigative order issued

CALIFORNIA WATER BOARDS San Diego - R9



Fluidion Alert Products

Analyzers

Fluidion analyzers cover a large range of water quality parameters, from water microbiology to multi-parameter chemistry, and are fully operational out-of-the-box. They can operate on battery and are IoT-enabled, transmitting all data wirelessly to our Data Analytics interface for centralized management of monitoring operations.

ALERT System V2

The ALERT System V2 is an autonomous in-situ analyzer for detecting E.coli and coliforms. Remotely controllable, it provides accurate, real-time water quality data and alerts, simplifying monitoring operations in any aquatic environment.

ALERT Lab

The ALERT Lab is a portable, remote-controlled analyzer that measures E.coli and other bacteria. It provides rapid, on-site bacterial enumeration for source water and environmental monitoring in labs or field locations.

ALERT One

The ALERT One is a compact portable analyzer for measuring bacterial contamination (E.coli, total coliforms, fecal coliforms) in a single sample of drinking or surface water. It works autonomously in any field location, powered from a universal USB-C port.

e-CHEM V2

The e-CHEM® Chemical Analyzer is a miniaturized, autonomous system for multi-parameter drinking water analysis using microfluidic technology. It can operate for several weeks in a row on a single battery charge while communicating wirelessly.

Alert Lab Testing

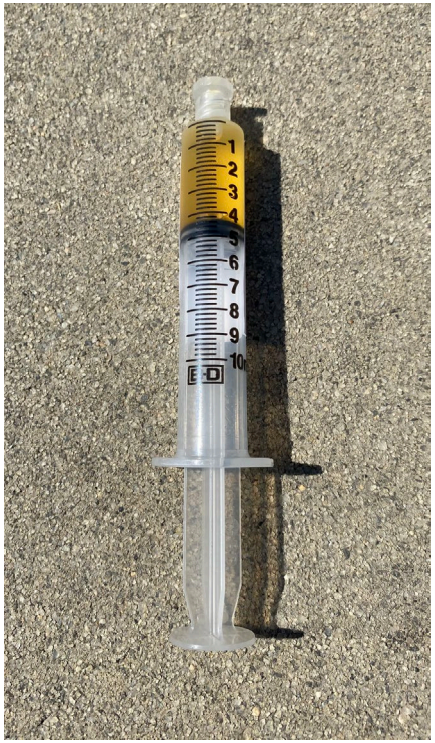
City of Columbia, SC

Alert Lab

- Measures in situ concentrations of bacteria after incubation – *E. coli*, Enterococci, Fecal Coliform
  - Capacity to analyze 6 samples, with addition of reagent
  - Individual sample incubation
  - Battery powered for field use
  - Includes built-in datalogger/modem – transmits to dashboard for operation
  - Similar analytical approach to standard lab methods

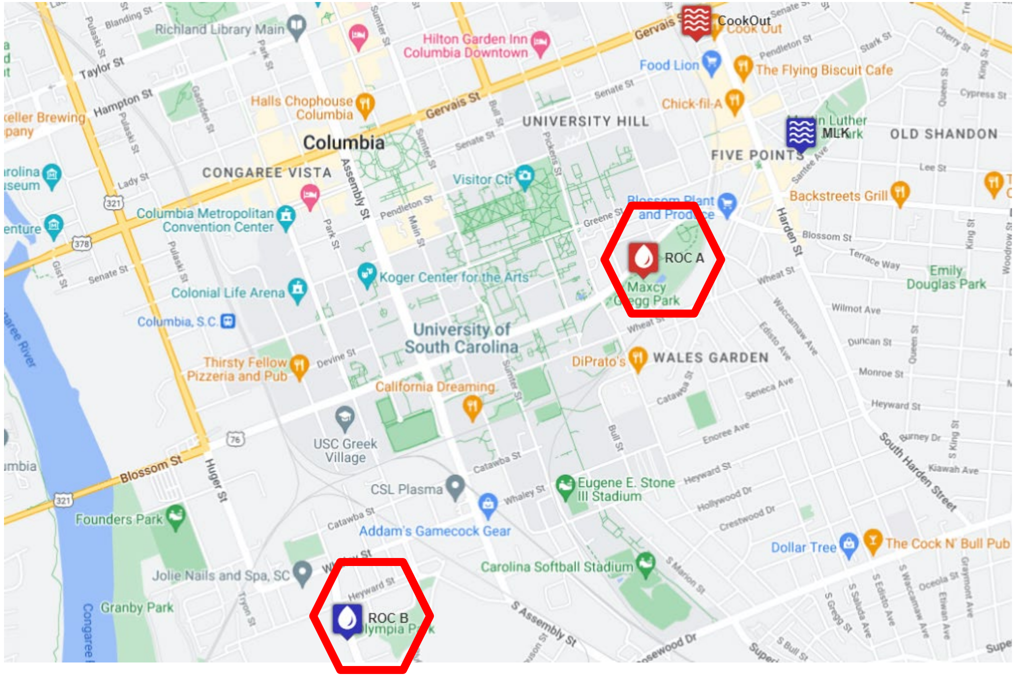
Alert Lab

- Measures in situ concentrations of bacteria after incubation – *E. coli*, Enterococci, Fecal Coliform
  - Ease of operation and maintenance
  - Reduces delays in results from several days to hours (8-12 hrs)
  - Reagent syringes – reagent best if used in 90 days
  - Passed WHO and Unicef verification
  - Measures free bacteria and bacteria absorbed to sediment



Columbia Monitoring Stations

- Rocky Branch
- Drains downtown and “Five Points” area
- Bacteria TMDL watershed



Alert Lab

Dashboard

Fluidion Data

My Dashboard

My Subscriptions

My Account

fluidion Water Intelligence

Device Information | Cell Status | Sample History | Command Portal

Dashboard / A5223005653 Woolpert Demo

Device Information - A5223005653 Woolpert Demo

Label	Woolpert Demo
Tags	
Type	ALERT Lab
Battery	12.3
GSM Number	882360019021292
GSM Signal	26 (LTE)
Last sync	2024-08-22 09:17:56
Last communicate	2024-08-22 09:19:23

Location	-82.411014,34.8270440
Last GPS Update	2024-08-13 10:09:49
Firmware Version	V5.56
Measurement type	E. Coli/Total Coliform
Absorbance notification	On
Fluorescence notification	On
Calibration	E. Coli/Total Coliform Fresh Water 1

Settings

Cell Status

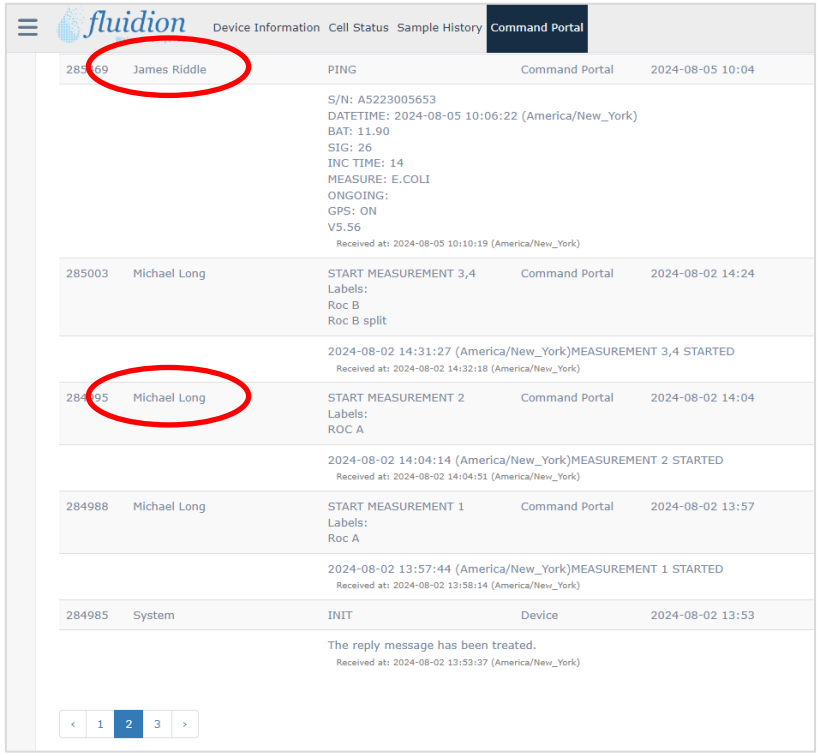
● - Cell Ready ● - Cell Full ● - Cell empty

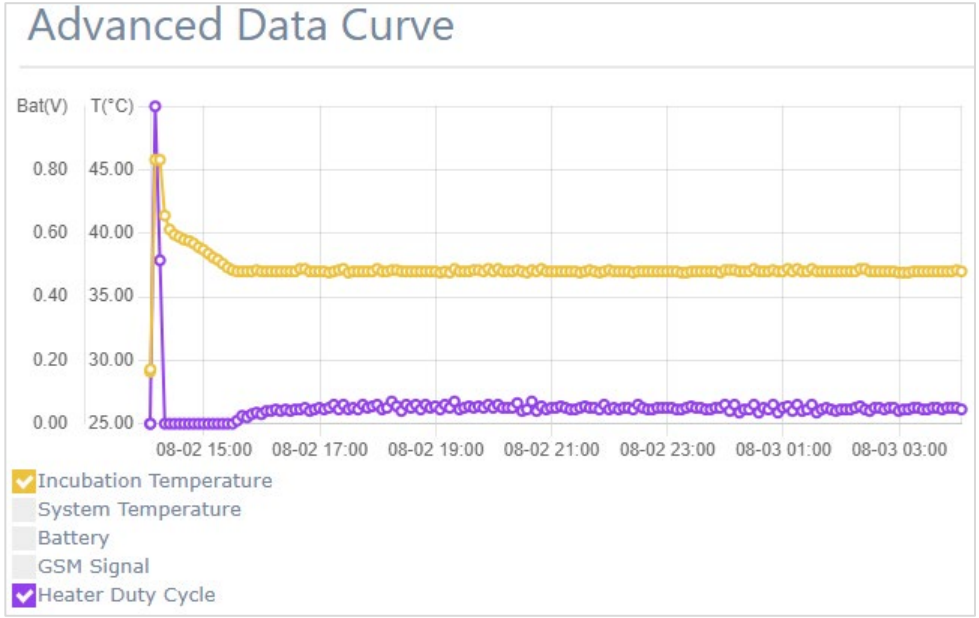
Cell 1 ● | Cell 2 ● | Cell 3 ● | Cell 4 ● | Cell 5 ● | Cell 6 ●

Cell #1 - Cell is available and ready for starting a new measurement.

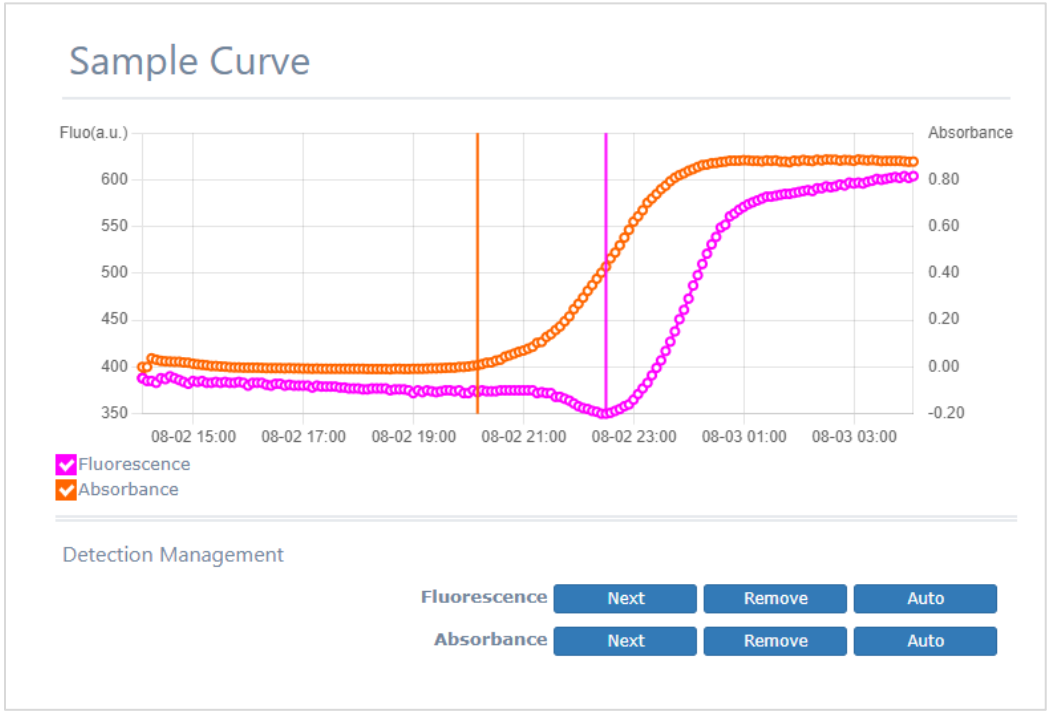
WOOLPERT

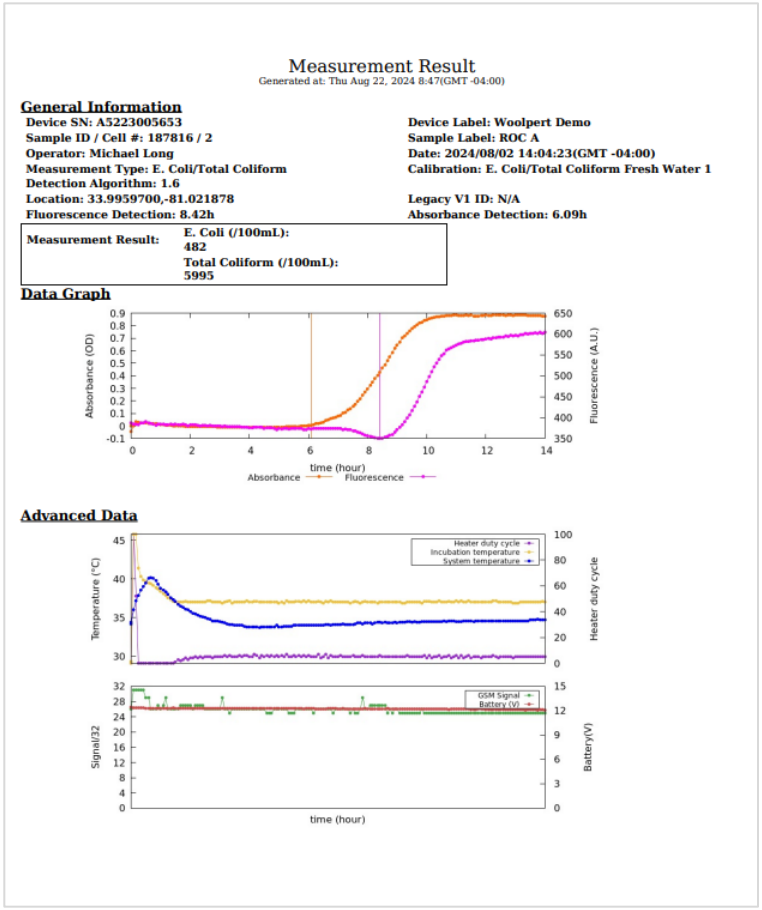
Dashboard Info





Results





Measurement Result

Generated at: Thu Aug 22, 2024 8:47(GMT -04:00)

General Information

Device SN: A5223005653
Sample ID / Cell #: 187816 / 2
Operator: Michael Long
Measurement Type: E. Coli/Total Coliform
Detection Algorithm: 1.6
Location: 33.9959700,-81.021878
Fluorescence Detection: 8.42h

Device Label: Woolpert Demo
Sample Label: ROC A
Date: 2024/08/02 14:04:23(GMT -04:00)
Calibration: E. Coli/Total Coliform Fresh Water 1
Legacy V1 ID: N/A
Absorbance Detection: 6.09h

Measurement Result: **E. Coli (/100mL): 482** **Total Coliform (/100mL): 5995**

Data Graph

Advanced Data

Dashboard Results

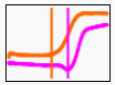
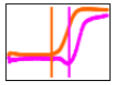
Sample History

Click here for the complete device historical data

Search by tags | ---Data Quality--- | From 2024-07-30 | To 2025-07-30 | Search by ID or label...

Apply | Clear Filter | Reports with Filter | Export with Filter

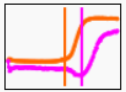
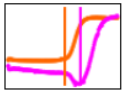
Expand >>

Snapshot	ID	Operator	Cell #	Label	Start Date	Measurement | Calibration	Result	Status
	187816 Detail Report	Michael Long	2	ROC A	2024-08-02 14:04	ECTC | ETFW1	E. Coli (/100mL): **482** Total Coliform (/100mL): **5995**	Finished
	187812 Detail Report	Michael Long	1	Roc A	2024-08-02 13:57	ECTC | ETFW1	E. Coli (/100mL): **356** Total Coliform (/100mL): **5995**	Finished

‹ 1 2 ›

WOOLPERT

Split Samples

	187821 Detail Report	Michael Long	4	Roc B split	2024-08-02 14:31	ECTC | ETFW1	E. Coli (/100mL): **81** Total Coliform (/100mL): **901**	Finished
	187820 Detail Report	Michael Long	3	Roc B	2024-08-02 14:31	ECTC | ETFW1	E. Coli (/100mL): **110** Total Coliform (/100mL): **916**	Finished

Alert V2 Case Study

Charleston County, SC

Fluidion Alert V2

- Measures in situ concentrations of bacteria after incubation – *E. coli*, fecal coliform
  - Eliminates the need for manual grab sampling
  - Battery powered
  - Includes built-in datalogger/modem – transmits to same dashboard as Lab for remote operation
  - Similar analytical approach to standard lab methods
  - Measures bacteria absorbed to sediment
  - Float or fixed mounting options

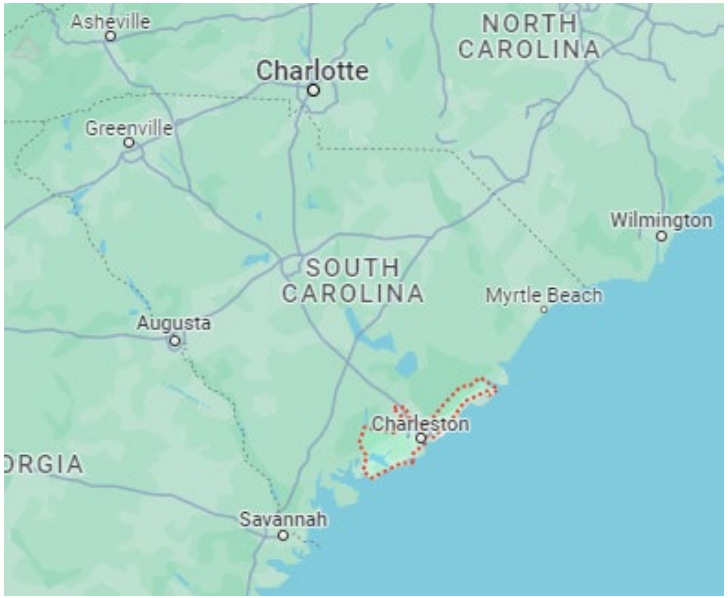
Fluidion Alert V2

- Measures in situ concentrations of bacteria after incubation – *E. coli*, fecal coliform
  - Ease of operation and maintenance
  - Capacity to collect 7 samples without field intervention
  - Can obtain time-series data during nights or weekends
  - Reduces delays in results from several days to hours (8-12 hrs)
  - Cartridge life cycle
    - 90 days for fresh water
    - 30 days for sea water

- Woolpert purchased for rental/use on behalf of our MS4 clients

Charleston County SC

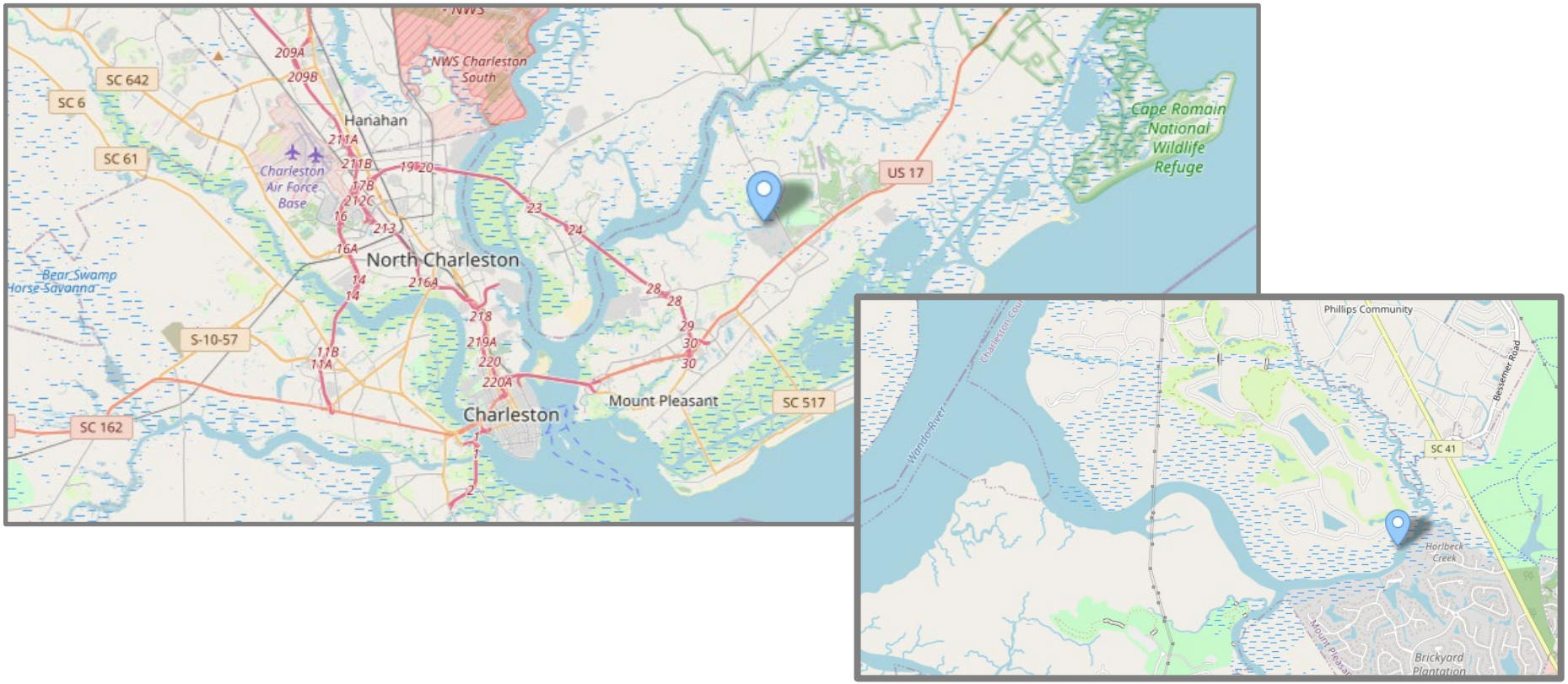
- Permitted Phase 2 MS4
- Third most populous County in SC with over 400,000 residents
- Land Area
  - 1,358 square miles
  - 440 square miles is water (32.4%)



Purpose

- To collect high frequency bacteria and accompanying data at a pilot location to better characterize the following:
  - Frequency of standard exceedances
  - Trends related to tidal conditions or storm water runoff
  - Correlation with other water quality parameters
  - Patterns that might improve source identification and possible MS4 contribution

Pilot Location – Horlbeck Creek



Alert V2 Deployment

Alert V2 Deployment

Key Items:

- Coordination with dock owner and Town
- Daily planned cartridge replacement over 2 weeks – target of 98 samples
- Sea water cartridges were required due to salinity
- Cellular service – LTE-M

Targeted Sampling - Random

Charleston County - Fluidion V2 Deployment In Horlbeck Creek

V2 and Grab Sampling Schedule

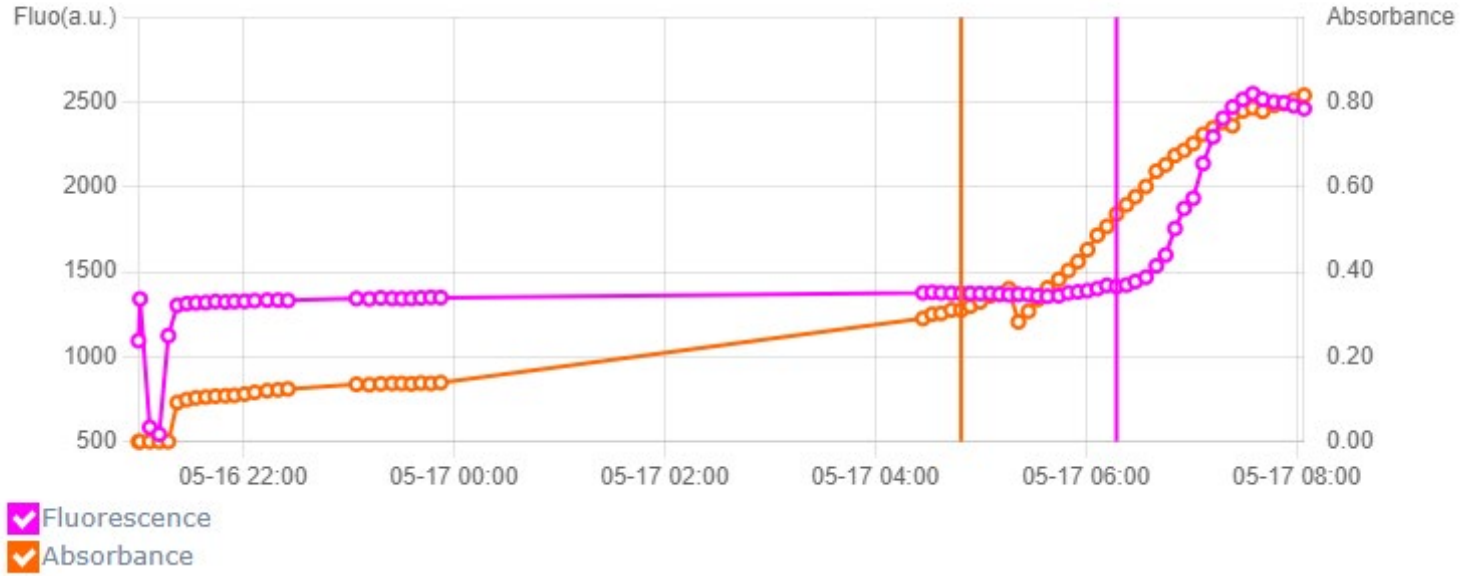
	cartridge replacement
	incubation period after 7th sample - 11 hrs
	incubation complete, awaiting dock access window to replace cartridges, delayed slightly on a few mornings to vary V2 sample start times
X	grab sampling during V2 sample

Day	Date		V2 Sample Increment (hrs)	Hours (HH:MM)																						
											Grab Sample Window															
											V2 Cartridge Replacement Window															
				0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
1	6-May	Mon	3								x			x			X			x			x			x	
2	7-May	Tues	2		x											x		X		x		x		x		x	
3	8-May	Wed	1	x											x	x	x	x	x	x	x						
4	9-May	Thurs	1								x	x	X	x	x	x	x										
5	10-May	Fri	3										X			x			x			x			x		
6	11-May	Sat	3	x			x											x			x			x			x
7	12-May	Sun	3			x			x			x											x			x	
8	13-May	Mon	NA		x			x			X			x			x										
9	14-May	Tues	2									x		x		x		x		x				x			
10	15-May	Wed	2								x		x		x		x		x		x		x				
11	16-May	Thurs	3										x			x			x			x			x		
12	17-May	Fri	3	x			x											x			x			x			x
13	18-May	Sat	1			x			x			x											x	x	x	x	
14	19-May	Sun	1	x	x											x	x	x	x	x	x	x					
15	20-May	Mon	1									x	x	x	x	x	x	x									
			Hourly V2 samples	4	3	2	2	1	2	0	4	5	5	5	4	8	7	7	5	5	5	5	4	5	3	4	3
			Total V2 samples	98																							

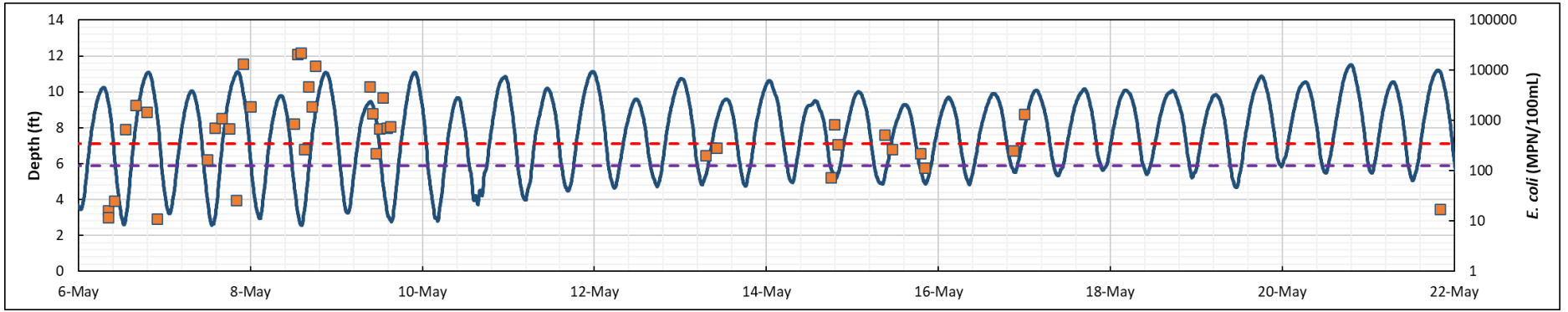
Not all rainbows and butterflies

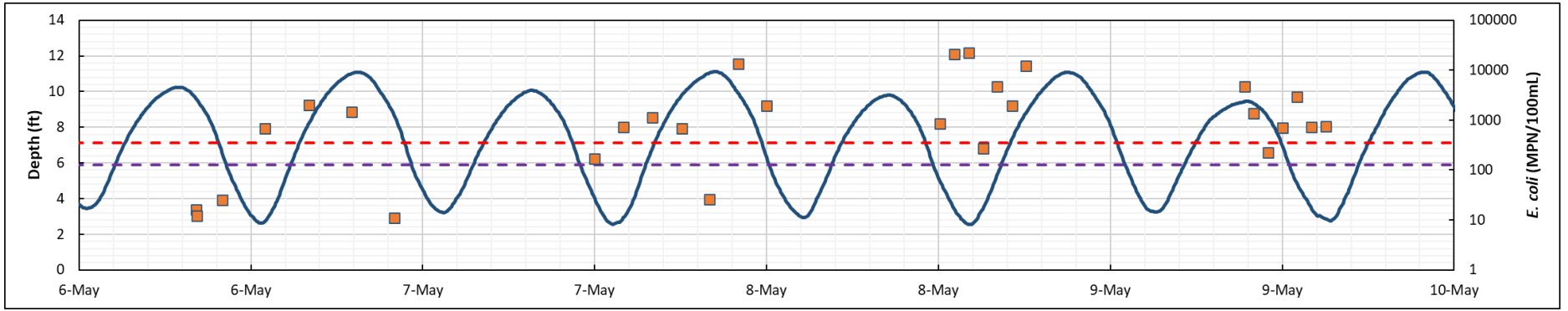
- Moisture blocking pump tubing
- Cellular signal reliability

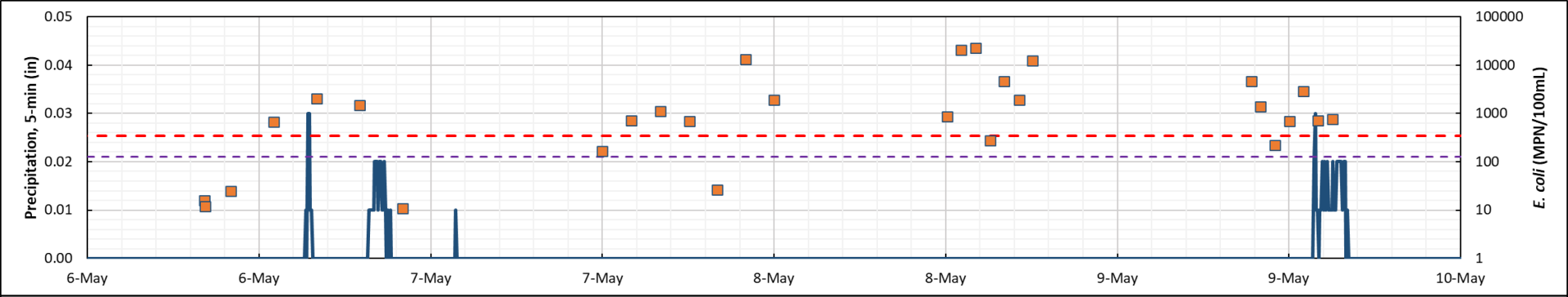
Sample Curve

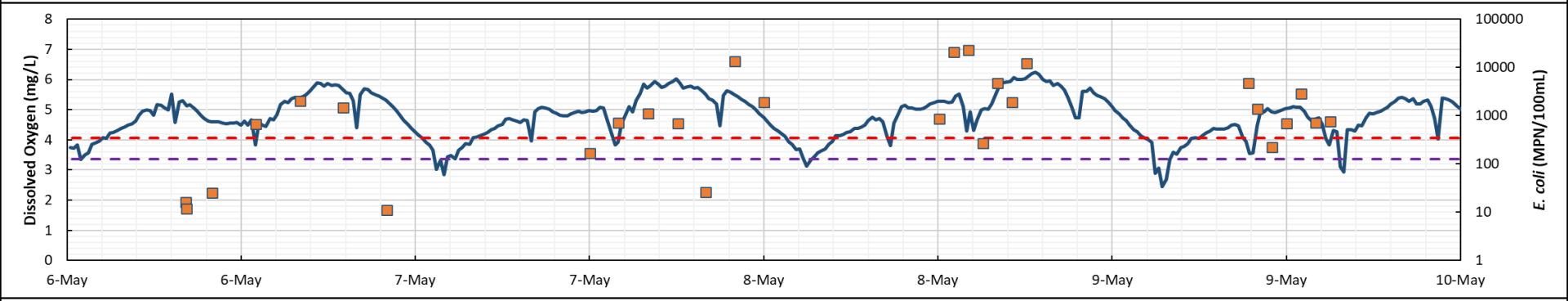


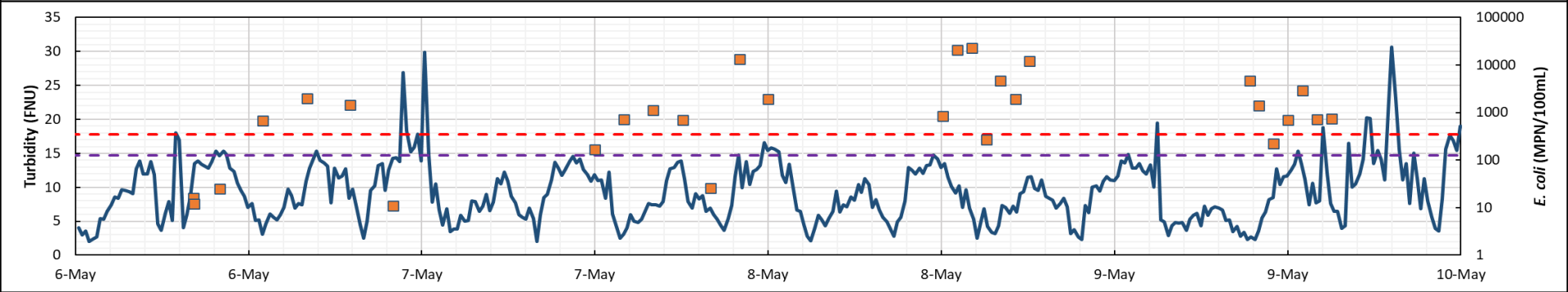
Results


Depth (ft)
14
12
10
8
6
4
2
0
6-May
8-May
10-May
12-May
14-May
16-May
18-May
20-May
22-May
100000
10000
1000
100
10
1
E. coli (MPN/100mL)

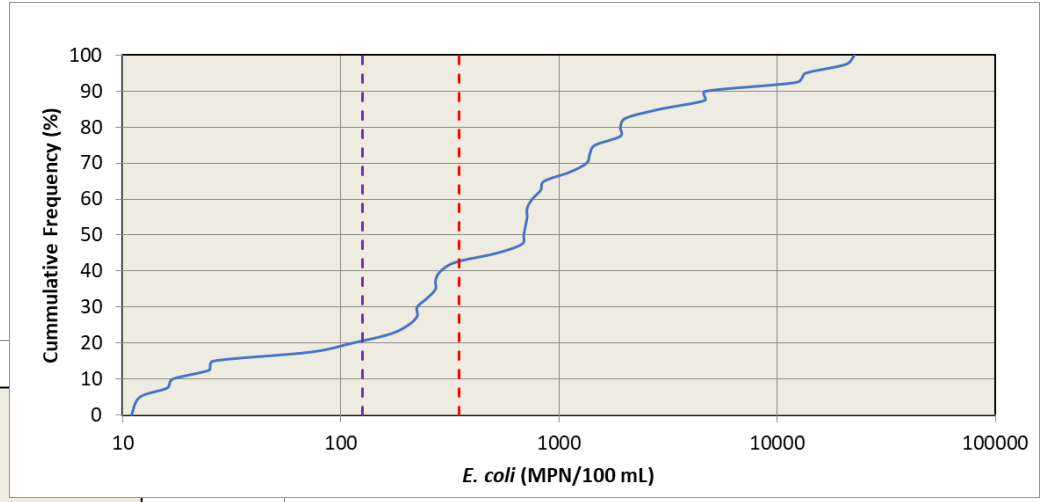

Depth (ft)
14
12
10
8
6
4
2
0
6-May
6-May
7-May
7-May
8-May
8-May
9-May
9-May
10-May
100000
10000
1000
100
10
1
E. coli (MPN/100mL)

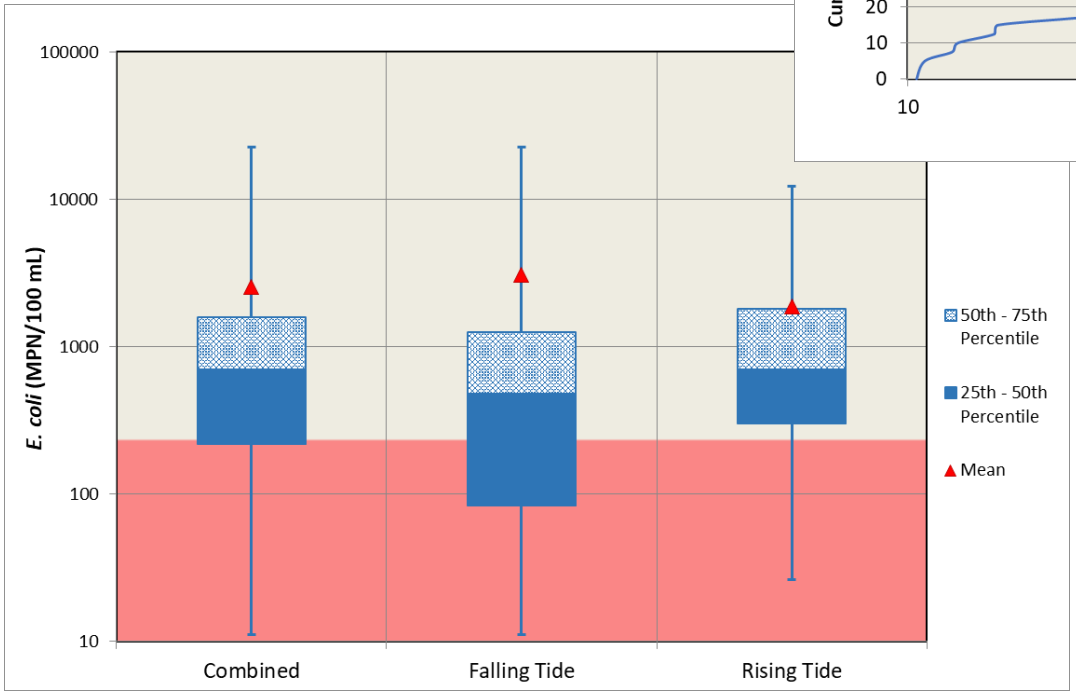

Precipitation, 5-min (in)
0.05
0.04
0.03
0.02
0.01
0.00
E. coli (MPN/100mL)
100000
10000
1000
100
10
1
6-May
6-May
7-May
7-May
8-May
8-May
9-May
9-May
10-May


Dissolved Oxygen (mg/L)
8
7
6
5
4
3
2
1
0
E. coli (MPN/100mL)
100000
10000
1000
100
10
1
6-May
6-May
7-May
7-May
8-May
8-May
9-May
9-May
10-May


Turbidity (FNU)
35
30
25
20
15
10
5
0
E. coli (MPN/100mL)
100000
10000
1000
100
10
1
6-May
6-May
7-May
7-May
8-May
8-May
9-May
9-May
10-May

Results


Cummulative Frequency (%)
100
90
80
70
60
50
40
30
20
10
0
10
100
1000
10000
100000
E. coli (MPN/100 mL)


E. coli (MPN/100 mL)
100000
10000
1000
100
10
Combined
Falling Tide
Rising Tide
50th - 75th Percentile
25th - 50th Percentile
Mean

SC Regulatory Approval

- Although technology not included in EPA analytical methods (40 CFR Part 136)
  - Two Fluidion customers have confirmed data meets EPA's ATPs
  - Flexible language in "*current*" SC Phase 2 MS4 permit

i. Samples and measurements taken for the purpose of the TMDL Monitoring Plan shall:

(1) Be representative of the SMS4 discharges,
(2) Be reasonably distributed in time, while maintaining representative sampling,
(3) Not be terminated for the purpose of preventing the analysis results from a permit or water quality violation,
(4) Describe and consider frequency, mass and/or rate of discharge, as appropriate, and,
(5) Be expressed in terms of units or measurements consistent with the requirements contained in the WLA.

vi. Where field analysis does not involve analytical methods approved under 40 CFR 136, permittees shall provide a description of the method used including the name of the manufacturer of the test method along with the range and accuracy of the test.

iii. The TMDL monitoring plan shall focus on the pollutant of concern, or its surrogates, to characterize the quality and quantity of the SMS4 permitted discharges to evaluate the progress toward the WLA and / or Water Quality Standards (WQS) attainment by implementing one, or a combination, of the following strategies to the MEP:

FL Regulatory Approval

(18) Sampling and monitoring data shall be collected and analyzed in accordance with Rule 62-4.246, Chapter 62-160 and 62-601, F.A.C. and 40 CFR 136, as appropriate.

(a) [*Not Applicable*]

(b) If the permittee(s) monitors any contaminate mo
permit, using Department approved test proced
shall be included in the calculation and reportin
[ANNUAL REPORT].

(c) Calculations for all limitations which require av
an arithmetic mean unless otherwise specified i

(d) Except as specifically provided in Rule 62-16
required by this permit shall be performed by a
through the Department of Health Enviror
Program. Such certification shall be for the m
being measured to comply with this permit.
[*Not Applicable*]

(e) Field activities including on-site test and sample collection shall follow the applicable standard operating procedures described in DEP-SOP-001/01 adopted by reference in Chapter 62-160, F.A.C.

(f) Alternate field procedures and laboratory methods may be used where they have been approved in accordance with Rules 62-160.220 and 62-160.330, F.A.C. [*62-620.610(18), F.A.C.*]

62-160.220 Approval of Alternative and Modified Field Procedures.

(1) Any person or entity may apply for use of a field procedure in place of the approved procedures specified in DEP-SOP-001/01 that is incorporated by reference in paragraph 62-160.800(1)(a), F.A.C., or in place of field procedures that are specified or required in other rules of the Department. Any field procedure proposed for use in place of those specified in DEP-SOP-001/01 or specified or required in other rules of the Department must be approved by the Department prior to use, according to requirements as further described in this rule (Rule 62-160.220, F.A.C.). Field procedures previously approved for use by a contract (including purchase requisitions), order, or permit issued by the Department shall remain approved while such documents remain in effect. In such cases, the documentation that approved the use of the procedure must be retained for at least five years after expiration of the contract, order or permit. Modified or alternative field procedures ~~previously~~ approved by the Department, but not specified in a contract, purchase requisition, order, or permit, shall remain approved indefinitely, unless revoked, ~~except~~ as provided in subsection 62-160.220(9), F.A.C.

(2) through (10) No change.

Limitations

- Need deep enough water to ingest sample without sediment/pluff mud with Alert V2
- Purchase price for direct ownership
- Security of equipment
- Reliable cellular service – LTE-M
- Indicator bacteria – instrument configuration

Applications

- Evaluate variability/range in bacteria over short windows of time
  - MS4 compliance – 303d, TMDLs, BMP performance
  - Sanitary sewer leaks/overflows/success of rehab
  - Freshwater public swimming areas, public health advisories
  - Beaches – advisories, removal of advisories
  - Oyster beds and harvesting
  - Others - triathlons, water parks

- Develop regression equation for bacteria

Our Role

- First purchaser in southeastern US
- Offered opportunity earlier this year to become distributor
- Benefits to you:
  - Tech support from those you know
  - Users that can relate to your challenges firsthand
- Still services provider first and foremost
- These products are not always the right solution

Questions?

James Riddle, PE
Vice President
Program Director | Water Market
D: 803.214.5920 | M: 803.422.4048
james.riddle@woolpert.com