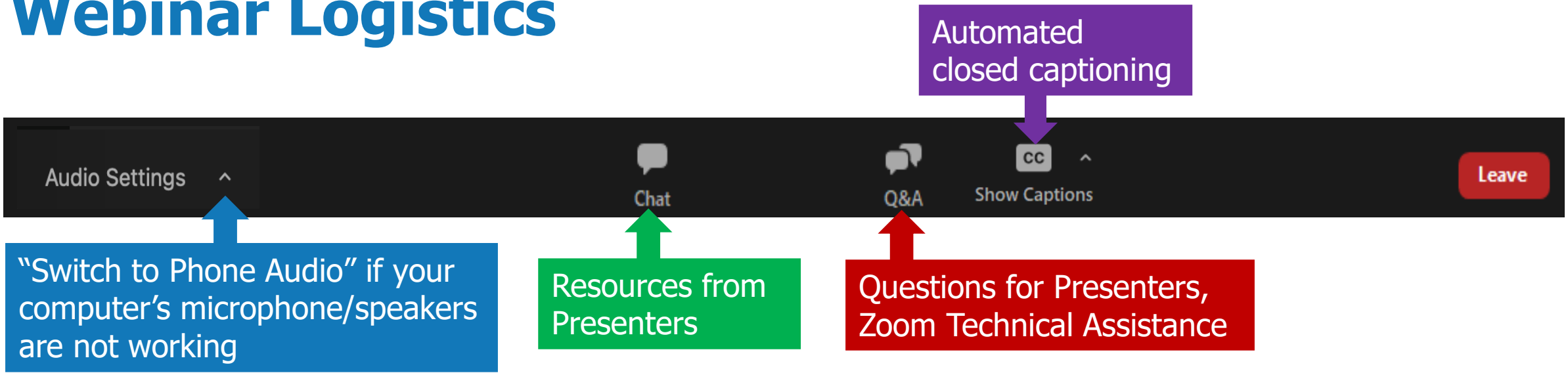
Community Air Monitoring Fundamentals

Webinar 4:
Building an Air Monitoring Network: Selecting Equipment, QAPPs, and Siting a Monitoring Device

TD Enviro
Eastern Research Group, Inc. (ERG)
US EPA Office of Air Quality Planning and Standards

Webinar Logistics



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Your Speakers

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Tim Dye

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Helena Pliszka

Overview of Webinar Series

Fundamentals of Air Quality:

Webinar #1. Introduction to Air Quality Concepts and Regulations

Webinar #2. Introduction to Community Air Monitoring and Measurements

Building a Community Air Monitoring Network:

Webinar #3. Objectives and Data Management

Webinar #4. Selecting Equipment, QAPPs, and Siting a Monitoring Device

Webinar #5. Installation, Operation, Data Analysis, and Communication

Agenda

1. Selecting Equipment
2. Planning and QAPPs
3. Determining Monitoring Sites
4. Recap
5. What's Next
6. Q&A

Recap of Webinar 3

- Building a community air monitoring network overview
- Developing a monitoring objective
- Setting up data management

Selecting Equipment

Revisit Your Objectives!

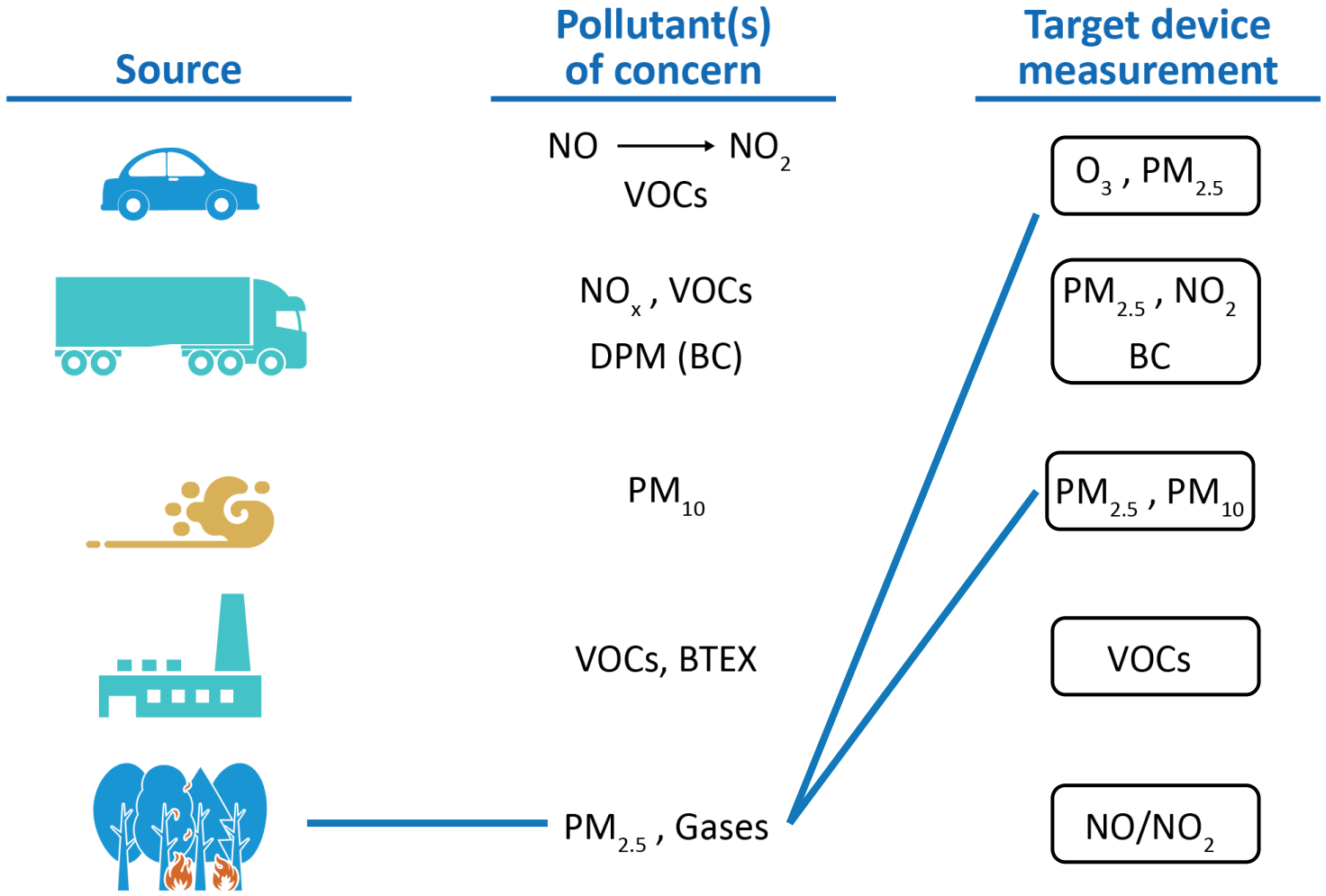
Why are you monitoring? The answer to this will guide all other decisions you make, including what equipment you select

What to Look for in a Monitoring Device

Pollutants of Interest

A device needs to measure your pollutant of interest

A project's pollutant of interest depends on your objectives



Accuracy

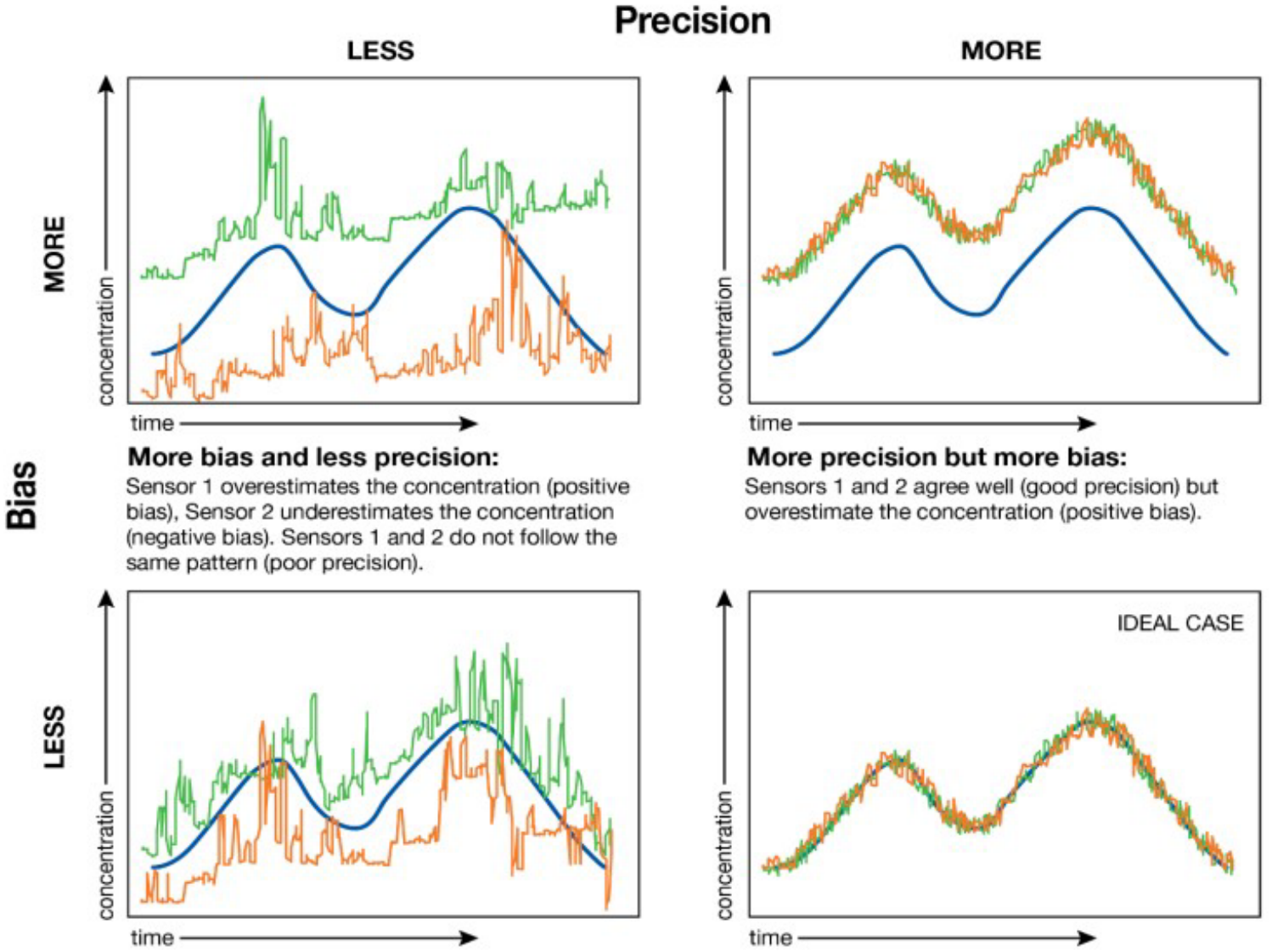
Accuracy describes the agreement between the device's pollutant concentration measurement and the concentration measured by a reference instrument. A device's accuracy is determined by two components: precision and bias

Bias refers to measurement error. For example, a device may always measure a little higher or lower than the true concentration

Precision refers to how well a set of sensors reproduces the measurement of a pollutant under identical conditions (e.g., same concentration and temperature)

Accuracy (cont.)

Accuracy = Bias + Precision



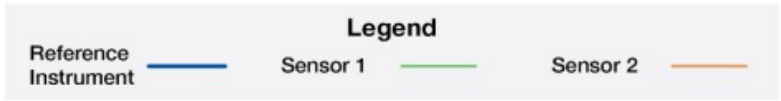


Illustration of Air Sensor Bias, Accuracy, and Precisi

Image: EPA

Reliability

Reliability describes several important features of an air measurement device:

- Lifetime – How long the device remains sensitive to the pollutant it detects
- Up-time – How long the device is up and operational
- Completeness – How much usable data the device produces

Other Supporting Data

Does the device measure other data that may be helpful in diagnosing device issues or understanding air pollutant trends?

Is some of this data available from a nearby source?

Or are there other instruments you may need to purchase to collect it?

Anemometer: an instrument that measures wind speed and direction

Other data might include:

- Outdoor temperature
- Relative humidity
- Device temperature
- Wind speed (likely need separate device)
- Wind direction (likely need separate device)

Power Needs

- Wall or main power
- Solar
- Battery

Solar Panel

Image source: Pixabay

Be aware of how this might impact where you site a device

Data Transmission

- Cellular
- Wi-Fi
- Bluetooth
- Satellite
- Low-power wide-area network (LoRa)
- Manual transfer (e.g., local on-board storage, memory card)

Consider project needs, cost constraints, and siting (cellular network availability)

Other Factors

Customer Service

- Does the vendor have customer service?
- What support is included or not included?

Ease of Use

- Are they plug-and-play?
- What skill level is needed?

Data Processing & Handling

- How are data processed? How are they corrected or calibrated?
- Quality control processing?
- Data management functions?

Cost

Upfront costs: purchasing the sensor and components

Long-term costs: Subscription services, repair/replacement, calibration services, data transmission charges, data hosting/storage fees

Selecting Equipment Q&A

Planning & Quality Assurance Project Plans (QAPPs)

Planning is Important

Why?

A plan is necessary for collecting quality data to meet your project objectives because it:

- Provides a roadmap for staffing, device selection, deployment, obtaining measurements, data processing, data validation, quality control (QC) tasks, and more
- Aligns people, objectives, and data needs
- Ensures that all tasks are completed and all devices and supporting instruments (e.g., weather instruments) are collecting useful data for the purpose of the project
- Saves time and money

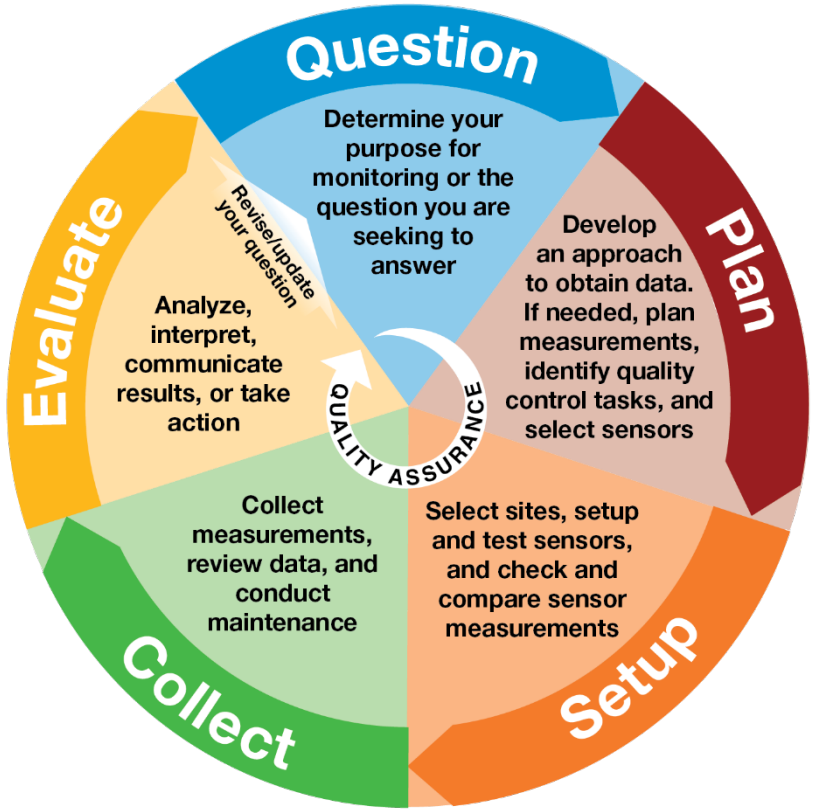


Image source: EPA

What is a Quality Assurance Project Plan?

Quality Assurance Project Plan (QAPP)

QAPP- A written document that explains how organizations ensure that collected data can be used for its intended purpose

A QAPP generally describes the following:

- Project goals/objectives/questions
- How/when/where project information will be generated
- What possible problems may arise and what actions can be taken to mitigate their impact on the project
- Type, quantity, and quality of data needed to support objectives
- How the data will be analyzed, assessed, and reported
- Decision(s) that will be made from the information obtained and who will use the data

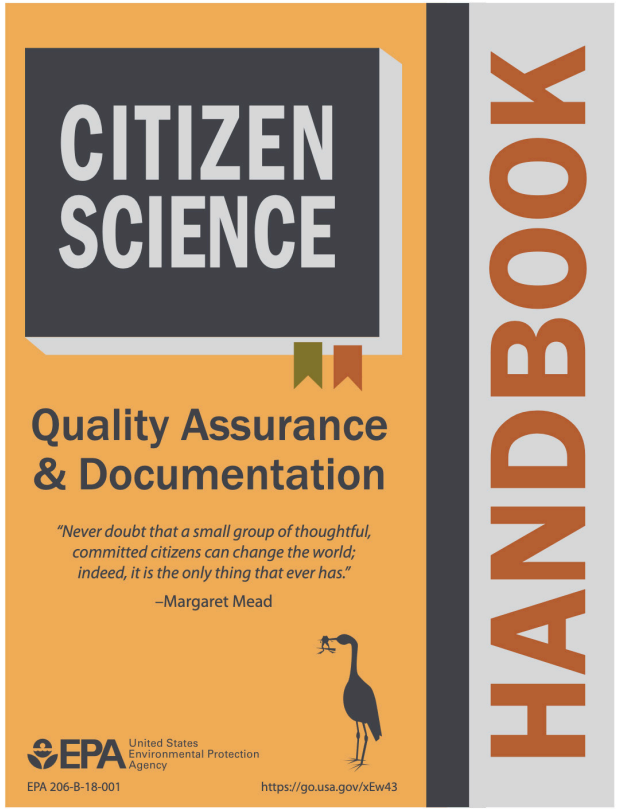


Image source: EPA

Quality Assurance Project Plan (QAPP) (cont.)

Creating a QAPP supports your project and team members!

- Roles and responsibilities are clear
- Plan for collecting quality data is agreed upon
- Potential problems are identified at an early stage
- Plan can be shared with stakeholders to gather input and interest
- Processes are documented to assist with future data interpretation and presentation

A QAPP is for everyone!

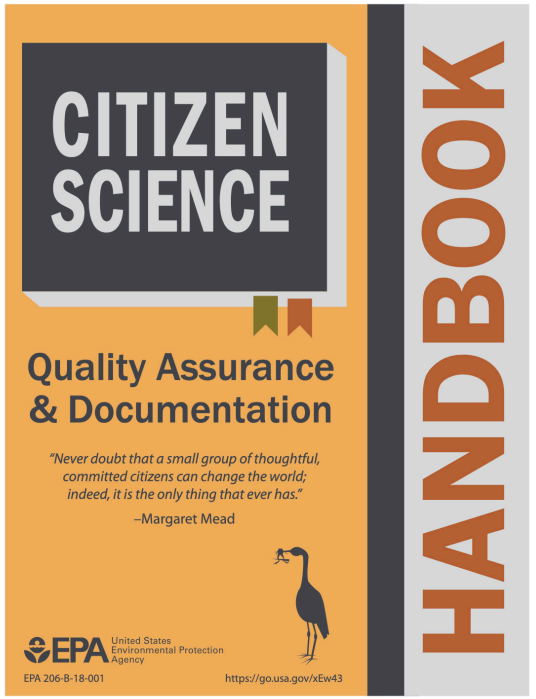


Image source: EPA

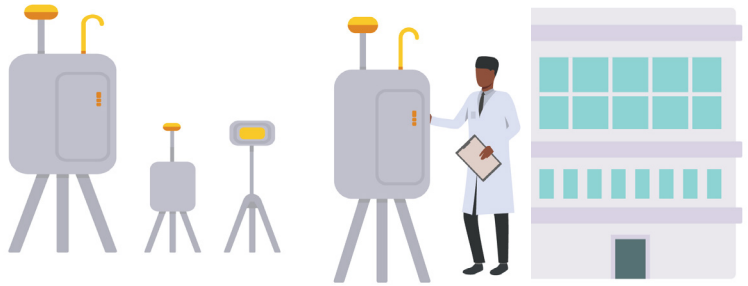
Helpful QAPP resources:

- EPA QA for Air Sensors Webpage
- EPA Quality Assurance Project Plan Development Tool

QAPPs are NOT one size fits all

QAPPs can vary in complexity based on a project and the intended use of the data

Deploying single device → Simpler plan, still important



Extensive network, more people, organizations, and resources → More detailed plan, critical for success

For some projects, QAPPs will require review and approval and may need to follow a specific format covering specific topics. Projects funded by the EPA require specifically formatted QAPPs.

Image source: EPA

Template	Increase Public Understanding	Science/Research	Legal/Policy
A. Managing the Project			
1. Title and Preparer Page	X	X	X
2. Table of Contents		X	X
3. Problem Definition, Background and Project Description	X	X	X
4. Data Quality Objectives and Indicators	X	X	X
5. Project Schedule		X	X
6. Training and Specialized Experience	X	X	X
7. Documents and Records	X	X	X
B. Collecting the Data			
8. Existing Data		X	X
9. Sampling Design and Data Collection Methods	X	X	X
10. Sample Handling and Custody		X	X
11. Equipment/Instrument Maintenance, Testing Inspection and Calibration		X	X
12. Analytical Methods	X	X	X
13. Field and Laboratory Quality Control	X	X	X
14. Data Management		X	X
C. Assessing the Data			
15. Reporting, Oversight and Assessments	X	X	X
D. Reviewing the Data			
16. Data Review and Usability	X	X	X
Managing the Project (continued)			
17. Organization Chart		X	X
18. Project/Task Organization		X	X
19. Project Distribution List		X	X

Major Sections of a Plan/QAPP

Project Description and Background

The importance and context of the project

- Summarize any known information, and also what information is not known
- Include map(s) of study location
- Include project schedule summarizing work

Project Objective

Describe specific decisions to be made or desired outcomes

- Describe the main air quality concern and why data are needed
- Identify how data will be used ("If…then…" statements) and who needs this information
- "***If*** *we collect quality* PM_{10} *data frequently in the project area,* ***then*** *we can identify if the source of* PM_{10} *is from passing dump trucks or blowing dust."*

Data Quality Objectives and Indicators

A Data Quality Objective (DQO) describes the data's acceptability for making decisions described in the project objective

1) Why are data needed?
2) What do data need to represent?
3) Is there a certain level of accuracy needed?

Determine whether DQOs are being met by evaluating Data Quality Indicators (DQIs)

Called 'Measurement performance and acceptance criteria'

- Accuracy (bias and precision)
- Representativeness
- Completeness
- Comparability
- Sensitivity

Example: Data Quality Objectives and Indicators

The project objective

To collect baseline PM data on the west side of town where no local data exists but where there is dense redevelopment and construction

Data quality objective

We need to collect hourly PM_{10} data that are **accurate**, **representative** of the study area, and **complete** enough to capture trends across at least a full year (baseline)

Data quality indicators (three important DQIs shown)

Accuracy (bias and precision) — The performance of devices during collocation (with a higher-quality instrument) needs to meet the EPA performance targets for air sensors (correlation, error, etc.)

Representativeness – devices need to be sited in the project area away from hyperlocal sources (e.g., grill, chimney, etc.)

Completeness – need to collect at least 85% of valid data across averaging intervals (e.g., month, year, etc.)

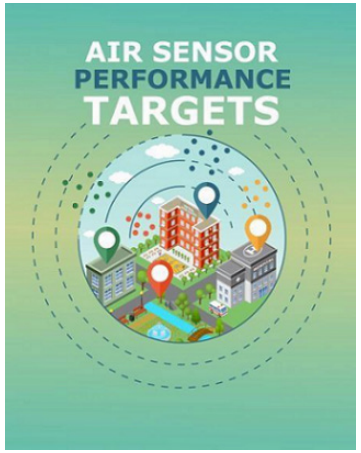


Image source: EPA

Discussing Roles & Responsibilities

Review the skills of your project team

- Technical expertise
- Data management and analysis
- Project and stakeholder management
- Quality assurance
- Communications

Do project needs and objectives match capacity and expertise?

- One individual may have more than one responsibility
- How can project budget support capacity?
  - Training to support the project team skillset
  - Sub-contracting project roles

- Identify problems with missing or insufficient roles and responsibilities at an early stage

Setting Roles & Responsibilities

Determine the roles and responsibilities

- Lead and support roles of all key players in the project

Create a project organization flow chart!

- Lines of reporting and communication between individuals and organizations

Discuss training needs

- Training/certification requirements (e.g., device operation, programming courses, etc.)

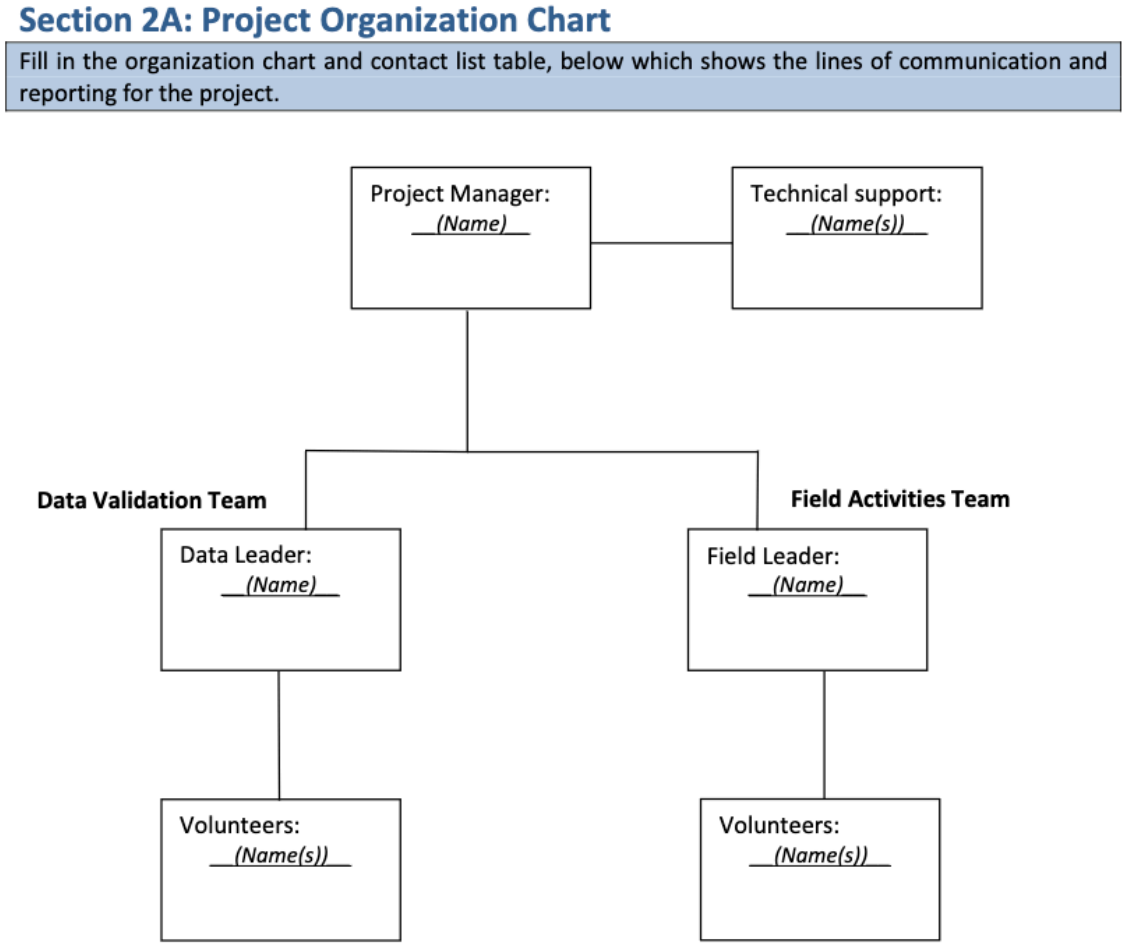


Image Source: New Jersey Department of Environmental Protection

QA/QC Activities

All the steps you perform to plan and manage the project and to collect, assess, and review data

Tasks and oversight that ensures project criteria are satisfied:

- Maintenance
  - What does the manufacturer recommend?
- Collocation
- Frequent data and site review
- Data validation against criteria

Ask your team: What possible problems may arise and what actions can be taken to mitigate their impact on the project?

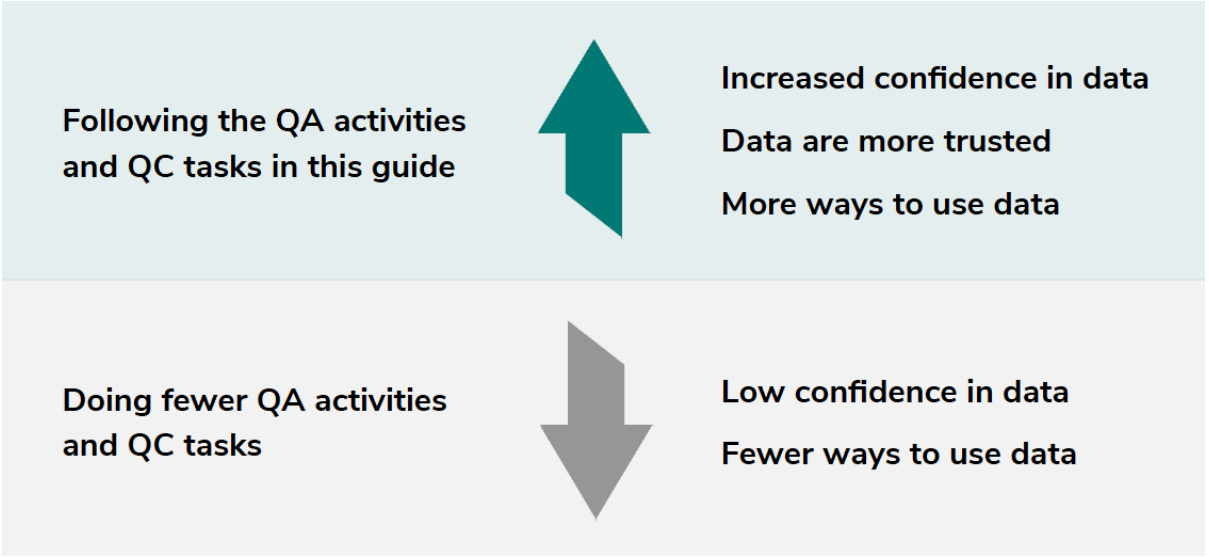
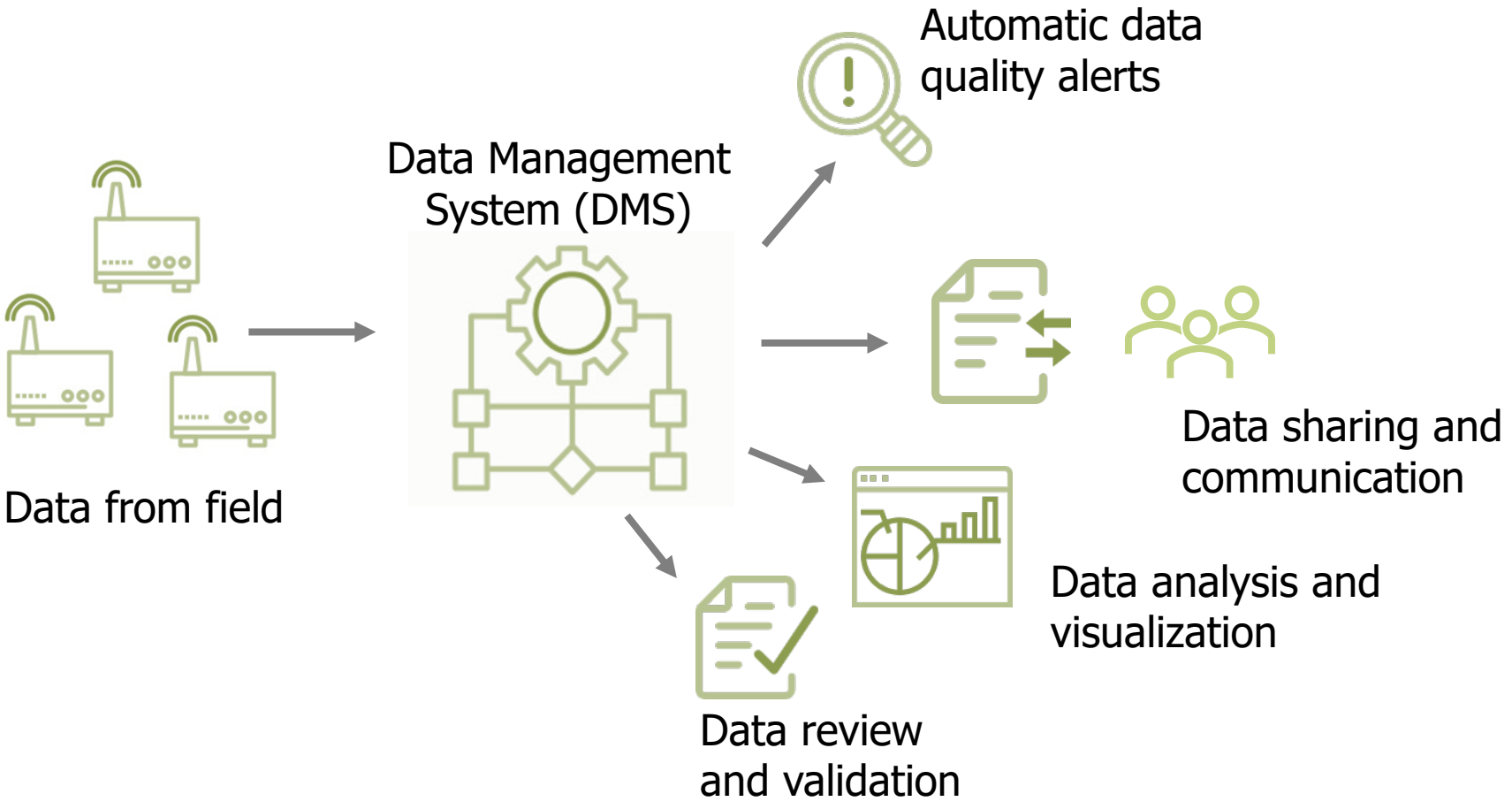


Image Source: EPA

QA/QC enables users to collect quality data, build trust in the data, and allow others to use the data

Data Flow

Describe how the data will be managed and trace the path of data generation in the field to the final data use and end storage. Add a flow chart to illustrate data flow.



5 Minute Break

Planning and QAPPs Guest Speaker

Michael King, Tribal Air Monitoring Support Center

QAPP Q&A

Determining Community Monitoring Sites

1. Review objective
2. Locate *General* sites to monitor
3. Locate *Specific* site to place the device

1. Revisit Your Objectives!

1. Revisit Your Objectives

Start by answering some questions about why and where to collect measurements, such as:

- What types of changes in air quality do I expect in the area?
- How do I expect one site to be different from another?
- Where should I put devices to measure and show these differences?
- What is the typical or prevailing wind flow in the area, and how might winds transport pollutants?
- Do I need to measure or find nearby meteorological data to interpret the air quality data?
- Could I use data from existing air monitoring networks?

2. Identify *General* Locations on a Map

2. Identifying *General* Locations on a Map

Identify the general locations on a map to place devices. Consider the following tips:

- Get community input. What concerns does the community have? What local knowledge do they have (e.g., locations that seem more or less polluted)?
- Locate a reference instrument for collocation activities
- Spread out the deployment locations to get good spatial coverage
- If there is an area of concern, locate sensors near/inside, upwind/downwind of the area to make meaningful comparisons (if resources allow)
- Reach out to local, tribal, or state air quality agencies, researchers, environmental consultants, or other experts who have experience with identifying locations

Identify *General* Locations on a Map

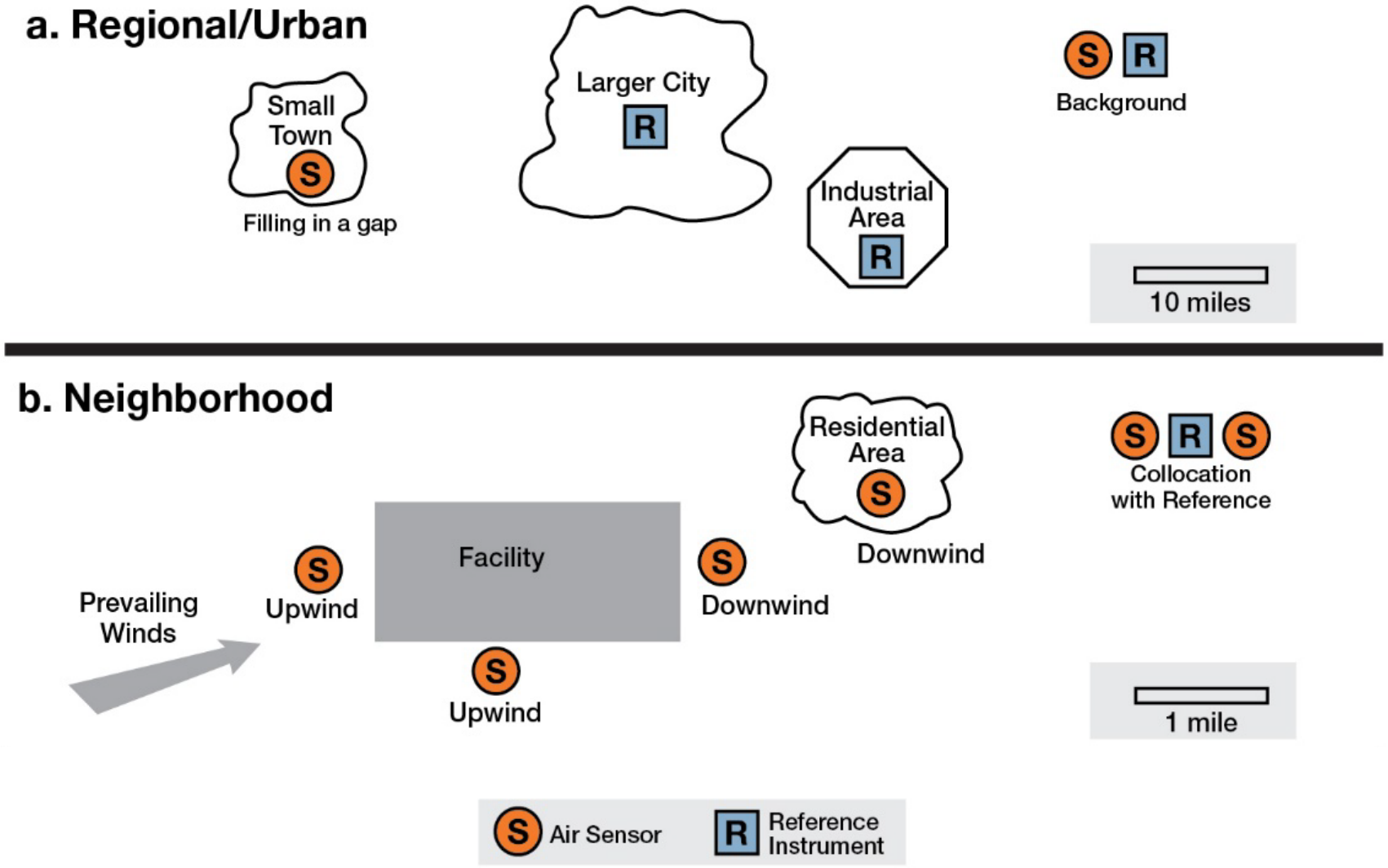


Image source: EPA

3. Identify *Specific* Locations

Based on the input you received, your assessment of general locations, and your project's objectives

3. Identifying *Specific* Locations: Logistics

GENERAL LOCATIONS

Considering the purpose of the measurements, where should the site be located?

SECURITY

Ensure that the sensor is secure and protected from vandalism or theft and that site operators can remain safe.

ACCESS

Determine the requirements (permissions, keys, etc.) to visit the site to install/service the sensor(s).

PLACEMENT

In general, place the sensor at least 3-6 feet above ground level, rooftop, or other objects and away from obstructions, vegetation, or emission sources that would interfere with the measurement.

POWER

Determine requirements and establish power early.

PHOTOS

Take photos of the sensor installation and area around the site.

COMMUNICATIONS

Ensure reliable communications (cellular, Wi-Fi, etc.) before installation.

DOCUMENTATION

Record information about the site, including latitude, longitude, elevation, nearby sources, date of installation, etc.

Image source: EPA

Review Your Siting

Do your sites match your objectives?

Do your sites meet all of the device's needs?

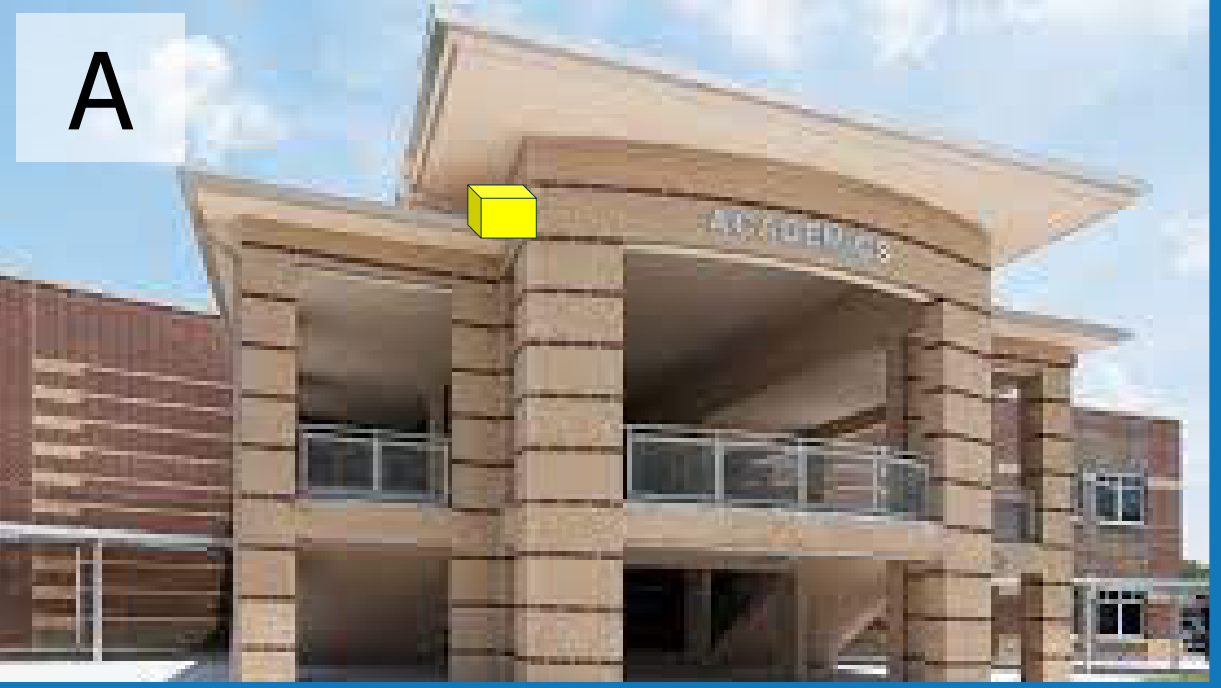
Is installing at each site feasible?

Interactive Quiz

Photos of possible sites & best practices

Example 1: Monitoring Objective

Examine the exposure of students when outdoors at school, and additionally understand the role of the school in generating emissions that impact their students. You will need a device that is solar-powered.


A


B


C


D

Example 2: Monitoring Objective

A rural community wants to monitor for smoke to help inform and notify residents of pollution during wildfires. You need to find one location to install a $PM_{2.5}$ air sensor. It will require power and Wi-Fi.


A

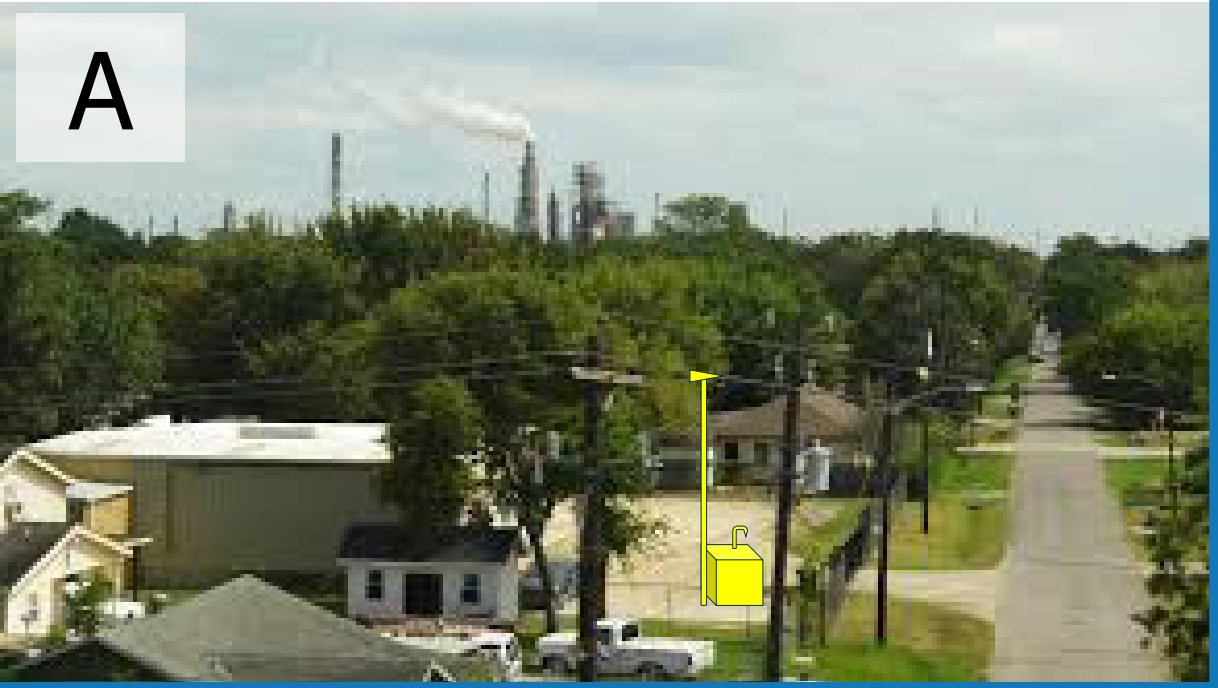

B


C


D
CAZENOVIA FABRICS

Example 3: Monitoring Objective

A community next to an industrial facility wants to detect and document pollution coming from that facility into their neighborhood. They need to install a monitoring station with air quality instruments that measure VOCs, $PM_{2.5}$, and weather instruments for wind speed and direction.


A


B


C


D

Recap

- Selecting equipment
- Planning and QAPPs
- Determining network sites

Interactive End-of-Session Feedback

What did you learn in today's presentation that's going to benefit your work?

What’s up next

Webinar 5

Building an Air Monitoring Network: Installation, Operation, Data Analysis, and Communication

Installing and operating devices, data wrangling, data analysis, resources for analysis, and communicating results

Q & A