ARCADIS Design & Consultancy for natural and built assets

LONG-TERM INSTRUMENT-BASED MONITORING FOR ASSESSING COMPLIANCE WITH WATER QUALITY STANDARDS

New England Water Environment Association

January 22, 2018

Overview

- Water Quality Monitoring Approaches
- Benefits and Limitations of LTIBM
- Can LTIBM Work for You?
- Equipment Selection and Installation
- Monitoring Workplan
- Data Review and QA/QC
- Case Study
- Conclusions
- Q&A

Water Quality Monitoring Approaches

Traditional Approach

- Grab or composite samples
  - Collect samples and analyze in laboratory
  - Hand-held instruments for real-time data

Enhanced Approach

- Long-Term Instrument-based Monitoring
  - Deployed instruments collect real-time data

Combined Approach

- Traditional + Enhanced

Benefits of LTIBM

- Cost-effective
  - Reduced analytical costs
  - Reduced labor costs
- Instantaneous data
  - No turnaround time
- Monitor water quality continuously
  - Water quality modeling
- Accepted by regulatory and scientific community

Limitations of LTIBM

- Parameter limitations
- Requires periodic maintenance
- Potential for loss of data
- Instruments require protection from damage/ tampering

Can LTIBM Work for You?

Full evaluation of project needs must be performed:

- Identify Driving Force and Project Goals
- Identify Regulatory Agencies and Stakeholders
- Determine Data Needs
- Gather and Review Existing Information

Identify Drive Force and Project Goals

Driving Force: Why am I measuring WQ?

- WQ Standards not being met
- Permit modification
- New discharge

Project Goal: What do I hope to accomplish?

- Assess WQ/Compliance with WQ Standards
- Establish/Modify WQ Standards
- Develop TMDL

Identify Regulatory Agencies and Stakeholders

- Who has has jurisdiction over the study area?
  - Local or National Agency
- Agency approval is paramount (no approval, no program)
  - Agency may dictate program details
- Who is affected by the program (Stakeholders)?
  - While Stakeholder acceptance is not required, it is preferred.

Determine Data Needs

- Ultimately dictated by the needs of the end-user(s)
- Based on several factors:
  - Parameters of Concern
    - Some parameters susceptible to diurnal fluctuations
  - Monitoring Frequency/Locations
  - Regulatory Standards
    - Compliance Requirements (e.g. at all times, daily average)
  - Physical conditions of waterbody
    - Tidal may require more data
    - More point sources, more monitoring locations

Gather and Review Existing Information

- Existing/historical data may supplement/reduce program
  - Reduced costs (Free data: NOAA, USGS)
  - Identify data gaps
- Understand waterbody
  - **Configuration** – Deep and/or wide waterbodies may require multiple depths, cross-sections
  - **Tidal or Non-Tidal** – Tidal cycle may require more frequent monitoring
  - **Saline or Fresh** - Saline water requires more robust materials
  - **Inputs** – Point sources into study area may need to be monitored separately

Has direct impact on equipment and monitoring location selection

Equipment Selection

- Equipment selected based on findings from previous steps
  - Parameters to be monitored
  - Minimum Level of Detection
  - Monitoring Frequency
  - Physical conditions of waterway
- Three types of monitoring configurations

Equipment Selection Cont.

Type 1 – Flow-through sensors

- Water pumped to sensors
- Advantages:
  - Sensors can be kept safely in a housed structure
  - Easiest to install
- Disadvantages:
  - Limited pumping distance
  - Requires power source for pump

Equipment Selection Cont.

Type 1 Configuration

Shoreline flow through setup (Courtesy of the USGS)

Equipment Selection Cont.

Type 2 – Wired In-situ sensors

- Sensors placed directly in waterbody
- Data wire extends to collection system onshore
- Advantages:
  - Data can be downloaded without retrieving sensor
  - No external power source required
- Disadvantages:
  - Requires sensor retrieval for maintenance/calibration
  - Data wire must be protected

Equipment Selection Cont.

Type 2 Configuration

IQ SensorNet 2020 XT Wired In Situ System. (Courtesy of YSI)

Equipment Selection Cont.

Type 3 – Wireless In-situ sondes

- Sondes placed directly in waterbody
- Sondes contains internal memory source
- Advantages:
  - Can be installed anywhere
  - No external power source required
- Disadvantages:
  - Requires retrieval for maintenance and calibration
  - Expensive

Equipment Selection Cont.

- Sondes have 8 slots for up to 8 probes
  - Common probes: Temperature/Conductivity, pH, DO, Turbidity
  - Larger probes (i.e. DO) occupy two slots
  - Some probes act as surrogates: Temperature/ Conductivity probe used for salinity
- Various manufacturers
  - YSI, OTT Hydromet (HACH)
  - Choice of manufacturer should be based on probe availability and level of accuracy

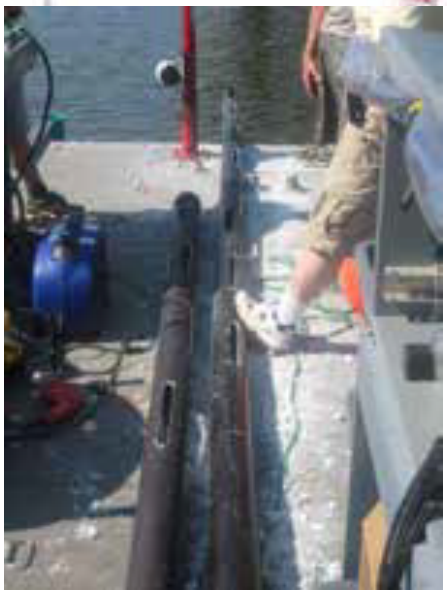
Equipment Installation Considerations

- Waterbody information (e.g. depth, width)
- Site Reconnaissance
- Permission required before installation (e.g. Coast Guard)
- Availability of waterway structures (e.g. bulkheads, dolphins)
- Uses of study area
  - Barge/Boat traffic: Protect from being hit
  - Recreational: Protect from vandalism/tampering
- Length of deployment
- Type of access (land vs. water)

Equipment Installation Cont.

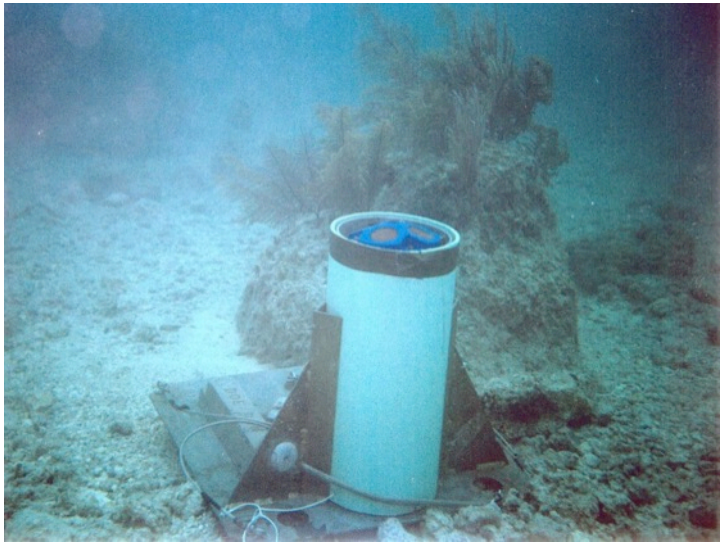
There are two predominate methods for deployment:

1. Structure support deployment
   - Instrument is placed inside encasement
   - Holes/slits cut out of encasement to allow free exchange of water
   - Encasement strapped to crossing/ pier/ piling/etc.
   - Confirmatory sampling may be required



Equipment Installation Cont.

2. Bottom/tether-mounted deployment
   - Instrument is tethered to a weight which sits on waterway bottom
   - Top of instrument tethered to buoy (above or below surface)



Equipment Installation Cont.

Structure Support Deployment

Pro	Con
Easier to access	Greater possibility of vandalism
Easier to install and maintain	Structure may not be in the ideal location
Typically safe from local boat traffic	Difficult to follow variations in tide height

Bottom-mounted Deployment

Pro	Con
Systems can be placed where needed	Can be vulnerable to ship traffic
Typically safe from vandalism	Harder to install and maintain
Can be designed to follow the variations in the tide height	

Monitoring Workplan

- Details entire monitoring program
- Must be approved before implementation
  - Failure to comply with plan can compromise data acceptance
- Specifies maintenance schedule for instruments
  - Instruments should be calibrated/serviced every 1-2 weeks regardless of medium
- Specifies supplemental water quality sampling
  - Grab samples collected to provide additional data not supported by instruments
  - Validate instrument data

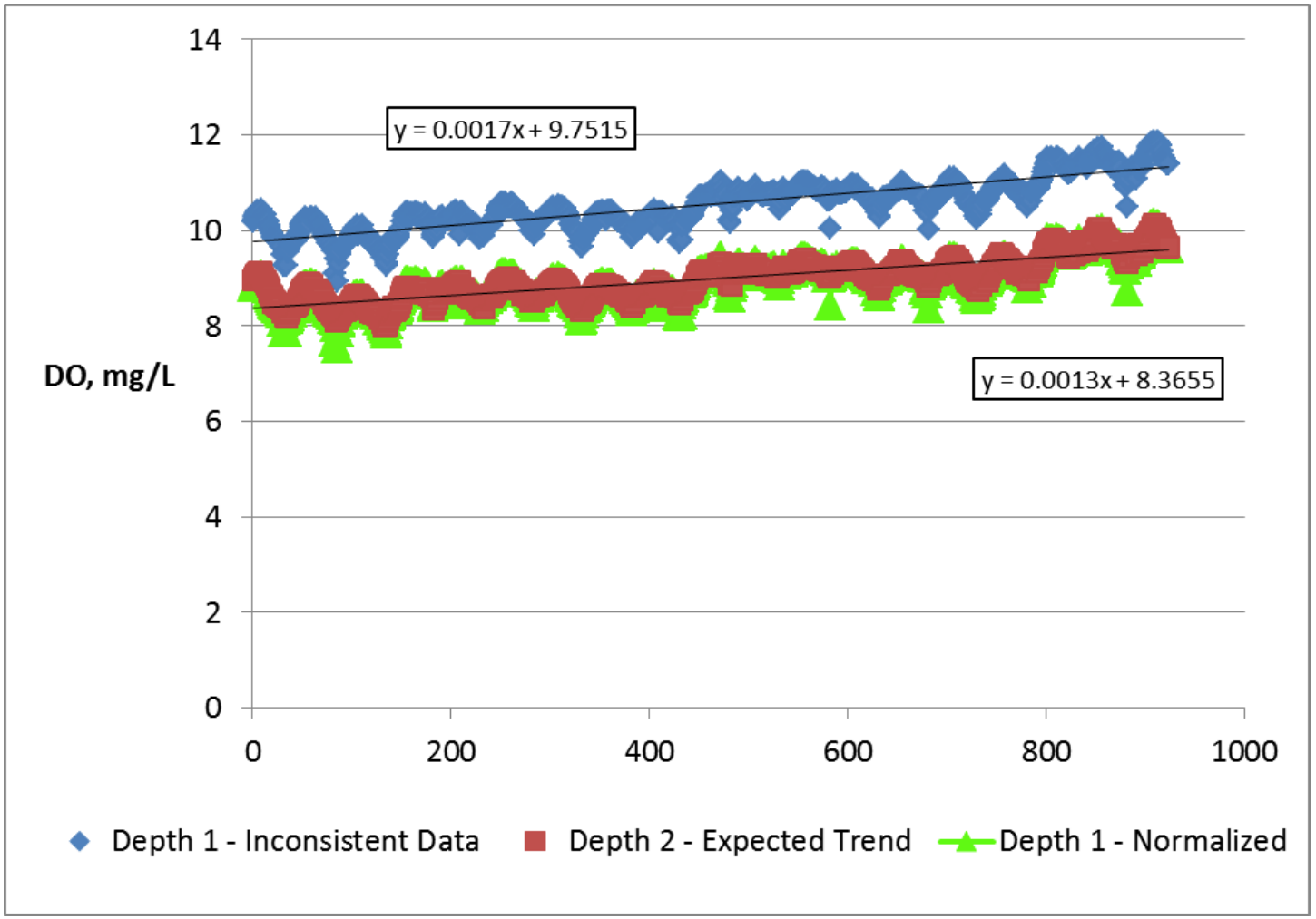
Data Review & QA/QC

- Enormous amounts of data can be collected depending on duration of study
- Data should be reviewed after each download
  - May decide to change location
  - May determine data frequency insufficient
- End-user should be kept abreast of initial data findings
- QA/QC starts with initial calibration of instruments
  - Instruments should be calibrated weekly and verified each time with secondary instrument

Data Review & QA/QC Cont.

- Be cognizant of affect surrogate data has on other data
  - If temperature probe fails, pH and DO data may not be acceptable
- Record good notes during servicing to justify erratic data (e.g. bubble observed in DO membrane)
- When measuring multiple depths, inconsistent data may be recoverable/normalized

Data Review & QA/QC Cont.



ARCADIS Design & Consultancy for natural and built assets

Case Study

Case Study

- Approach implemented for LTIBM for a river estuary not meeting DO quality
- Took over a year for Workplan approval
- Program included:
  - LTIBM of six (6) parameters at multiple locations and depths
  - Weekly servicing and in situ monitoring
  - Tide and current monitoring
  - Supplemental weekly sampling

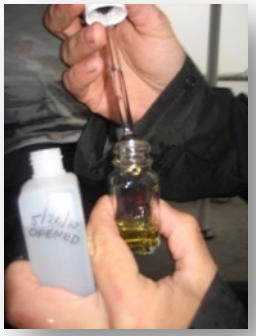
Case Study Cont.

- Driving Force: Understand assimilative capacity of waterway not meeting DO standards
- Project goal: Develop baseline conditions for model
- Project team: Arcadis, marine subcontractor and modelers
- Regulatory Agencies: local DEP, USEPA
- Parameter of Concern: DO
- Equipment Selection: Type 3 – Wireless in situ sensors
- Installation methodology: Structure support structure deployment

Case Study Cont.

Instrument Calibrations

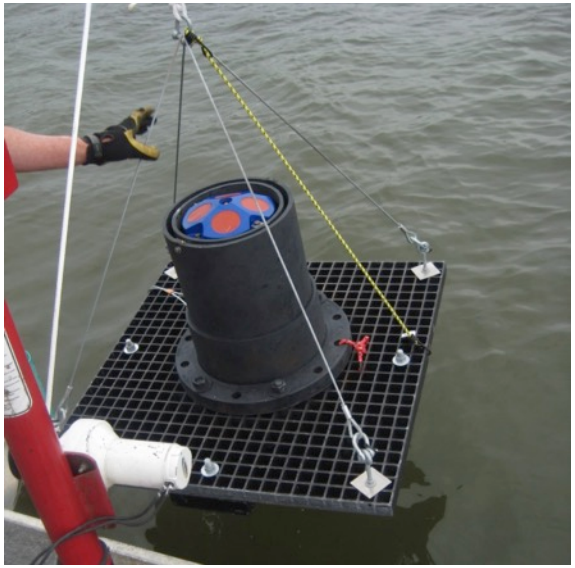
- All sondes cleaned, serviced, and calibrated on a weekly basis
  - 3-point pH Calibration
  - 2-point Turbidity Calibration
  - DO calibration confirmed via Winkler test
- ADCPs retrieved, cleaned, and calibrated once each month

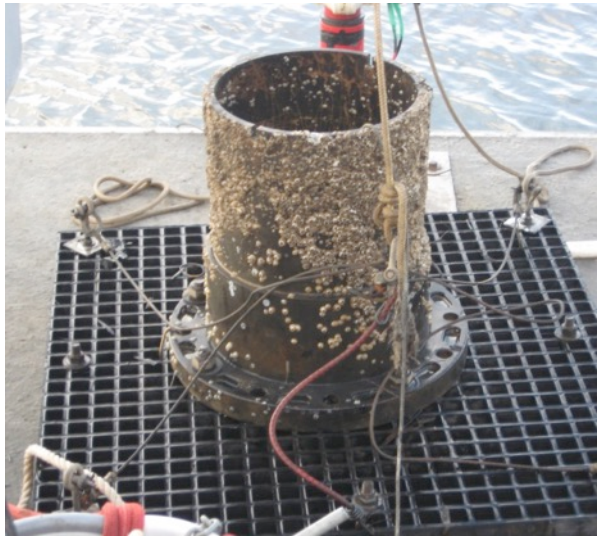


Case Study Cont.

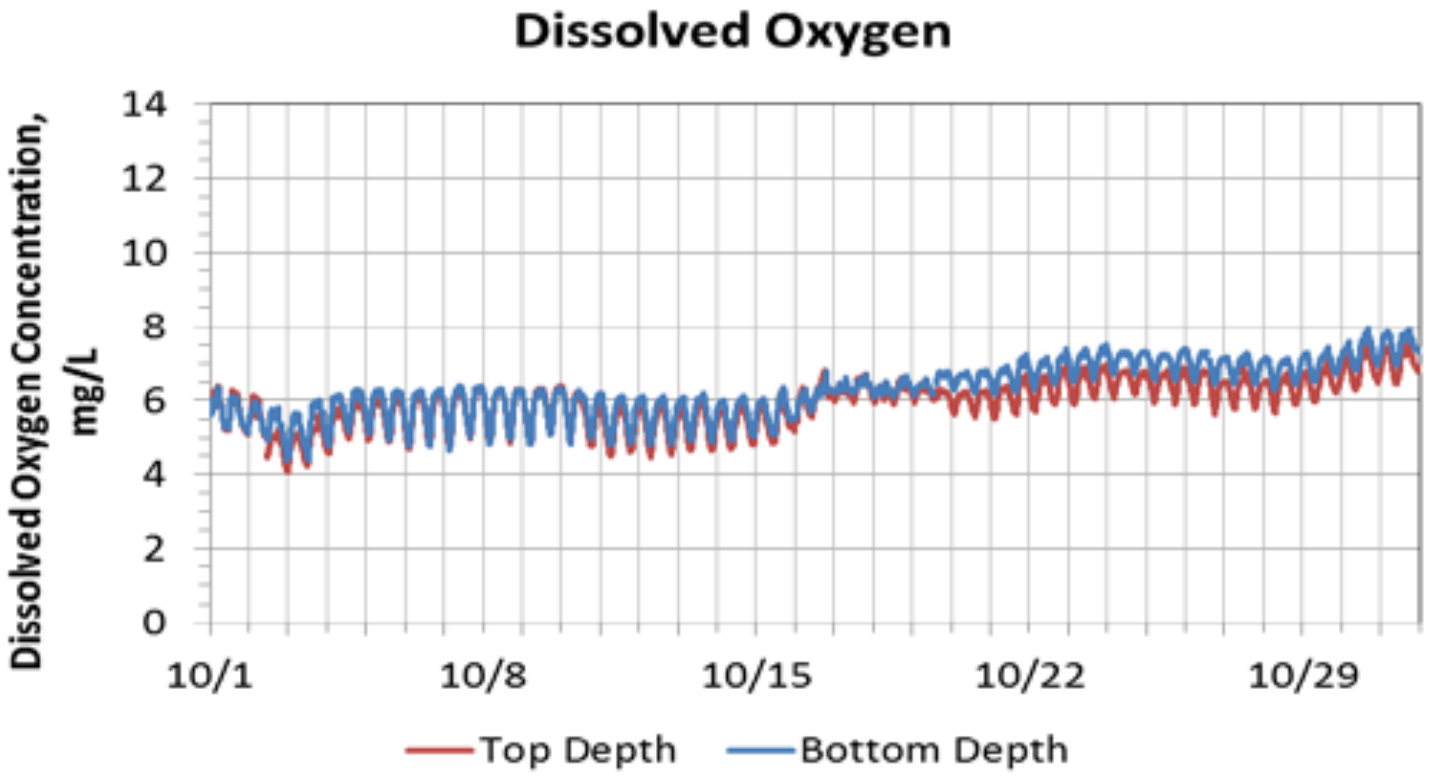
Takeaways

- Communication is key!
- Review data weekly
- Tides are strong
  - Tide ripped support off structure; resulted in loss of instrument
- Fouling is unavoidable
- Programmed amassed:
  - Over 1,000,000 data points
  - Over 1,200 WQ samples
- Study currently in negotiation stage

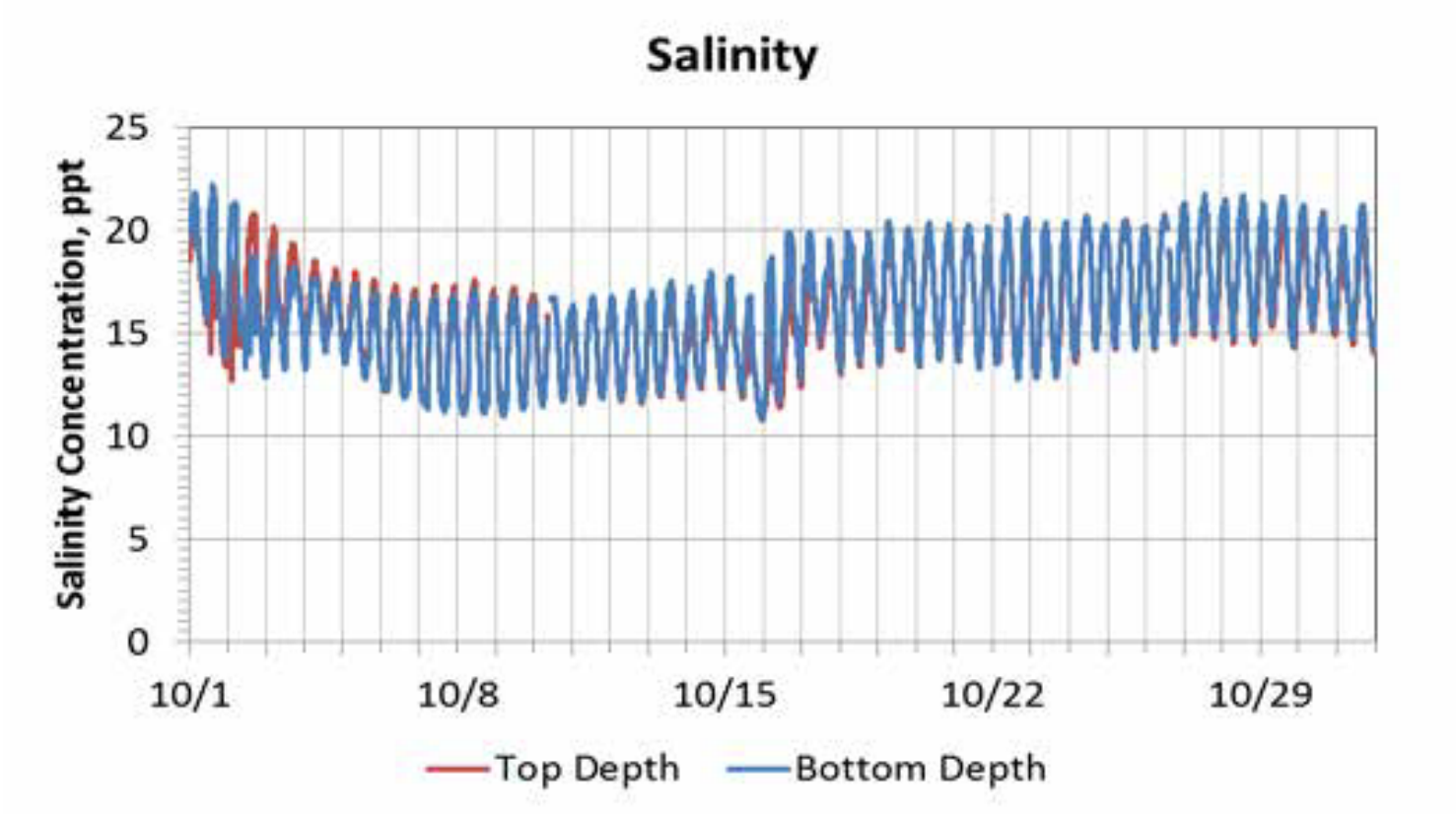




Case Study Cont.



Case Study Cont.



Conclusions

Pros	Cons
Monitor water quality continuously	Requires periodic maintenance and calibrations checks
Data collection interval can be specified in internal memory	Limited list of parameters
Reliable, proven instruments available	Requires protection from environment and tampering
Cost effective	Potential for data loss dependent
Accepted by regulatory and scientific community	

Acknowledgements

Dominic L. DiSalvo, P.E., BCEE

- Formerly Arcadis, currently Director of Engineering at the Bergen County Utilities Authority

Mark Kosakowski

- VP at Alpine Ocean Seismic Survey

Thank you!

ALEX J. SANTOS
Project Chemical Engineer
o 914-641-2805
c 917-301-2259
e Alex.Santos@arcadis.com