CONTINUOUS MONITORING FOR WATER QUALITY

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WATER QUALITY INDICATORS

- Analytical: Grab Samples
  - Nutrients
  - Biological Oxygen Demand
  - Metals
  - Organics
  - Etc.
- Event Driven

- *In situ: Probes*
  - pH
  - Dissolved Oxygen
  - Temperature
  - Conductivity
  - Turbidity
  - Stage
- Event Driven &
- Continuous Sampling Possible

WATER QUALITY INDICATORS (CONT.)

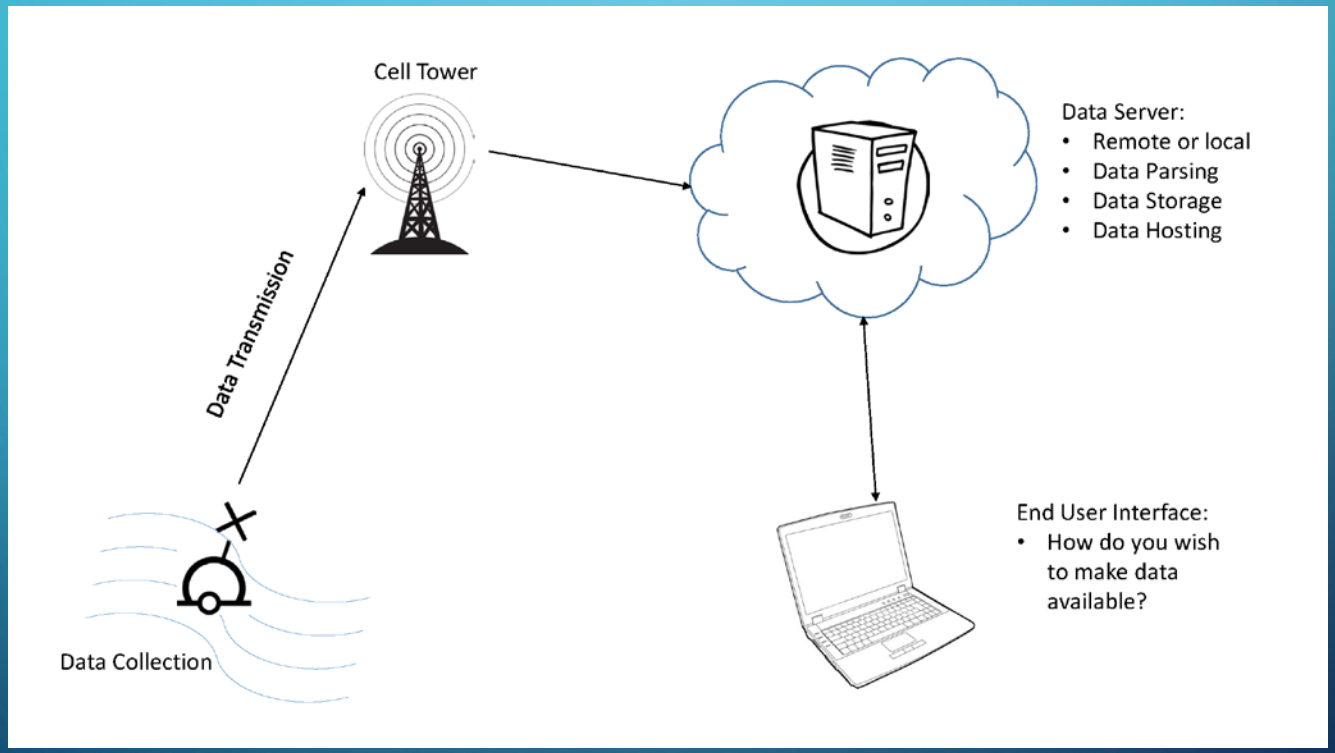
- pH
- Dissolved Oxygen
- Temperature
- Conductivity
- Turbidity
- Stage

- Are they regulatory?
  - Defined state by state
  - Numeric or Narrative
- Or indicators?
  - Alerting to change in water body pattern

WHAT DO WE MEAN BY CONTINUOUS?

- What is the goal of your measurement?
  - Monitoring: Collection of data
  - Alarm: Trigger for action; “Smoke Alarm”
- How often do you want to take a measurement?
  - Every: second, minute, hour, day?
  - Data Management Plan

REAL TIME ACCESS



IN SITU WATER QUALITY MONITORING

PROS

- Fill in data gaps between grab samples
- Long term data trends
- Alert to problems while still manageable
- Large Scale Network possibilites

CONS

- Capital cost to purchase, maintain, and calibrate equipment
- Does not eliminate need for analytical sampling
- Learning Curve
- Murphy's Law Compounded

CONSIDERATIONS FOR IN SITU MONITORING

- Powering:
  - Grid Connection – Solar Power – Battery Exchange
- Maintenance:
  - Who and how will you keep equipment operational.
- Data Management:
  - Longevity, Quality Assurance, Access
- Data Quality Objectives:
  - Why are you collecting the data?

SITE INSTALLATION EXAMPLES


YAMAHA
150
150
PRIVATEER

RESOURCES

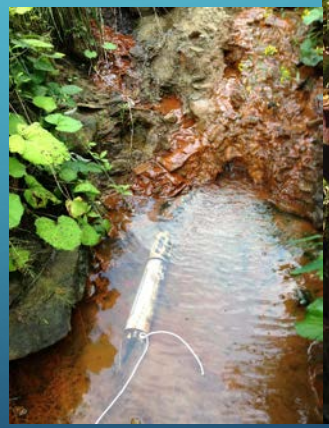
- USGS Techniques and Methods 1-D3
  - Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting

- **Quality System and Technical Procedures for SESD Field Branches**
  - https://www.epa.gov/quality/quality-system-and-technical-procedures-sesd-field-branches

MONITORING STATION INSTALLATION, SECURITY AND MAINTENANCE

POND MONITORING STATION THEFT

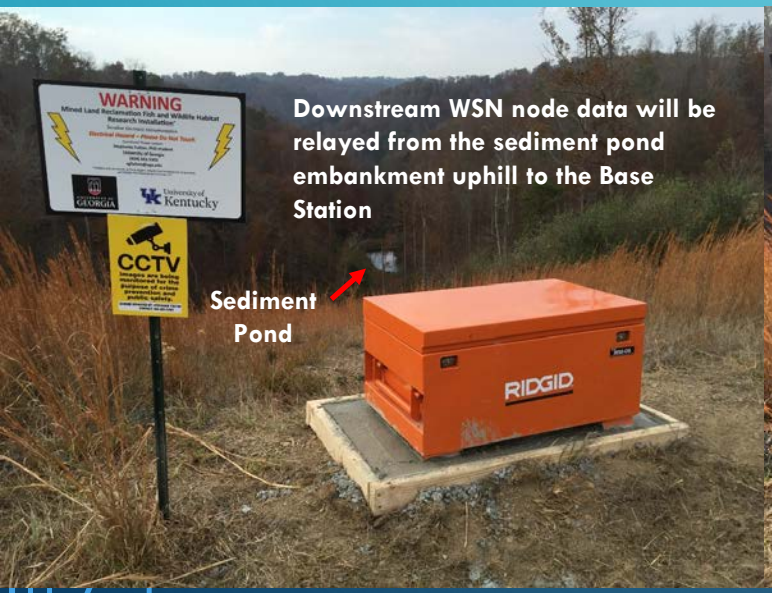
- Equipment damaged/stolen (2x)
  - 2 Campbell data loggers (rain damage)
  - 2 Marine grade battery and 20W solar panel (stolen)
  - Data lost (rainfall and pond water level)
- Retrieved HydroLab
  - Found beached on sediment bar
  - No data retrieved (failed? Not turned on?)
  - Subsequent installation of RIDGID boxes for WSN nodes



BASE STATION

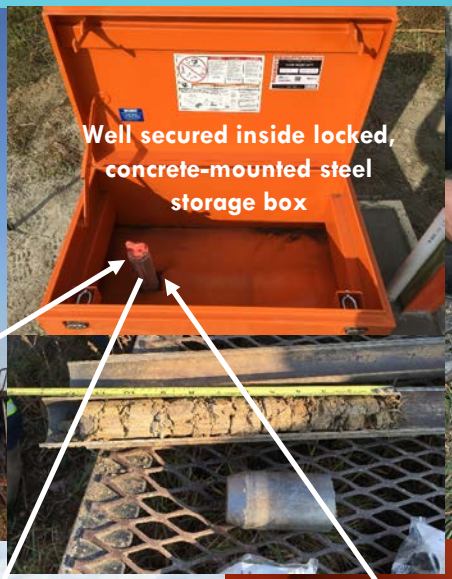
INSTALLED SECURE LOCKING STORAGE BOX, PEDESTAL FOR PVC POLE, SIGNAGE AND CAMOUFLAGE PAINT. STATION WILL INCLUDE CELLULAR MODEM (GSM 2G), XBEE PRO 900 MHZ RF MODULE, 12V BATTERY, ELECTRICAL MONITORING SYSTEM (AND POSSIBLY FUTURE SURVEILLANCE SYSTEM), AND 100W SOLAR PANEL.

VIEW UPHILL TO MONITORING WELL STATION

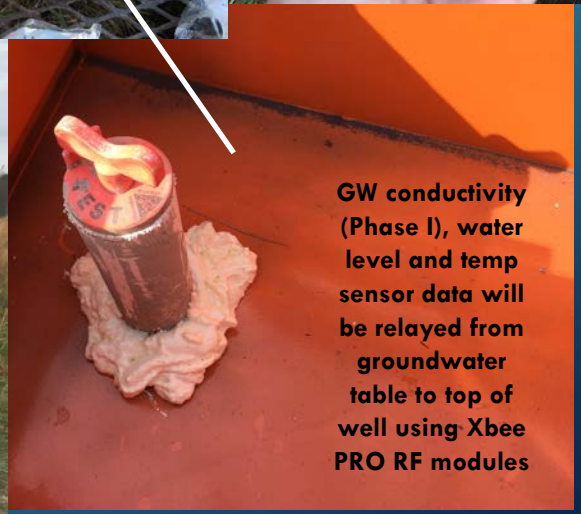


MONITORING WELL

- Installed on ridge above hollow fills (HF) 2 and 3
  - Hollow stem auger with center bit
  - 29’ deep to bedrock
- Weather station will be co-located with monitoring well
  - Anemometer (wind speed)
  - Humidity, barometric pressure and air temperature
  - Rainfall
  - Solar Panel w/ 3.7V li-poly battery
  - XBee PRO 900 MHz RF module


Well secured inside locked, concrete-mounted steel storage box

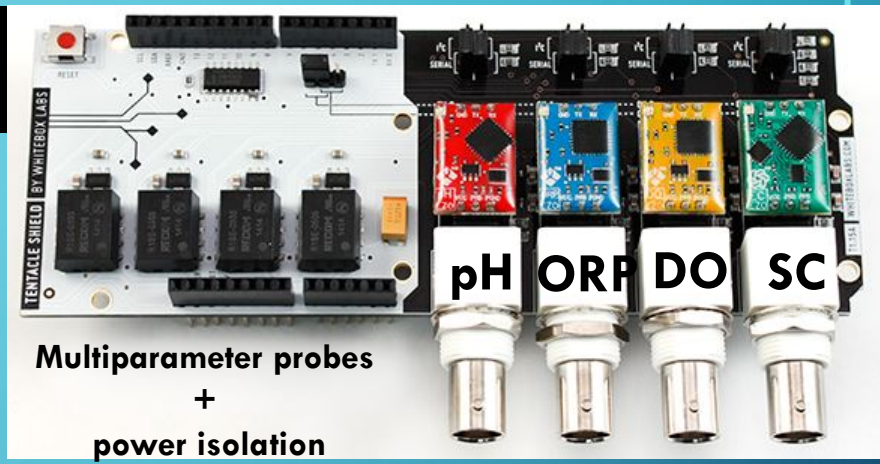

Weather station data logger will be pole mounted, co-located with well, and grounded


GW conductivity (Phase I), water level and temp sensor data will be relayed from groundwater table to top of well using Xbee PRO RF modules

Water Chemistry Sensors

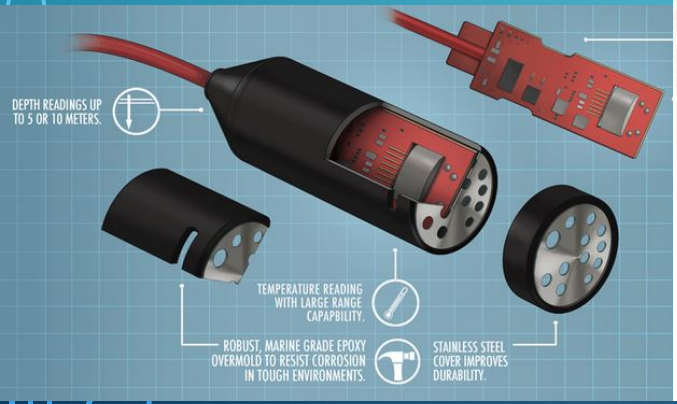
Redox Potential

Conductivity



Multiparameter probes
+
power isolation

Conductivity, depth & temperature



Temperature

2’ H-FLUME

- Installed secure locked storage box and warning signs. Monitoring equipment and data logger not yet installed.
- Downloaded Decagon CTD-10 data (not connect to wireless sensor network yet)
- Sensor data comparison (ranked lowest > highest $$):

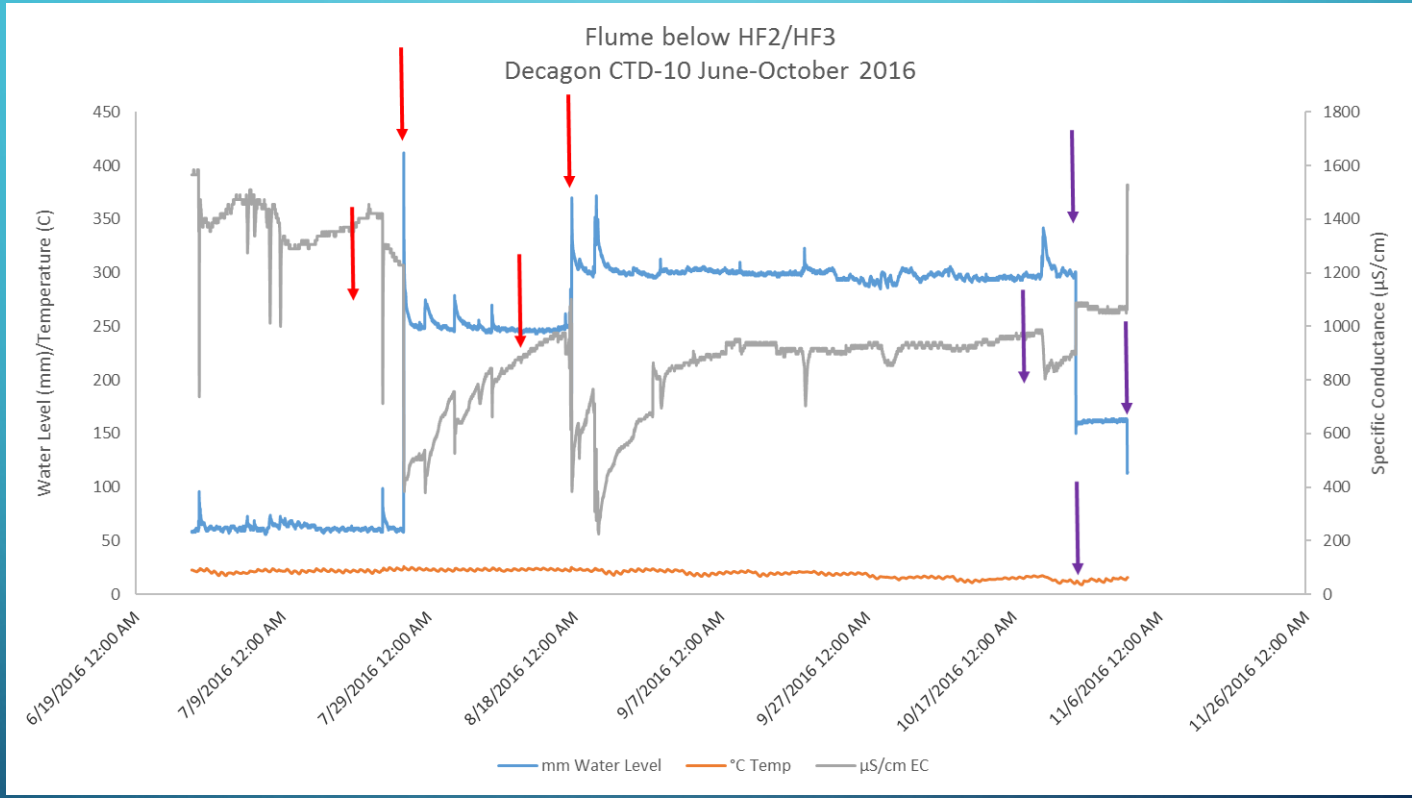
Oakton handheld: 1785 µS/cm, 16.4 °C
Decagon CTD-10*: 1157 µS/cm, 16.3 °C
YSI EcoSense: 1725 µS/cm, 16.7 °C

*Note the significant deviation of the commercial Decagon sensor conductivity values from both the YSI EcoSense and the handheld Oakton Multimeter sensors. The probe hasn’t been cleaned in many months.

Decagon CTD-10 sensor and EM50R data logger (must be downloaded manually)

I found the sensor in the stream channel below the flume rather than in the stilling well.* Heavy stormflows (red arrows) or a person (more likely) picked the sensor up and deposited it in stream channel below the flume.

Removed sensor briefly twice (purple arrows) to investigate its condition and then replaced it.



*This is why monitoring equipment need to be installed in a safe location and secured tightly. Heavy storms, animals, etc. can simply pick up and move equipment.

LESSONS LEARNED

- Remote monitoring sites need continual maintenance which requires frequent and costly site visits.
- The availability of a wireless sensor network that can live-stream data can alert you to **when you need to visit** a site to either recalibrate or clean the sensors, **rather than having scheduled maintenance** visits.
- Equipment must be installed semi-permanently and tightly secured against heavy flooding, animals and human interactions.
  - Include warning signs with your organization and contact info.

QUESTIONS?

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