Water Quality Monitoring and Quality Assurance Project Plans

Principles and Considerations

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What I hope to do during this presentation:

1. Keep you awake after lunch!
2. Stimulate thinking about the design and goals of a monitoring program
3. Discuss monitoring approaches
4. Highlight the importance of a Quality Assurance Project Plan (QAPP) as a vital document and not a "box to check/grant requirement"

What I won't attempt to do in the short time we have today:

1. Cover all the required elements of a QAPP
2. Cover the detailed techniques associated with certain monitoring methods

But! That doesn't mean we can't talk in between sessions or after hours to address your program needs – or connect after the conference through email or calls.

Why Monitor Water Quality?

- Characterize baseline conditions
- Determine suitability for certain uses
  - e.g. aquatic life or contact recreation
- Identify existing or emerging water quality problems
- Identify changes or trends over time (Worse? Better?)
- Measure effectiveness of efforts to maintain or improve water quality
- Develop water quality standards and/or assess compliance with standards

Monitoring may address one or all these objectives

Define Your Objectives BEFORE getting started on your monitoring approach!

Why? *(class participation – "Oh, c'mon, it's right after lunch")*

When Defining Your Objectives:

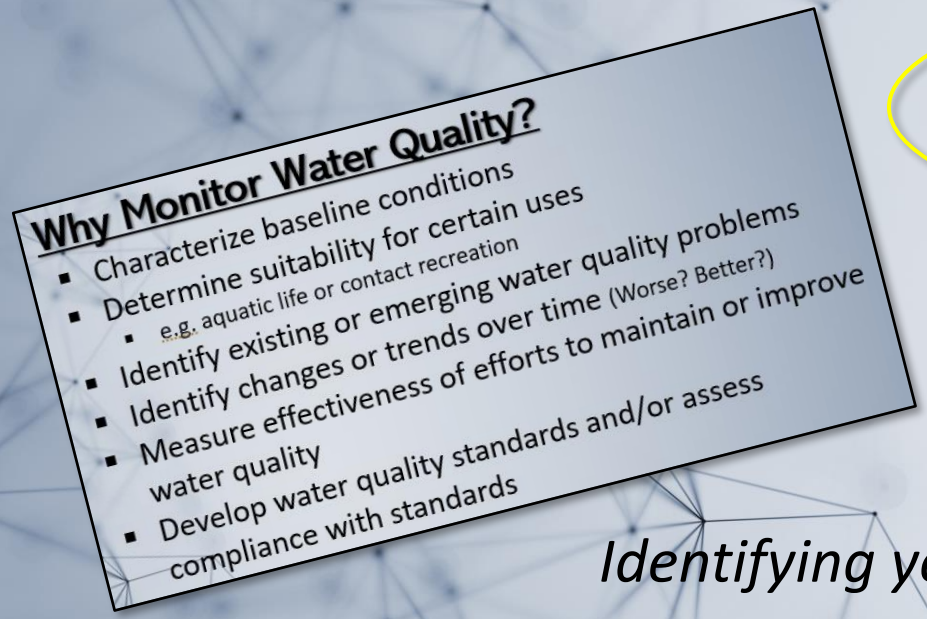
- *Be realistic about monitoring limitations*
  - Lack of resources/expertise to conduct a full spectrum contaminant analysis
  - Presently limited to use of a multi-probe device (dissolved oxygen, pH, temperature, specific conductance) and site observations/notes
- Staff time is limited – can only visit sites periodically

- These are real things, and every program experiences some sort of limitation whether it be:
  a. Time
  b. Money
  c. Experience
  d. All of the Above

Let's Talk About Objective-Driven Monitoring

Identifying your objective guides your monitoring approach

- Where are you going to sample?
- How often are you going to sample?
- What parameters will be sampled?



Identifying your objective also guides your data evaluation approach

- How often are you going to sample?
- What parameters will be sampled?

Reminder that real-world limitations exist in the form of $, time, experience. This is reality, so don't let limitations or the desire to have a perfect approach get in the way of progress

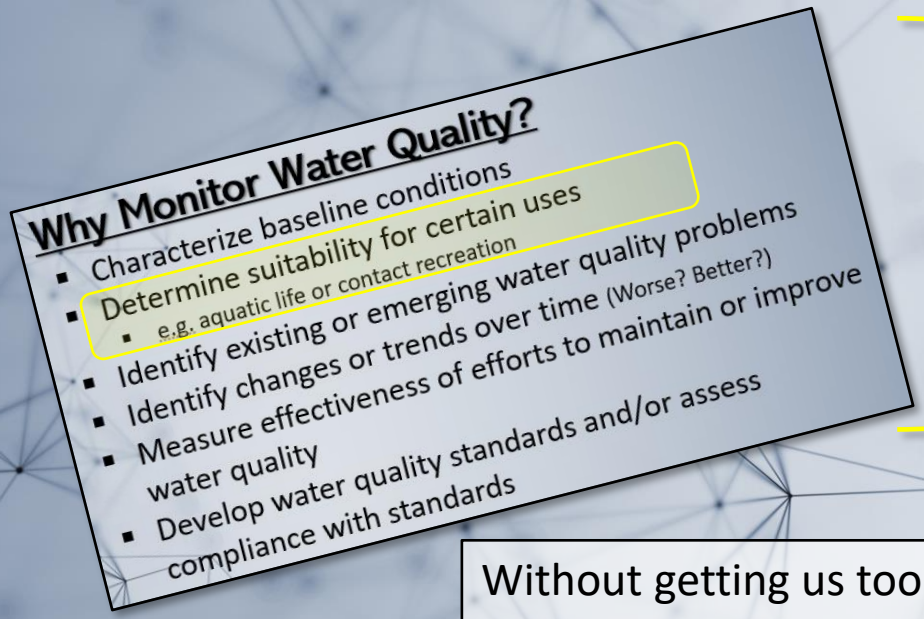
Let's Talk About Objective-Driven Monitoring

Types of Monitoring Designs

- We can't monitor everywhere, so we must monitor "smart"
- Types of monitoring designs include:
  - Statistically-valid surveys
  - Targeted monitoring
  - Fixed Site Network
  - Rotating basin
- EPA recommends that States/Tribes integrate a variety of designs to best meet the range of monitoring objectives and multiple decision needs.

Let's Work Through An Example

We want to answer the question:
Is Fish Creek suitable for Aquatic Life?



Data collection using a multi-parameter sonde tends to be the backbone of most monitoring programs, therefore, for this example, we are going to proceed with the collection of data for dissolved oxygen, pH, temperature, and specific conductance.

Can we address other objectives at the same time?

Without getting us too sidetracked on Data Assessment, you should have a plan for how you will evaluate your field data. You need to be able to convey what is a "good" or "bad" water quality condition. This evaluation is usually accomplished by applying tribal or state water quality standards. Access standards here: https://www.epa.gov/wqs-tech/state-specific-water-quality-standards-effective-under-clean-water-act-cwa

Many tribes and all states have water quality standards for dissolved oxygen, temperature, pH. These parameters are typically associated with the evaluation of data to determine the suitability for aquatic life. Therefore, the data you collect with your multiprobe sonde can be used to inform Fish Creek's suitability for aquatic life.

Let's Work Through An Example

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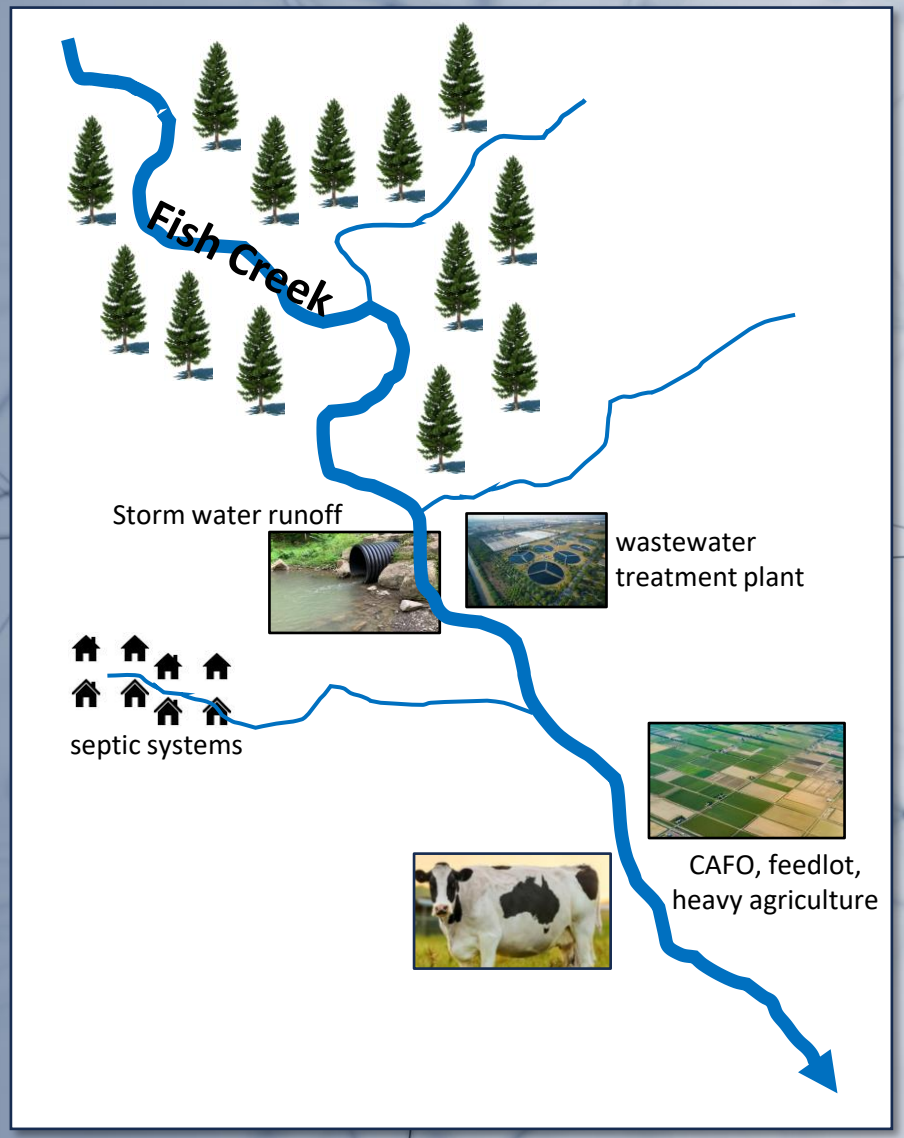
Is Fish Creek suitable for Aquatic Life?



Where are you going to sample?

1. Evaluate the characteristics and land use in your watershed
2. Identify factors that could contribute to changes in water quality
3. Consider adding sites that offer background or less disturbed conditions as these sites can offer you baseline or sites (data) for comparison
4. Consider sites with already known issues to better characterize conditions and/or improvements or degradation
5. Are there other data sources already in the region?

Note: These locations are not set in stone and monitoring approaches should be iterative. You can make changes in the future!

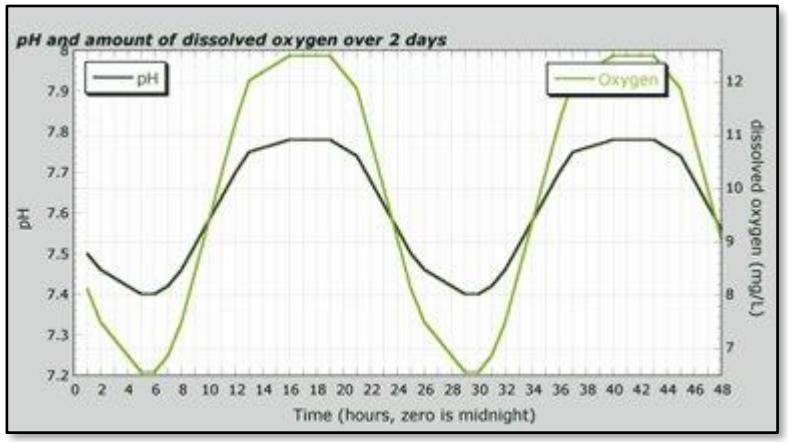
Where would you place monitoring locations?

Let's Work Through An Example

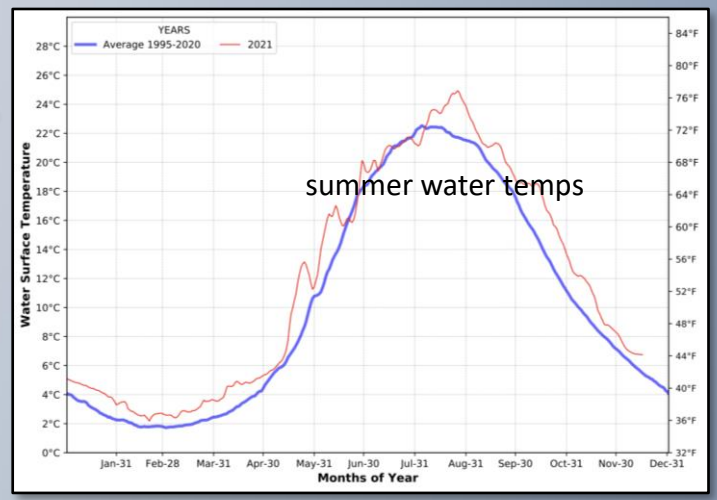
We want to answer the question:

Is Fish Creek suitable for Aquatic Life?

How many times are you going to sample?



- How many visits do you need to render meaningful data and meet your objective?
  - *Increased # of samples increases likelihood of seeing trends*
- Are you targeting sampling at the right time of day, season, or year to characterize water quality or identify problems?
  - Daily rhythms
  - Seasonal or Annual rhythms
    - Summer considerations
  - Protection goals



This again highlights the need to identify Your goals and evaluation criteria

•DO and pH follow somewhat predictable pattern throughout each day – more pronounced in areas of high aquatic plant growth and/or algae caused by nutrient enrichment

•The best time to measure DO and pH is in the morning as this is when DO will be at minimum

Let's Work Through An Example

We want to answer the question:
Is Fish Creek suitable for Aquatic Life?

At the beginning of this example, we made clear that we were employing a multi-parameter sonde for most of our data collection. However, field observations and notes often help explain certain water quality readings and can help you explain certain water quality conditions

- Water color – why?
- Riparian characteristics – why?
- Odors – why?
- Presence of algae – why?
- Last rainfall – why?
- Flow condition (high, low, flood, normal, no flow) – why?
- Flow – why?
- Human disturbance – why?
- Others????

Best to put these on a standardized field sheet that prompts you to make certain observations

Resources:

- EPA's Watershed Academy (includes learning modules): https://www.epa.gov/watershedacademy/online-training-watershed-management#themes
- The EPA technical contact in your EPA regional office!

Common indicators:

	Aquatic Life	Recreation	Drinking Water	Fish/Shellfish
CORE	•Biological communities (fish, benthic macroinvertebrates, plants, plankton) •Basic chemistry (e.g. DO, pH) •Nutrients •Flow •Habitat assessment •Landscape condition	•Cyanobacteria toxins •Pathogen indicators (*E. coli,* enterococci) •Nuisance plant growth •Nutrients •Chlorophyll •Flow •Landscape condition	•Cyanobacteria toxins •Trace metals •Pathogens •Nitrates •Salinity •Sediments/TDS •Flow •Landscape condition	•Pathogens •Mercury •Chlordane •DDT •PCBs •Landscape condition
OTHER	•Ambient toxicity •Environmental DNA •Sediment toxicity •Health of organisms •Other chemicals of concern in water or sediment	•Hazardous chemicals •Aesthetics •Other chemicals of concern in water or sediment	•VOCs •Hydrophylic pesticides •Algae •Other chemicals of concern in water or sediment	•Other chemicals of concern in water or sediment

Let's shift gears. Let's take all that info we just discussed and figure out how to best capture it in a document. What do you say?

Quality Assurance Project Plans (QAPPs)

Quality Assurance Project Plans (QAPPs)

- The blueprint from which you operate
  Who, What, Where, When, How
- You can find the EPA's policies and other tools and guidance on the Quality Staff's web site here: https://www.epa.gov/quality
- A QAPP should be completed and approved by the EPA before the project is started.
- My disclaimer:

  *I am not a QA officer, and **I will not be covering all the required elements of a QAPP**. I serve as a technical point of contact for tribal and state water quality monitoring programs – which means that I'm to collaborate on the technical soundness of monitoring approaches and programs and aid tribal and state partners. I will speak today on a few areas of QAPPs that I key into during my evaluations of monitoring QAPPs and where I find the most issues/needs for improvement*

It's pretty simple really. Your monitoring QAPP can create either the….

Circle of Life?
Or
Circle of Strife?

The lottery question:

- If you bought a lottery ticket on the way home tonight and your numbers hit and made you a millionaire several times over. Would you come back to work?
  (I already know the answer)

- Would the next person that came in the door to fill your monitoring waders have the ability to duplicate everything you did based solely on the QAPP? Down to every last detail?
  (I do not already know the answer)

You should be able to hand this document to someone and he/she should be able to use this document to know:

- Who will use the data
- What the project's goals/objectives/questions or issues are
- What parameters, number of measurements/samples, and quality of data are needed
- How, when, and where project data will be measured/collected or acquired
- What possible problems may arise and what actions may mitigate their impact on the project
- What decision(s) will be made from the information obtained
- How "good" those data must be to support the decision to be made
- How the data will be analyzed and assessed to make that decision

- *These are the "nuts and bolts" we look for when evaluating QAPPs*

Select QAPP Elements:

Problem Definition and Background

- What are the project's goals/objectives/questions
- Indicate why the project is being done (think back to the monitoring discussion)
- You are telling a story. Orient the reader.

Project/Task Description

- How will you reach this goal or answer the questions
  - *Parameters, number of measurements, quality of data needed*
- How, when, and where project data will be measured/collected
- Summary! Don't worry, you'll hit the details later
- It's OK to refer the reader to other sections for details such as a table with monitoring locations, map of locations, etc

Select QAPP Elements:

Problem Definition and Background
Project/Task Description

- In one of these sections, you should identify how you will evaluate your data to answer your question. You can take this straight from your assessment methodology or you can attach your methodology as an appendix
- Use tables
- Reference tribal or state standards, if appropriate. Provide web links

Example table of standards or thresholds and how data will be evaluated.

Criteria for Measurement data and decision criteria for designated use attainment
High Quality Coldwater Fishery

II. Chemical/Physical Data

Constituent or group	High Quality Coldwater Fishery Water Quality Criterion	Decision Criteria[see 1]		Collection Method	Analytical Method	Project Objective Requirement
		Designated Use supported	Designated Use not supported			
Dissolved Oxygen (mg/L)	6.0	<15 percent of samples exceed criterion	15 percent of samples exceed criterion	Multiprobe sonde	Std. Method 4500-OG or EPA 360.1	Critical
pH	6.6 - 8.8				Std. Method 4500HB or EPA 150.1	Critical
Temperature (°C)	20				Std. Method 2550B or EPA 170.1	Critical
Turbidity (NTU)	10				Std. Method 2130B or EPA 180.1	Critical
Conductivity (at 25°C) (µmhos/cm)	300				Std. Method 2510B or EPA 120.1	Critical

Select QAPP Elements:

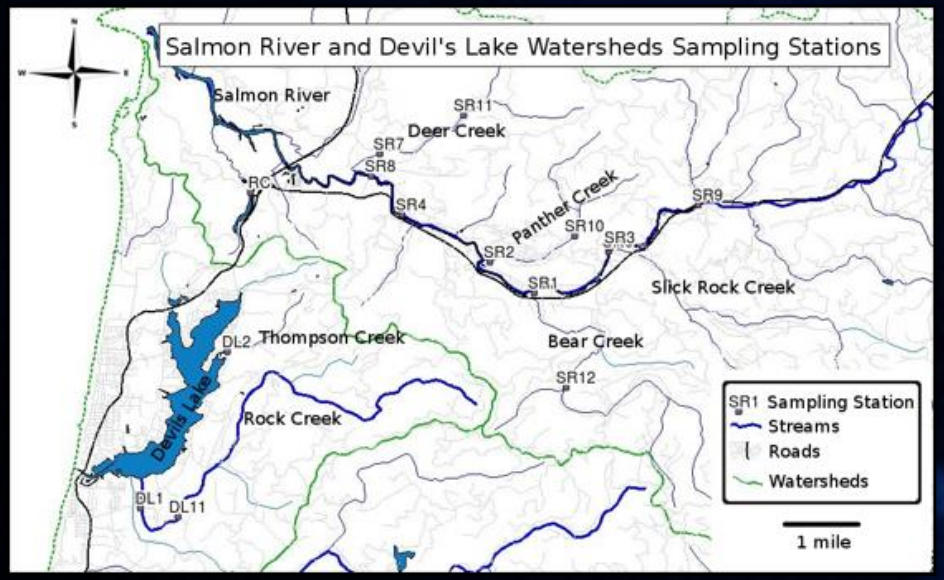
Quality Objectives and Criteria for Measurement Data

- Describe the data quality indicators
  - Usually these are Precision, Bias, Accuracy, Representativeness, Comparability, Completeness
- You are identifying thresholds or goals for your data
  - Helpful link: Table 3, page 20 of this document: https://www.epa.gov/sites/default/files/2015-06/documents/g5-final.pdf
- For instance, you may address accuracy and bias by calibrating post-calibrating your multi-parameter sonde
- You may address representativeness by collecting all of your samples in the middle of the flow and not backwater areas
- You may address comparability by using the same collection methods
- You may consider your data needs complete if you collect 90% of all the data you set out to collect (Hint: don't say 100% - you are tempting the fates!)

Select QAPP Elements:

Experimental Design

- Get Detailed!
- Reference sample locations, parameters, frequency of collections, any daytime considerations
- USE TABLES – they are easier to read and easier to modify when you want to change things around in the future *(consider double duty with workplan)*



example figure - site map

Table 1: Projected Sampling Locations, Parameters and Frequency, 10/01/2023 – 9/30/2025

	Sampling Sites and Frequency of Monitoring						
Parameters to be Monitored	Clear Creek at Farm to Market (FM) Road 458 (Site CC1)	Soggy Bottom Creek at County Road (CR) 39 (Site SB1)	Kiamichi River at Old Bridge Crossing (Site KR1)	Denton Creek at Interstate 35 Bridge (Site DC1)	Long Lake at Dam (Site LL1)	Long Lake at Muscadine Marina Pier (Site LL2)	Red River 0.4 km from intersection of CR 25 and CR 82 (Site RR1)
Temperature	12	12	12	12	12	12	12
pH	12	12	12	12	12	12	12
Specific Conductance	12	12	12	12	12	12	12
Dissolved Oxygen (D.O.)	12	12	12	12	12	12	12
Turbidity	12	12	12	12	12	12	12
Total Nitrogen	6	6	6	6	6	6	6
Total Phosphorus	6	6	6	6	6	6	6
E. coli	12	12	12	12	12	12	12
Latitude / Longitude	32.4542 / 92.6241	31.6475 / 93.8249	30.5874 / 91.8542	33.5874 / 92.58743	31.8532 / 91.8542	33.9852 / 91.6587	35.9852 / 89.6328

example table - site location, frequency and parameters

Select QAPP Elements:

Sampling Methods

- Get Detailed! Remember, a brand-new person should be able to read this section and be able to duplicate the collection methods (remember *comparability*)
- Don't reinvent the wheel. If there are documents out there already such as SOPs or Field Methods, attach as an appendix and reference here. Or, cut and past the information here
  - Because of my background, I tend to provide the following examples to tribal monitoring programs looking to document their sampling methods. These are suggestions and not considered mandatory approaches
    - TCEQ Surface Water Quality Monitoring Procedures https://www.tceq.texas.gov/publications/rg/rg-415
    - NMED Surface Water Quality Bureau SOPs: https://www.env.nm.gov/surface-water-quality/sop/
- Location of sample/where in stream, grab or composite sample, flow considerations, time of day, days after rainfall, Observations needed – attach monitoring field sheet as an appendix, if appropriate

Select QAPP Elements:

Quality Control Requirements

- If you are collecting water (e.g. nutrients, *E. coli*, metals) we look for how replicates and field blanks are prepared
- The frequency with which duplicats and/or blanks are collected
- A description of post-calibration procedures for your multi-probe sonde and the post-calibration limits (to address bias)
- How precision for water sample duplicates is calculated (e.g. Relative Percent Difference)
- How data are treated/corrective actions are taken when precision goals or limits on bias are not met.

Example: Post-calibration of multi-probe sonde

Table 8.3. Error limits for the post-calibration check.

Parameter	Value
Dissolved oxygen	± 6% saturation, ± 0.5 mg/L
pH	± 0.5 standard units
Specific conductance	± 5%
Temperature	± 0.2°C (schedule maintenance); ± 0.5°C (flag data)

If your meter is outside of these limits for one or more parameters, how will you handle data reporting for that day or week? Are you confident in your data?
Need to know!

Select QAPP Elements:

Instrument/Equipment Calibration and Frequency

- Since so many data are collected with sondes, we need to make sure that calibration and post-calibration are addressed adequately.
- Don't reinvent the wheel. You can find several SOPs out there. Feel free to attach as an appendix.
  - Examples:
    - TCEQ: https://www.tceq.texas.gov/downloads/publications/rg/chapter-8-rg-415.pdf
    - NMED: https://www.env.nm.gov/wp-content/uploads/sites/25/2017/06/6.1-SOP-Sonde-Calibration-and-Maintenance-20210205-approved.pdf

- Make sure that each instrument has its own logbook for all calibration/post-calibration records and that the location of the logbook is documented in the QAPP.

Parting Thoughts:

- Again, my purpose was not to provide an exhaustive discussion of all the required elements of a QAPP, but rather to try and convey where we see the most opportunities for increased communication and clarity
- Remember, the goal is to prevent the “Circle of Strife”. Be clear about the who, what, where, when and how and you’ll be fine
- Don’t let perfection get in the way of progress – there is no such thing as a perfect QAPP! Progress can be incremental
- Make use of tables. You can use some of the same tables in workplans and TARs
- Use outside resources (SOPs) and make use of appendices when appropriate
- Make use of your technical reviewers at the EPA. Play *Stump the Chump*!
- Ask questions

Questions?

Thank you for your time!

RESOURCES:

- Agency-wide Quality System Documents:
  - https://www.epa.gov/quality/agency-wide-quality-system-documents
- EPA Requirements for Quality Assurance Project Plans
  - https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf
- Guidance for Quality Assurance Project Plans
  - https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf
- Guidance on Systematic Planning Using the Data Quality Objectives Process
  - https://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf