

Finally!! Automated, In Situ Bacteria Measurement

MS4 Case Studies using the Fluidion Alert V2

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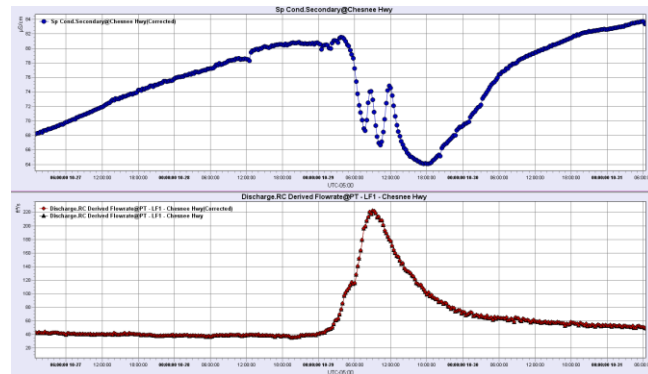
The Bacteria Conundrum

- 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 – tryptophan, sucralose, pharmaceuticals
- Microbial source tracking



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 dashboard 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



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

Seine River



La Villette

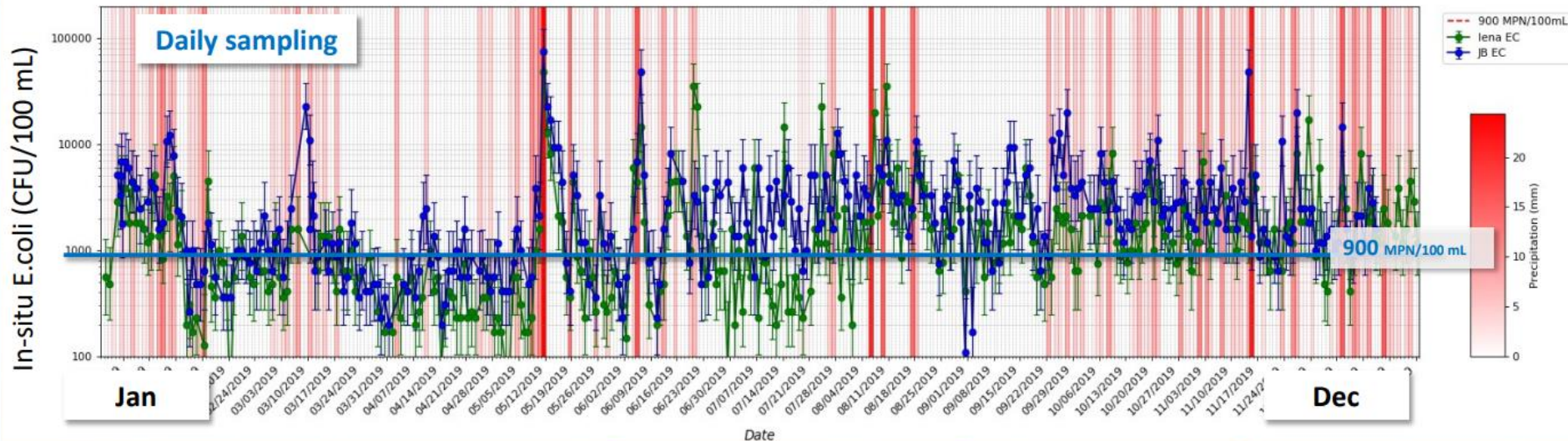


High-frequency data captures CSO events over the course of the year (2019, Paris)



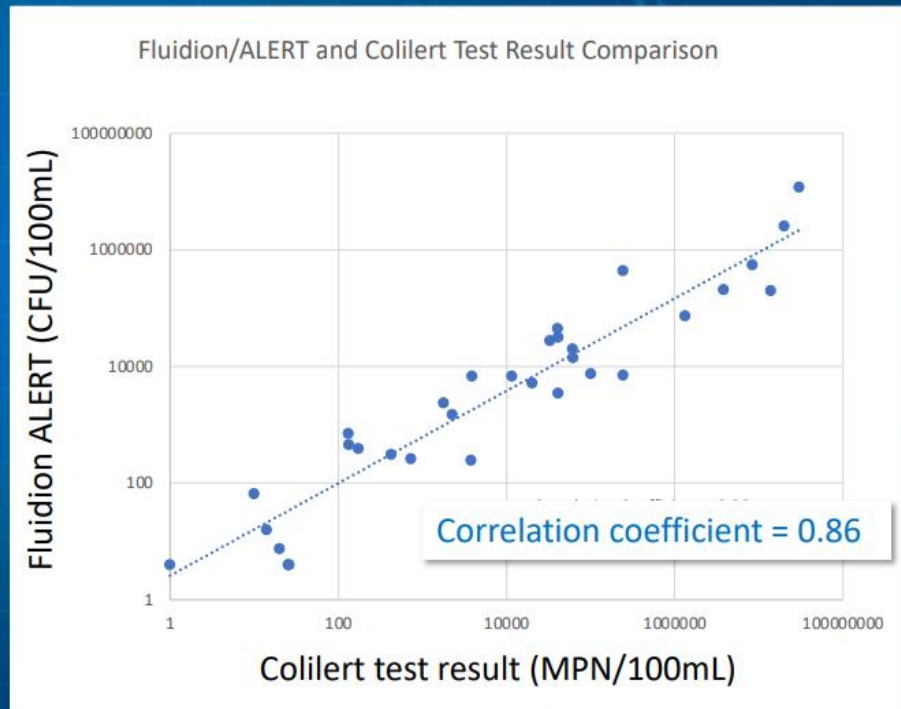
CSO events – high E.coli consistently seen after heavy rainfall

Iena and JB Time Series with Rain (From 15 Jan 2019 to 29 Dec 2019)



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



Case Study #1

Confidential Client

Project Specifics

- Inland community and permitted Phase 2 MS4
- Located within TMDL watershed for DO and bacteria - requires sampling
- Woolpert developed and implementing SWMP
- Small urban watershed approx. 2 square miles – includes continuous water quality monitoring station downstream
- Client interested in pilot project to assess potential benefit of high frequency E Coli data from Alert V2

Scope of Work

- Floating lake deployment on client behalf (weekly rental)
- Two-week deployment – O&M and cartridge replacement
- Programming and sample initiation
- Fluidion dashboard access to monitor sample status
- Data analysis and summary results



Table 4: Summary Statistics of *E. coli* Grab Samples

| Summary Statistics: <i>E. coli</i> Grab Samples, 2022 | | | | | |
|---|----------------|--------|-----|--------|-------|
| Parameter | Geometric Mean | Median | Min | Max | Count |
| <i>E. coli</i> | 5,049 | 6,896 | 350 | 48,390 | 19 |

Alert V2 Deployment



Alert V2 Deployment



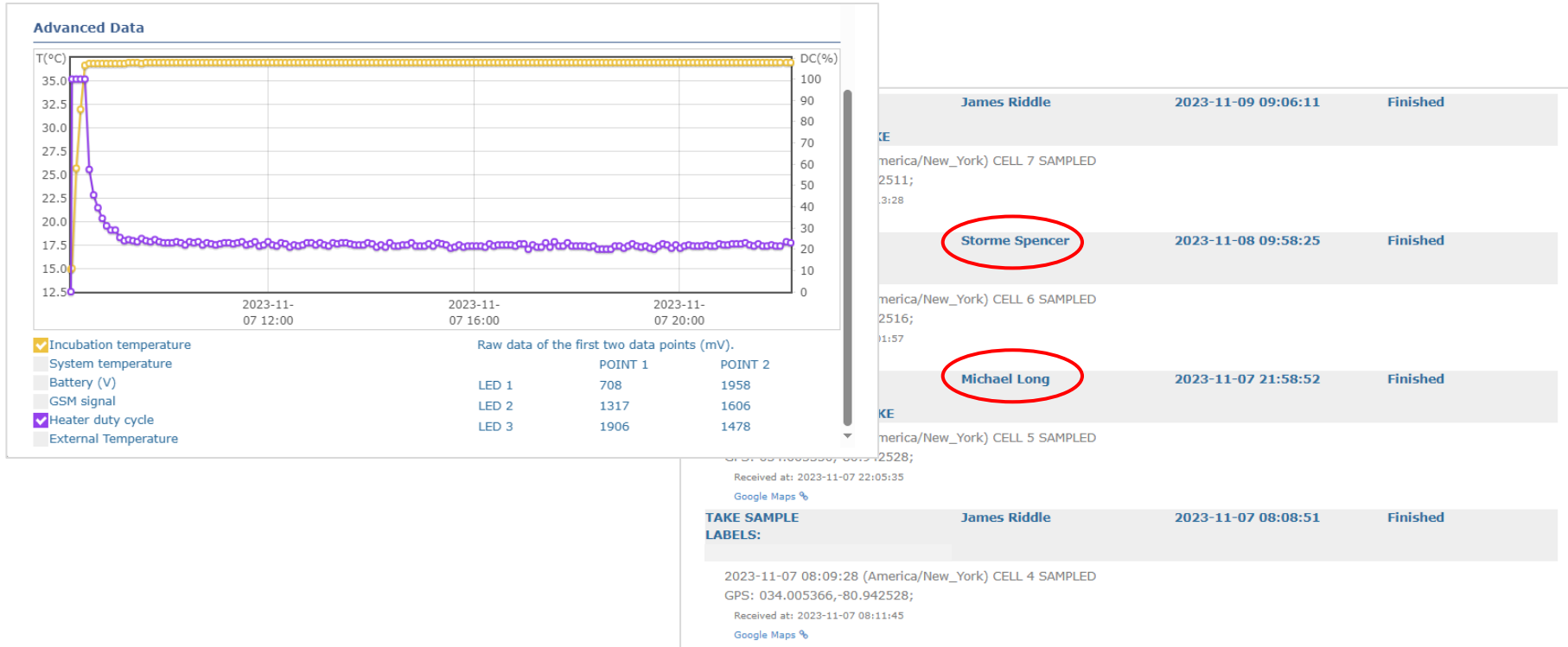
Dashboard



Measurement history

| ID | Operator | Information | Status |
|--------|--------------|---|----------|
| 186227 | James Riddle | Cartridge: 6 Label: Tag: Result: E. Coli: 49 /100mL Total Coliform: 100 /100mL Date: 2023-11-01 20:45:29 Location: 34.00536,-80.942485 show data graph generate report | Finished |
| 186209 | James Riddle | Cartridge: 5 Label: Tag: Result: E. Coli: 875 /100mL Total Coliform: 947 /100mL Date: 2023-10-30 12:04:13 Location: 34.005348,-80.942497 show data graph generate report | Finished |
| 186201 | Michael Long | Cartridge: 4 Label: Tag: Result: E. Coli: 5 /100mL Total Coliform: 1573 /100mL Date: 2023-10-28 14:27:19 Location: 34.005363,-80.942481 show data graph generate report | Finished |
| 186199 | Michael Long | Cartridge: 3 Label: Tag: Result: E. Coli: 1160 /100mL Total Coliform: 1227 /100mL Date: 2023-10-27 07:27:55 Location: 34.005363,-80.942497 show data graph generate report | Finished |

Dashboard

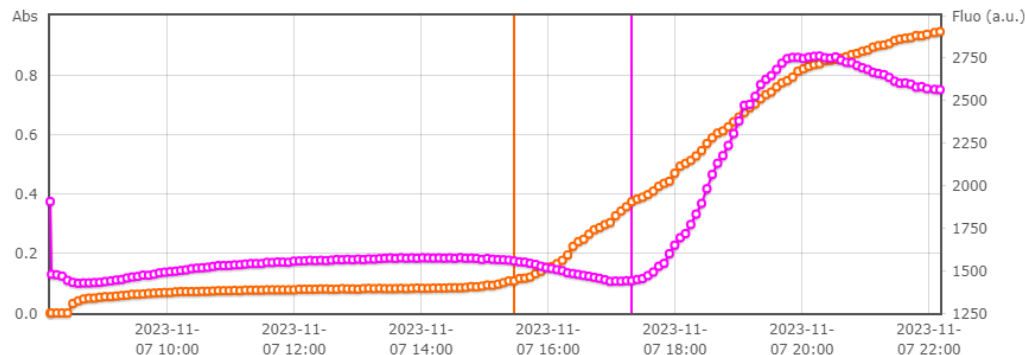


Sample Results

Select a calibration to see different results: [E. Coli/TC ALERT System V2 Freshwater - Beta 2.0](#) ▼

Calculated E. Coli concentration: 249 /100mL.

Calculated Total Coliform concentration: 1746 /100mL.



☒ Absorbance
☒ Fluorescence

Find next detection

Remove detection

Find next detection

Remove detection

Set measurement invalid

Show advanced data

Export

Report

Measurement Result

Generated at: Tue Dec 12, 2023 13:56(GMT -05:00)

General Information

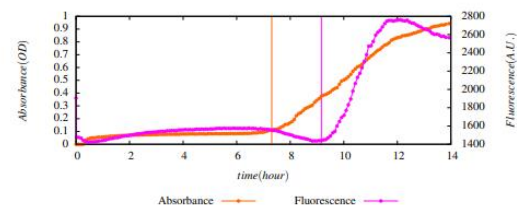
Device: A5322008840
Measurement ID: 186265
Sample Cartridge: 4
Sampled By: James Riddle
Measurement Type: E. Coli/Total Coliform
Location: 034.005375,-80.942510
Fluorescence Detection: 9.16h

Sample Date: 2023-11-07 08:09:28(GMT -05:00)
Sample Status: Finished
Calibration: E. Coli/TC ALERT System V2 Freshwater - Beta 2.0

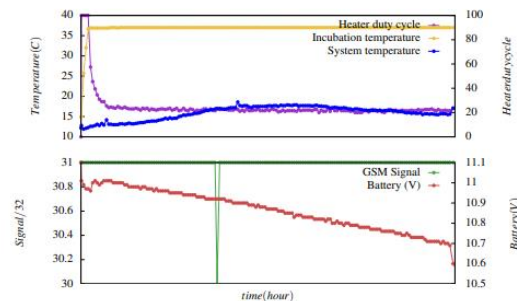
Absorbance Detection: 7.31h

Measurement Result: E. Coli level: 249/100mL.
Total Coliform level: 1746/100mL.

Data Graph

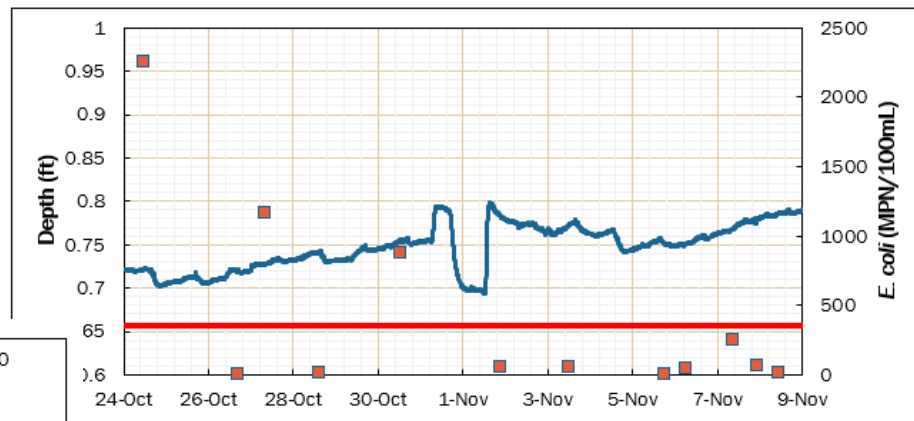
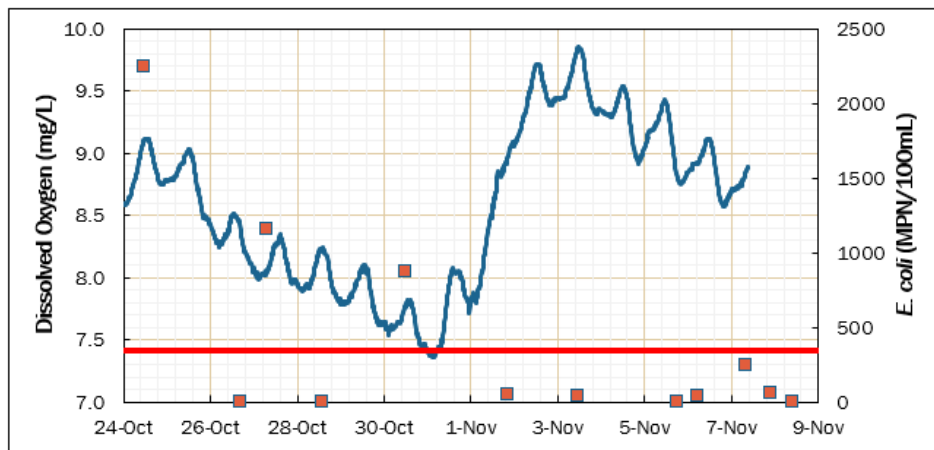


Advanced Data



Analytical Results

| E Coli | WQ Standard | Results |
|---------------|-------------|---------|
| Geomean | 126 | 57 |
| Single Sample | 349 | 2249 |



| | |
|-------------------|---|
| <i>f. E. coli</i> | Not to exceed a geometric mean of 126/100 ml based on at least four samples collected from a given sampling site over a 30 day period, nor shall a single sample maximum exceed 349/100 ml. |
|-------------------|---|

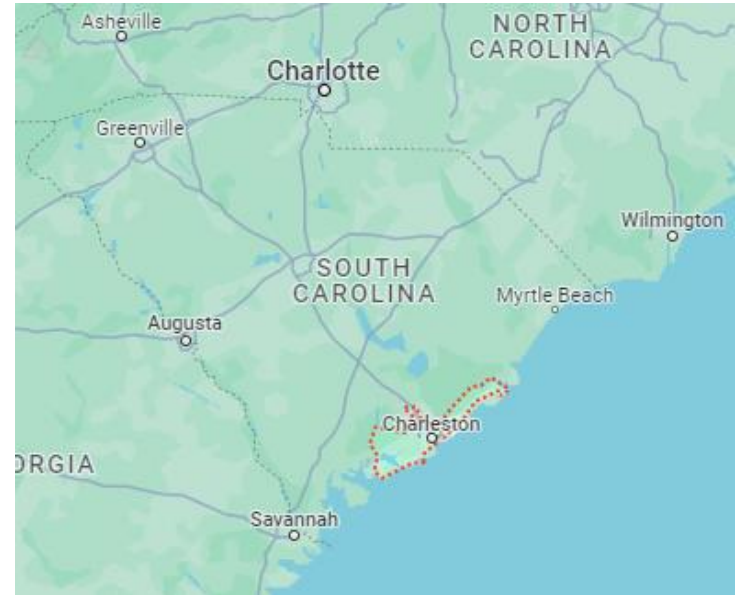
FL Recreational Waters - MPN or MF counts shall not exceed a monthly geometric mean of 126 nor exceed the Ten Percent Threshold Value (TPTV) of 410 in 10% or more of the samples during any 30-day period. Monthly geometric means shall be based on a minimum of 10 samples taken over a 30-day period.

Case Study #2

Charleston County, SC

Charleston County SC

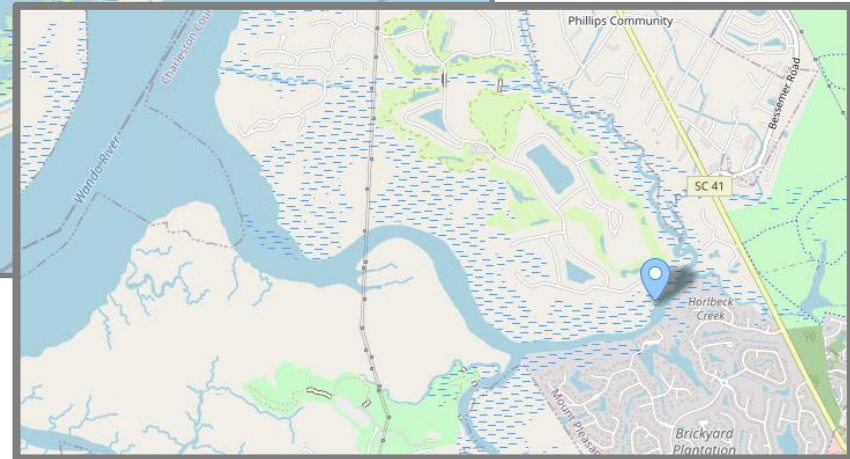
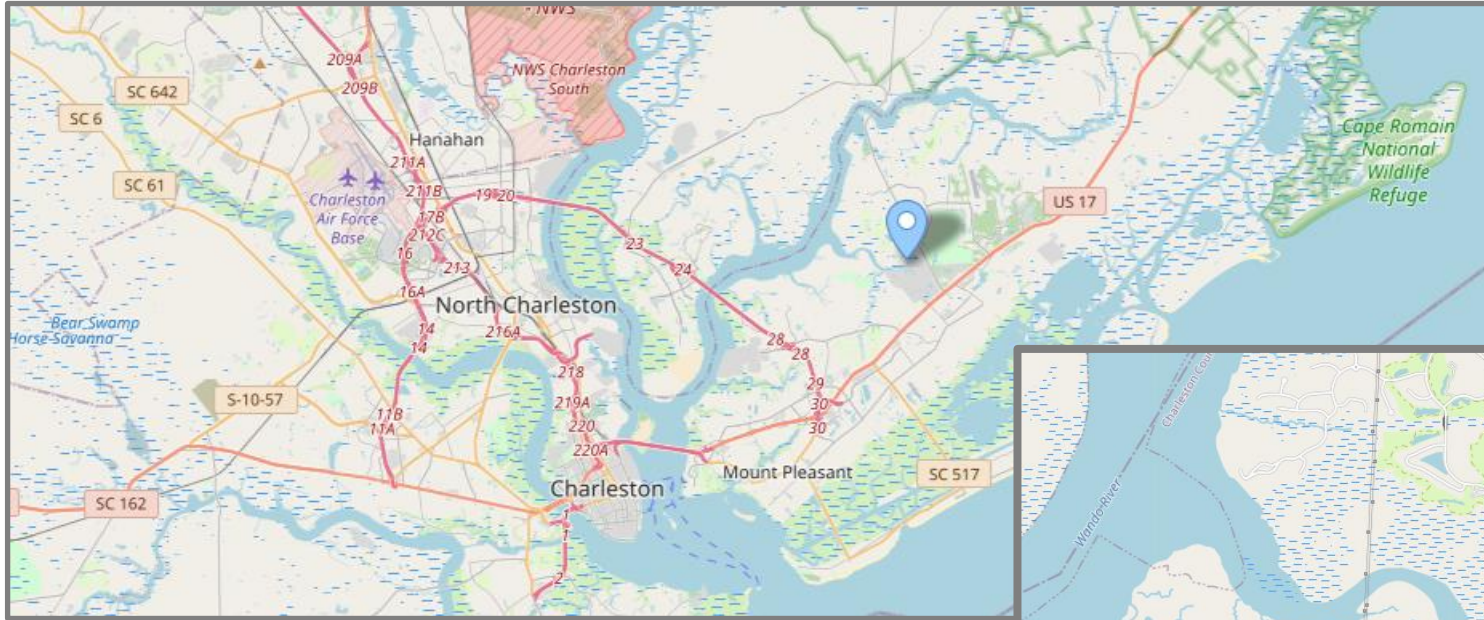
- Permitted Phase 2 MS4
- Third most populous County in SC with over 400,000 residents
- Land Area
 - 1,358 square miles
 - 440 square miles is water (32.4%)



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
- County conducted daily sampling
- Cellular service – LTE-M



Targeted Sampling - Random

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----|--|--------|---------------------------|-------------------|----|---|---|---|---|----|----|----|----|---------------------------------|------|------|------|------|------|------|--------------------------------|---|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|--|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | | | | | | | | | | | | |
| 1 | Charleston County - Fluidion V2 Deployment In Horlbeck Creek | | | | | | | | | | | | | | | | | | | | cartridge replacement | | | | | | | | | | | | | | | | | | | |
| 2 | V2 and Grab Sampling Schedule | | | | | | | | | | | | | | | | | | | | | incubation period after 7th sample - 11 hrs | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | incubation complete, awaiting dock access window to replace cartridges, delayed | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | slightly on a few mornings to vary V2 sample start times | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | X | grab sampling during V2 sample | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 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 | | | |
| 11 | 1 | 6-May | Mon | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | 2 | 7-May | Tues | 2 | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | 3 | 8-May | Wed | 1 | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | 4 | 9-May | Thurs | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | 5 | 10-May | Fri | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | 6 | 11-May | Sat | 3 | x | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | 7 | 12-May | Sun | 3 | | | | x | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | 8 | 13-May | Mon | NA | | x | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | 9 | 14-May | Tues | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 10 | 15-May | Wed | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | 11 | 16-May | Thurs | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | 12 | 17-May | Fri | 3 | x | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | 13 | 18-May | Sat | 1 | | | | x | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | 14 | 19-May | Sun | 1 | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | 15 | 20-May | Mon | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 27 | | | | 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 | | | | | | | | | | | | |
| 28 | | | | Total V2 samples | 98 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Dashboard

Fluidion Data

My Dashboard

My Subscriptions

My Account

fluidion

Water Intelligence

Device Information

Schedules

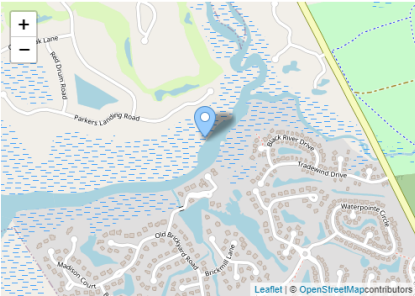
Cell Status

Sample History

Command Portal

Dashboard / A5322008840 Horlbeck Crk

Device Information - A5322008840 Horlbeck Crk



| | |
|------------------|---------------------|
| Label | Horlbeck Crk |
| Tags | |
| Type | ALERT System V2 |
| Battery | 12.53 |
| GSM Number | 882360016912313 |
| GSM Signal | 27 (LTE) |
| Last sync | 2024-06-04 20:06:47 |
| Last communicate | 2024-06-04 20:40:11 |
| Deep Sleep Mode | Deep Sleep Off. |

Settings

| | |
|--|------------------------------------|
| Location | -79.811392,032.870042 |
| Last GPS Update | 2024-05-22 09:25:21 |
| Firmware Version | V2.14 |
| Detection Algorithm | 1.6 |
| Measurement type | E. Coli/Total Coliform |
| Absorbance notification | On |
| Fluorescence notification | On |
| Calibration | E.coli/TC ALERT System V2 Seawater |
| Measurement Offset Applied (log10 units) | N/A |

My Account

| | | | | | |
|---|--------------|--|----------------|------------------|-----------------|
| 274498 | SYSTEM | 1716318059 CELL 2 SAMPLED GPS: 032.869830,-79.811172 | Device | 2024-05-21 15:03 | Reply processed |
| The reply message has been treated. Received at: 2024-05-21 15:03:51 (America/New_York) | | | | | |
| 274495 | SYSTEM | 1716314459 CELL 1 SAMPLED GPS: 032.869846,-79.811209 | Device | 2024-05-21 14:02 | Reply processed |
| The reply message has been treated. Received at: 2024-05-21 14:02:57 (America/New_York) | | | | | |
| 274492 | James Riddle | SET SCHEDULE LIST | Command Portal | 2024-05-21 13:17 | Reply processed |
| Schedule 1: 2024-05-21 14:00:00 (America/New_York) Schedule 2: 2024-05-21 15:00:00 (America/New_York) Schedule 3: 2024-05-21 16:00:00 (America/New_York) Schedule 4: 2024-05-21 17:00:00 (America/New_York) Schedule 5: 2024-05-21 18:00:00 (America/New_York) Schedule 6: 2024-05-21 19:00:00 (America/New_York) Schedule 7: 2024-05-21 20:00:00 (America/New_York) Received at: 2024-05-21 13:18:13 (America/New_York) | | | | | |
| 274487 | James Riddle | PING | Command Portal | 2024-05-21 13:11 | Reply processed |

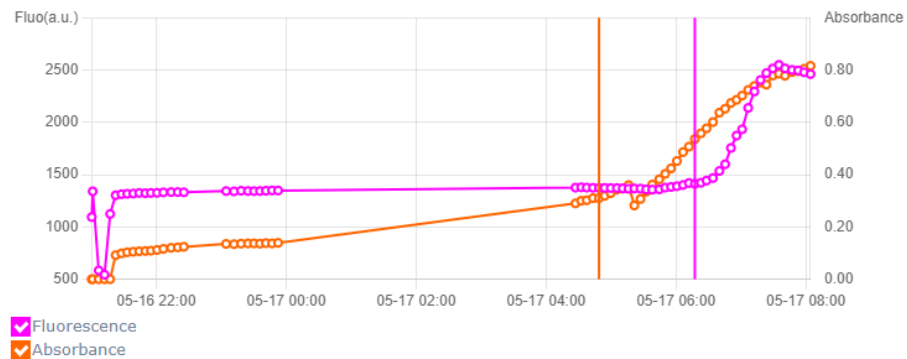
Not all rainbows and butterflies

- Cellular signal reliability
- Humidity and issues with condensate

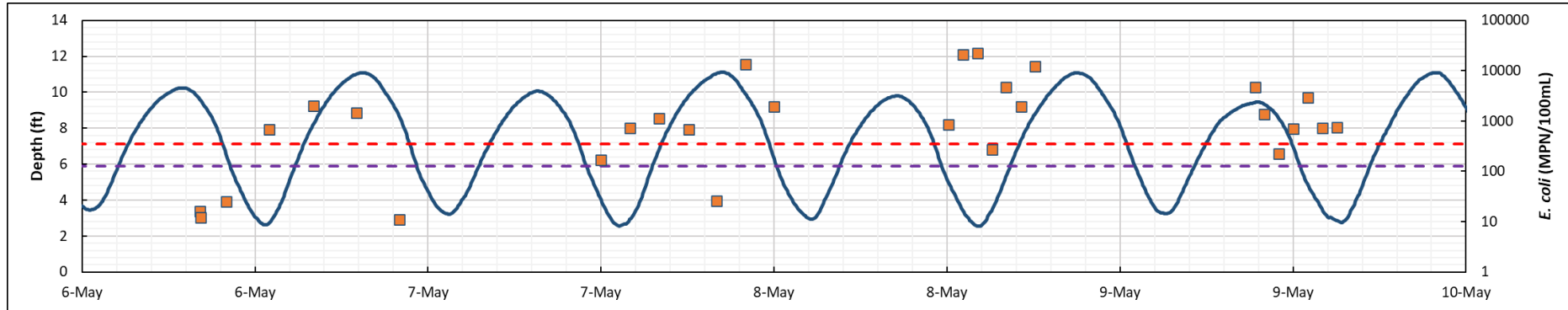
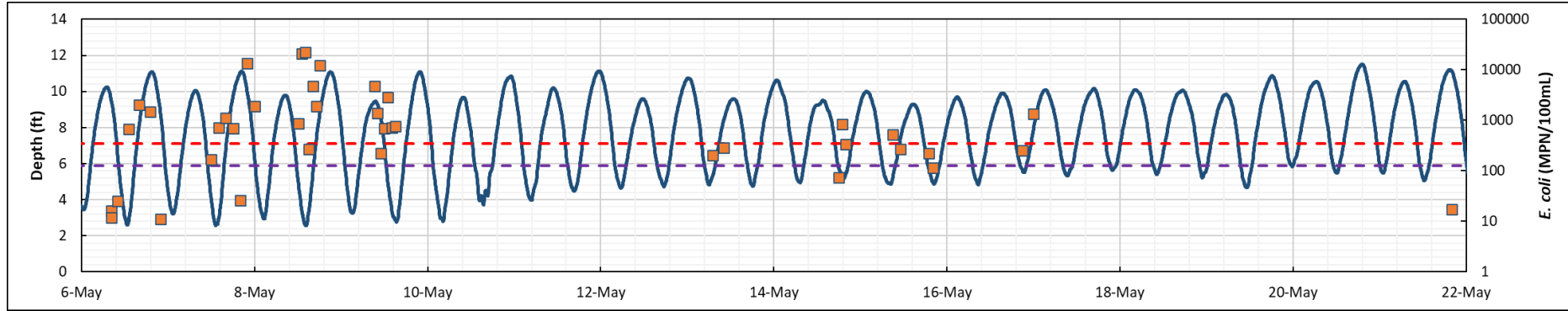


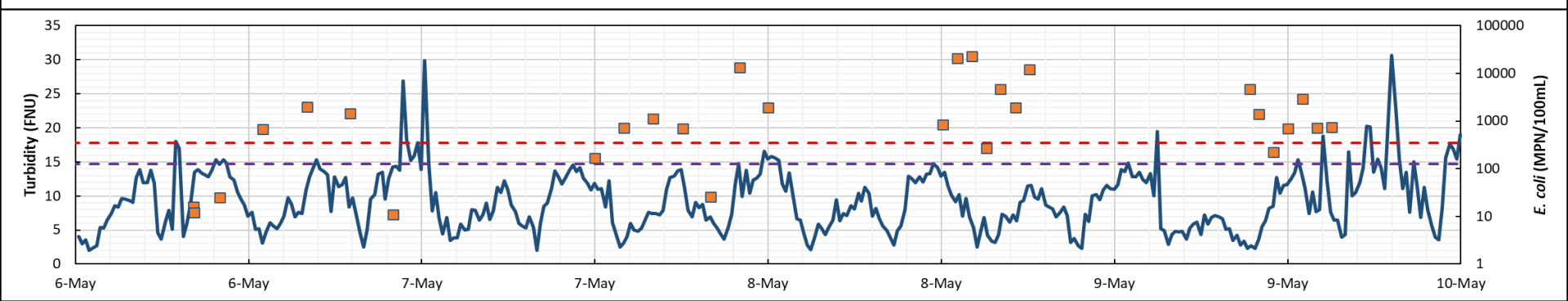
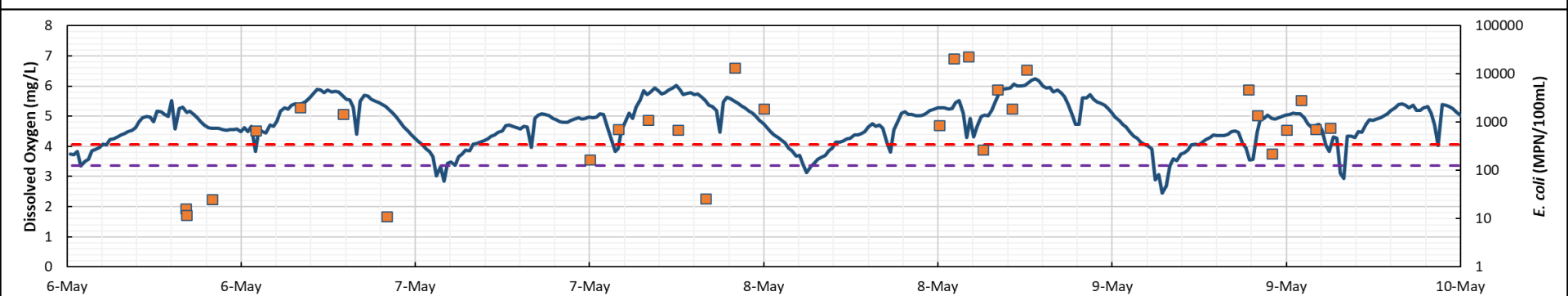
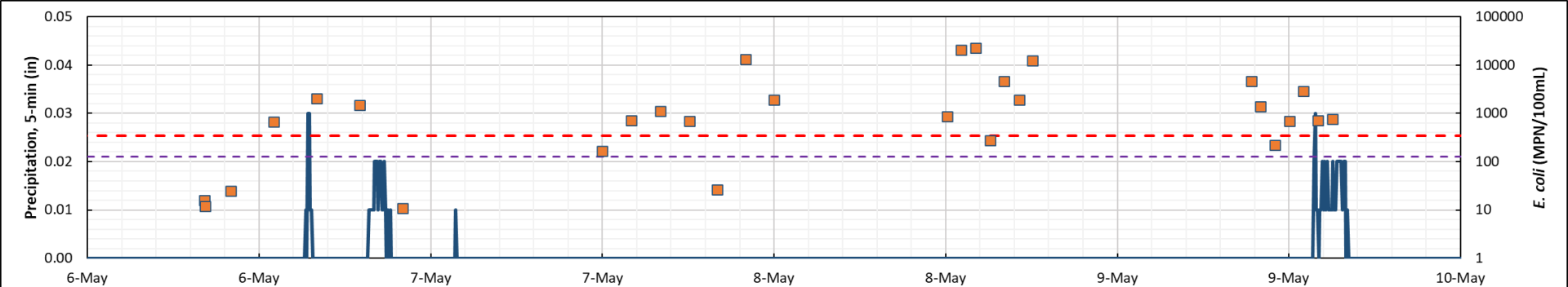


Sample Curve

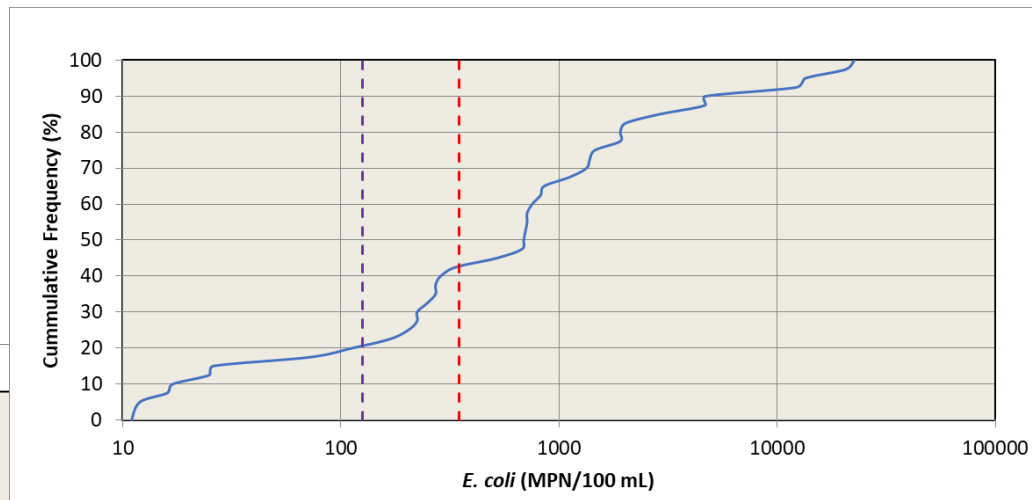
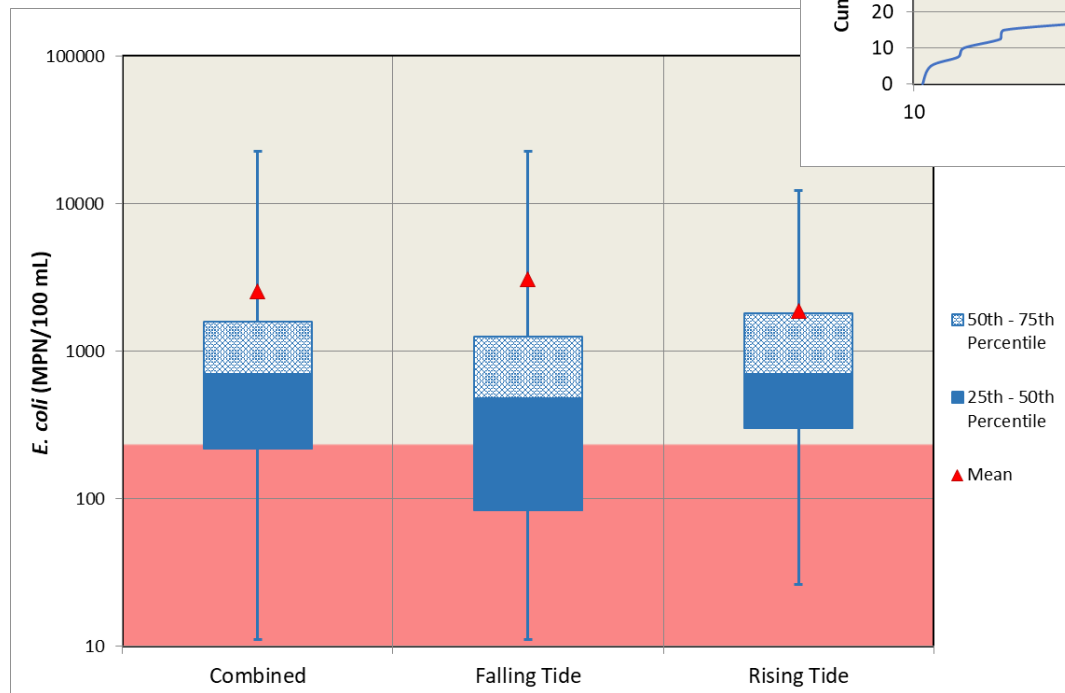


Results





Results



FL Regulatory Approval

**New technology not included in EPA analytical methods (40 CFR Part 136) but two Fluidion customers have confirmed data meets EPA's ATPs*

- (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 on the permit, using Department approved test procedures, shall be included in the calculation and reporting [ANNUAL REPORT].

(c) Calculations for all limitations which require averaging an arithmetic mean unless otherwise specified in the permit.

(d) Except as specifically provided in Rule 62-160.220, all sampling required by this permit shall be performed by a certified person through the Department of Health Environment and Natural Resources Program. Such certification shall be for the method of 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.

FL Regulatory Use - IDDE

| STORMWATER MANAGEMENT PROGRAM: | | |
|---|--|-----------------------|
| 7. c.) <i>Illicit Discharges and Improper Disposal — Inspection and Investigation of Suspected Illicit Discharges and / or Improper Disposal.</i> | | |
| PERMITTEE | ACTIVITY | REPORTING REQUIREMENT |
| | Implement a proactive inspection program to inspect the MS4 and identify and eliminate sources of illicit discharges, illicit connections, illegal dumping, or other sources of non-stormwater to the MS4 (excluding those non-stormwater discharges listed in Part II.7.a). | |



| STORMWATER MANAGEMENT PROGRAM: | | |
|--|--|---|
| 7. g.) <i>Illicit Discharges and Improper Disposal — Limitation of Sanitary Sewer Seepage.</i> | | |
| PERMITTEE | ACTIVITY | REPORTING REQUIREMENT |
| ALL Except FDOT District One and FDOT Florida's Turnpike Enterprise | <p>Implement a wastewater contamination program to reduce or eliminate sanitary wastewater contamination into the MS4, including discharges to the MS4 from sanitary sewer overflows (SSOs) and from inflow / infiltration from collection / transmission systems and / or septic tank systems.</p> <p>Example activities to reduce sanitary wastewater contamination include: repair/lining of sanitary sewer; septic systems removed emergency generator added. The permittee should contact the appropriate authorities for accurate reporting information, such as the sanitary sewer system operator who is responsible for investigating and eliminating SSOs and the local health department who is responsible for permitting / overseeing septic tank systems.</p> <p>Advise the appropriate utility owner of a possible violation if constituents common to wastewater contamination are discovered in the permittee's MS4. The written SOP shall be reviewed annually.</p> <p>Maintain documentation of the SSOs and inflow / infiltration incidents addressed.</p> | Report on the type and number of activities undertaken to reduce or eliminate SSOs and inflow / infiltration, the number of SSOs or inflow / infiltration incidents found and the number resolved, and the name of the owner of the sanitary sewer system within the permittee's jurisdiction, in each ANNUAL REPORT. |

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
- Enterococci not currently available through the Alert V2 (technology is available via the ALERT LAB)



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



Questions?



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