Quality Assurance and Quality Control Tools for Monitoring Projects

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Today's Overview

- QA is Confusing
- Class Example – Cache Creek
- Data Quality Objectives
- Data Quality Indicators & Measurement Quality Objectives
- QA Project Plans
- Method Selection and PBMS
- Laboratory/Field Crew Selection
- Technical Assistance
- RFPs and Contracts
- Introducing Error
- SWAMP Comparability
- Take Home Messages

QA/QC is Confusing!

MDL, PQL, or RL?

bias

QAPP

DQI

Power Analysis

replicate

CRM or SRM?

SURROGATE

RPD

Calibration

On-site Systems Assessment

MS/MSD

QA or QC?

MQOs

CCV

D

Q

O

QAPrP

Duplicate

Audit

precision

QMP

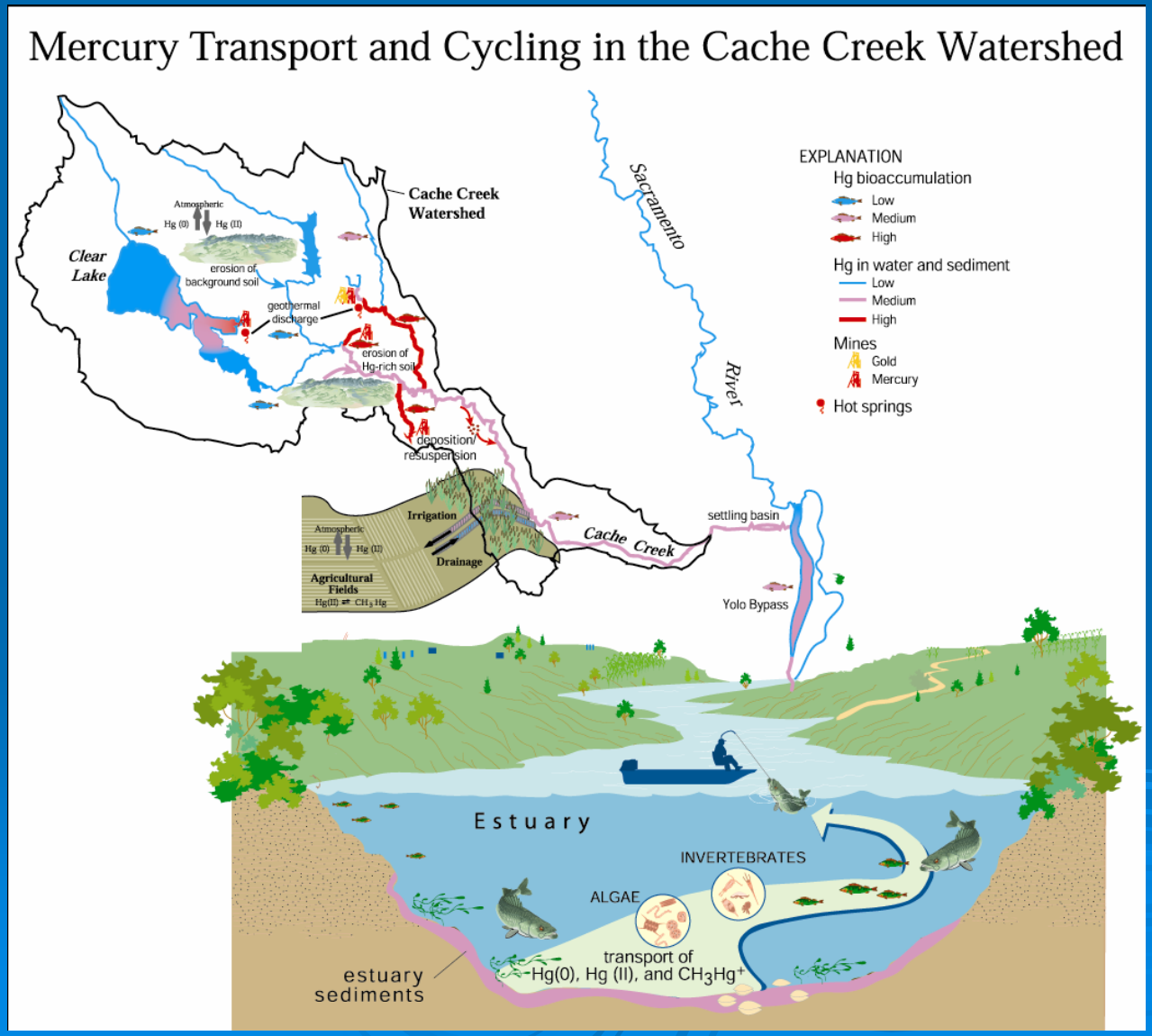
RSD

data verification or validation???

Questions/Complaints/Frustrations

- It is unclear how to write a QAPP.
- Writing a QAPP takes too long.
- QA seems to be a waste of money.
- The QA Officers never know the answer to my questions.
- Every lab/field team wants to modify the methods mentioned in the QAPP.
- My project contributes data to a program whose requirements are unclear.
- It is difficult to select a laboratory/field crew.
- The laboratory/field crew wants to use methods that differ from those in the QAPP.
- The laboratory wants to substitute its state certification for QAPP adherence.
- It's impossible to know if laboratories/field crews are following the QAPP.
- Some of my project's work is being duplicated by other projects/programs.
- I'm uncertain how to budget for QA.
- What is a performance-based method (PBMS)?

Fictitious Example Exercise



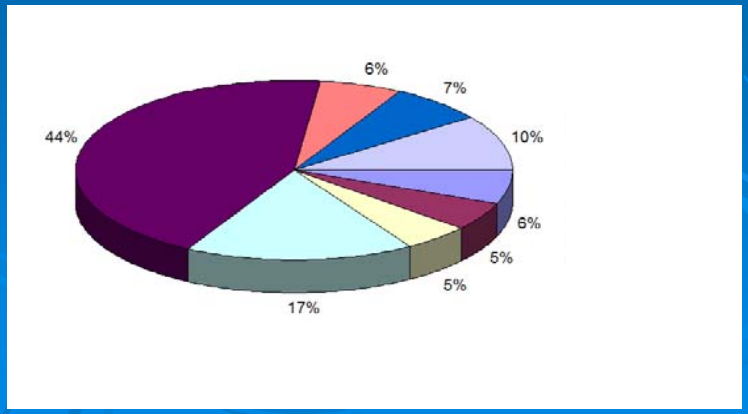
Map Source: Domagalski et al. (2004)

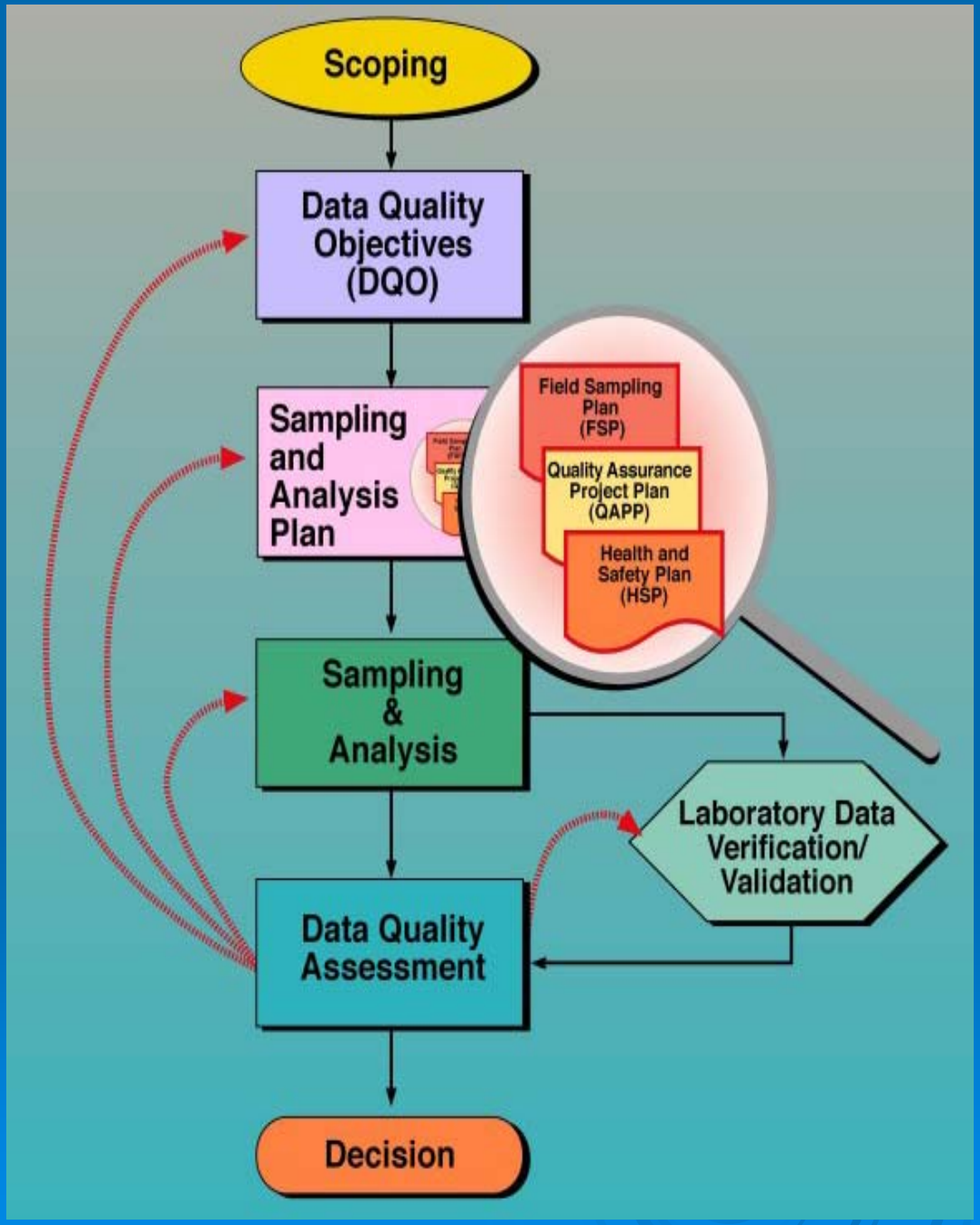
Cache Creek Example

- Monomethyl Mercury (MMHg)
- TMDL Goal: To reduce methylmercury concentrations in bass and catfish
- Study Objectives:
  - To determine whether methylmercury concentrations in catfish and bass tissue exceed the numeric tissue objective of 0.23 mg/kg in selected sites
  - To determine whether methylmercury concentrations in water exceed the numeric objective of 0.14 ng/L in selected sites
  - To help characterize fluctuations of total mercury concentrations (as ng/L) in the creek

Cache Creek Example

- Concept needs to fit budget
- $70 K for 18 months
- What % of budget for:
  - planning, technical assistance, general administration, collection, analysis, QA/QC, data management, reporting





EPA Decision Making Process

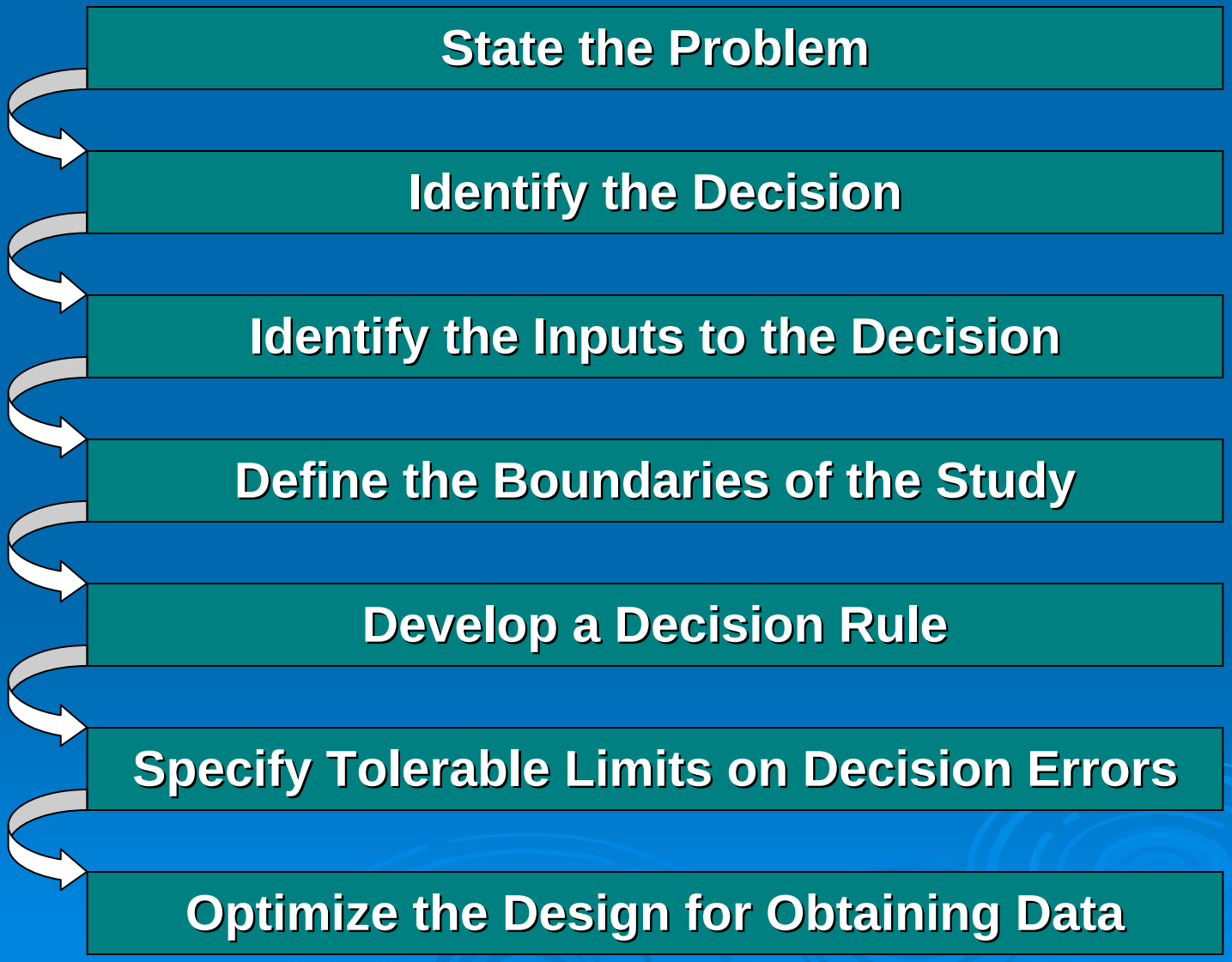
Data Quality Objectives

DQOs…What are they?

The Data Quality Objectives Process

- The EPA's DQO process provides a procedure for defining the criteria that a data collection design should satisfy.
- DQOs are used as the basis for establishing the quality and quantity of data needed to support a decision.
- What question do we want to answer?
- Use of a systematic planning process

The Data Quality Objectives Process



Systematic Planning for Environmental Data

- Identify sponsoring organizations and personnel
- Describe project goal, objectives, and schedule
- Budget project funding for needed components
- Identify type of data and link to project goal
- Determine the type, quality, and quantity of data needed
- Specify acceptance or performance criteria
- Develop a sampling plan and QA/QC requirements
- Preliminary description of how the data will be analyzed

What does this mean to my project?

- Do we need to follow EPA's steps and statistical requirements?
- Systematic Planning Process
- Need to have desired outcomes for project
- Uses that the data will be subjected to
- How do we decide number of samples and locations?
- The DQOs are part of your PAEP, Monitoring Plan and QAPP

Cache Creek Exercise

- Identify sponsoring organizations and personnel
  - The County of Yolo and the RWQCB, Central Valley Region; John Doe at the RWQCB serves as the Contract Manager; Sarah Dough at the County of Yolo serves as the QA Officer
- Describe project goal, objectives, and schedule
- Is our project goal to reduce methyl-mercury concentrations in bass and catfish? No - program's goal.
- Our project goals are:
  - To determine whether methyl-mercury concentrations in catfish and bass tissue exceed the numeric tissue objective of 0.23 mg/kg in selected sites
  - To determine whether methyl-mercury concentrations in water exceed the numeric objective of 0.14 ng/L in selected sites
  - To help characterize fluctuations of total mercury concentrations (as ng/L) in the creek

too vague

Cache Creek Exercise

- Budget - $70K, 18 mo., figured % for each component
- Identify type of data and link to project goal
  - Methylmercury concentrations in fish tissue and water data that meet a 90% completeness criteria for each selected site
- Determine the type, quality, and quantity of data needed
  - Ten fish homogenized for each tissue concentration and one water sample for each creek sample; data shall be produced at a technically-defensible quality (need a QA Program)
- Specify acceptance or performance criteria
  - Follow guidance in the Quality Assurance Project Plan for SWAMP and the CALFED Project for performance criteria
- Develop a sampling plan and QA/QC requirements
  - Monthly sampling for 12 month sampling period; two sites sampled for fish tissue concentrations, 10 sites sampled for water concentrations; see MQO tables in SWMAP and CALFED QAPP
- Preliminary description of how the data will be analyzed
  - Mean sample and instantaneous concentrations relative to numeric limits. Loads will not be calculated by this project, but will be by the Regional Board.

Data Quality Indicators and Measurement Quality Objectives

DQIs and MQOs…What are they?

Data Quality Indicators

- **DQIs are the quantitative statistics and the qualitative descriptors used to interpret the degree of data's acceptability or utility.**

- **The principal DQIs are:**
  - **Precision**
  - **Accuracy**
  - **Representativeness**
  - **Comparability**
  - **Completeness**
  - **Sensitivity**

- **Called PARCCS**

Data Quality Indicators

DQI	Examples
Precision	Sample Replicates, MDL Studies
Accuracy (bias)	Sample Spikes, Reference Materials
Representativeness	Sample Replicates, Total # of Samples, PAEP
Comparability	Intercomparison Studies, Consistent Methods
Completeness	Data Verification (# of samples with results)
Sensitivity	MDL Studies, Calibrations

What does this mean to my project?

- DQIs help objectively define the analytical capabilities and systems needed to address each DQO.

- For example, the DQI comparability would be emphasized by large programs/projects with many contributors. The DQI accuracy would be emphasized when DQOs reference regulatory action limits.

Cache Creek Example – Methyl Mercury in Water

DQI	Assessment Method
Precision	Laboratory Duplicate, Matrix Spike Duplicate, Field Duplicate
Accuracy	Reference Materials, Matrix Spike, Matrix Spike Duplicate, Continuing Calibration Verification Standards
Representativeness	Data Quality Assessment
Comparability	PTs/Intercomparisons
Completeness	Data Verification
Sensitivity	MDL Studies, Calibration

Measurement Quality Objectives

- **MQOs are the individual performance or acceptance goals corresponding to each of the data quality indicators (DQIs - *PARCCS*).**

- **MQOs help "translate" the selected DQIs (*PARCCS*) into discrete analytical performance criteria. Commonly encountered MQOs include:**

  - **Analytical Control Limits – P, A**
  - **Method Detection Limits (MDLs) – P, S**
  - **Reporting Limits (RLs) – C, C**
  - **Holding Times – P, A, R, C, C, S**

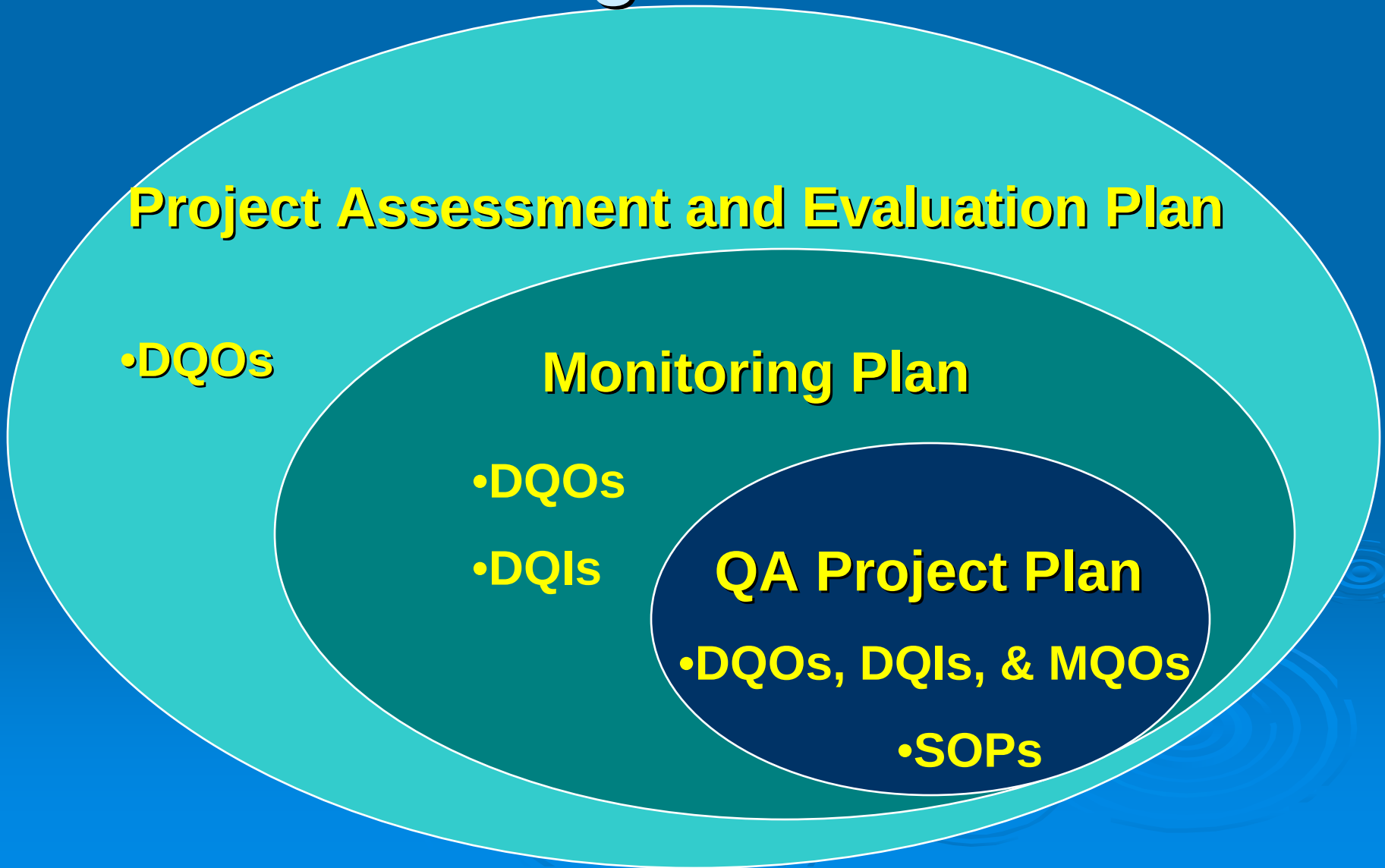
What does this mean to my project?

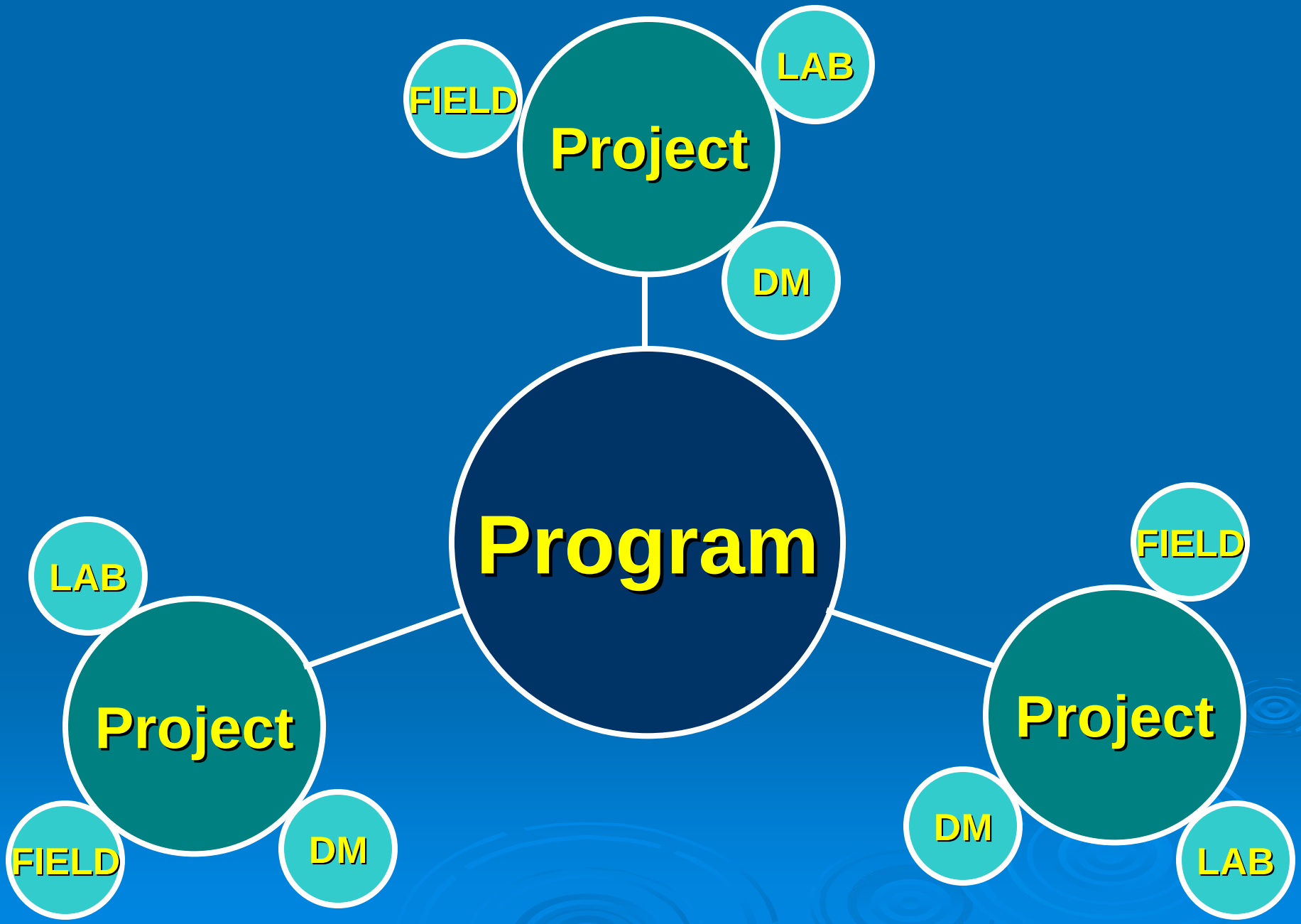
- How you communicate to the field crews and laboratories what is needed
- How you will assess data usability in answering your question
- How you will pick your field/analytical methods
- How you are integrated (comparability) with other programs

Cache Creek Example – Methyl Mercury in Water

QC Sample	Frequency	Control Limits
Equipment Blanks Bottle Blanks	Random statistical testing	< MDL (0.020 ng/L) for low level samples < 1/5 sample concentration for high level samples
Field Blanks	1 per field event	< MDL (0.020 ng/L)
Field Duplicates	1 per 20 samples collected	RPD < 25%
Calibration Curve	1 per analytical day, consisting of 5 non-zero calibration points and 3 bubbler blanks	r > 0.995
Continuing Calibration Verification Standards (CCVs)	After initial calibration and after every 10 samples	80-120% recovery
Method Blanks	3 blanks per set of 20 field samples	Mean < ML (0.5 ng/L)
Reference Materials	1 per set of 20 field samples	70-130% recovery
Laboratory Duplicate	1 per set of 20 field samples	RPD < 25%
Matrix Spike	1 per set of 20 field samples	70-130% recovery
Matrix Spike Duplicate	1 per set of 20 field samples	70-130% recovery RPD < 25%

Nesting of your Project's Planning Documents




Program
Project
FIELD
LAB
DM
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FIELD
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Project
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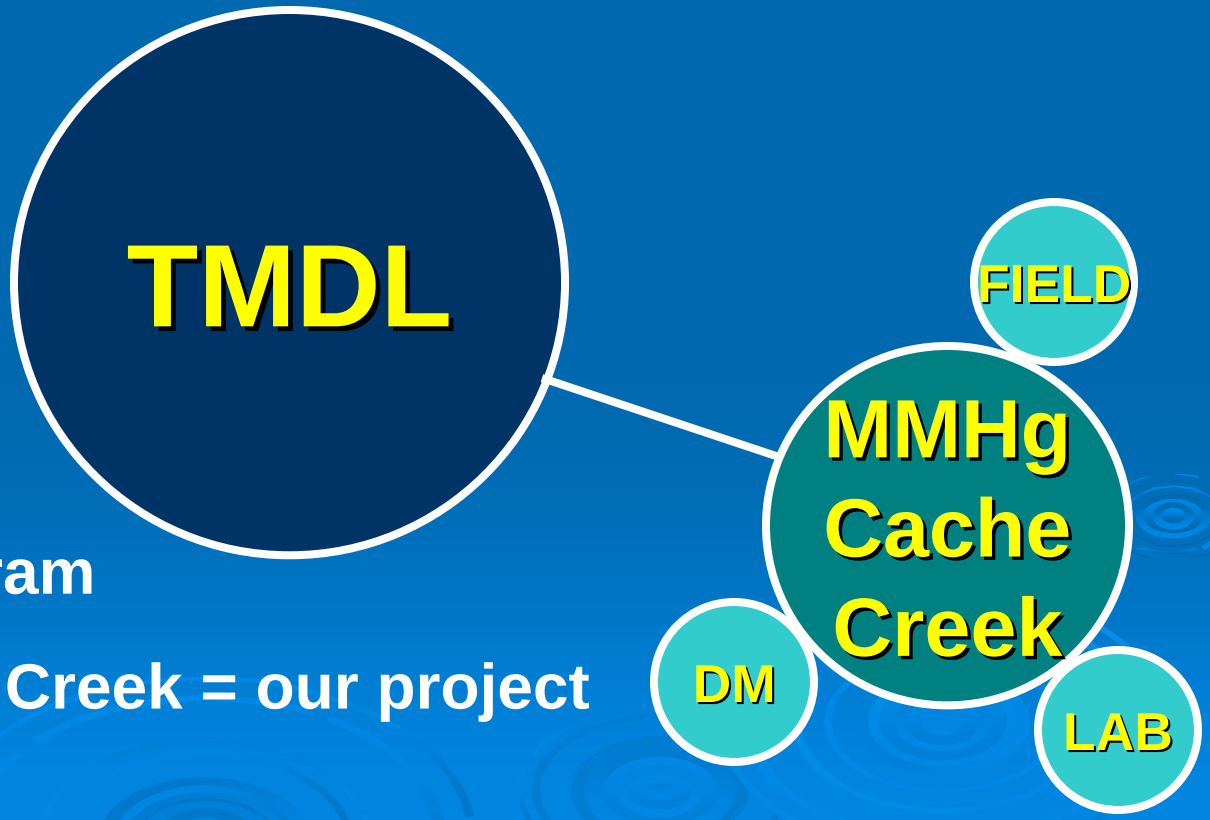
LAB

Cache Creek Example



TMDL = program

MMHg Cache Creek = our project

Quality Assurance Project Plan

- What is the QAPP?
  - 24-element document written and approved prior to sample collection
  - Outlines project goals (DQOs)
  - Describes who (personnel, staff) is doing what (field, lab, reporting)
  - Tables with QC samples and control limits (MQOs)
  - Outlines the ways you will assess (data ver./val. and interpretation) and report (database?) your data

24-Element QAPP

- A1 – Title and Approval Sheet
- A2 – Table of Contents
- A3 – Distribution List
- **A4 – Project/Task Organization**
- **A5 – Problem Definition and Background**
- **A6 – Project/Task Description**
- **A7 – Quality Objectives and Criteria**
- A8 – Special Training/Certifications
- A9 – Documentations and Records
- **B1 – Sampling Process Design (Experimental Design)**
- B2 – Sampling Methods
- B3 – Sample Handling and Custody
- B4 – Analytical Methods
- B5 – Quality Control
- B6 – Instrument/Equipment Testing, Inspection, and Maintenance
- B7 – Instrument/Equipment Calibration and Frequency
- B8 – Inspection/Acceptance of Supplies and Consumables
- B9 – Non-direct Measurements
- B10 – Data Management
- C1 – Assessment and Response Actions
- C2 – Reports to Management
- D1 – Data Review, Verification, and Validation
- D2 – Verification and Validation Methods
- D3 – Reconciliation with User Requirements

What does this mean to my project?

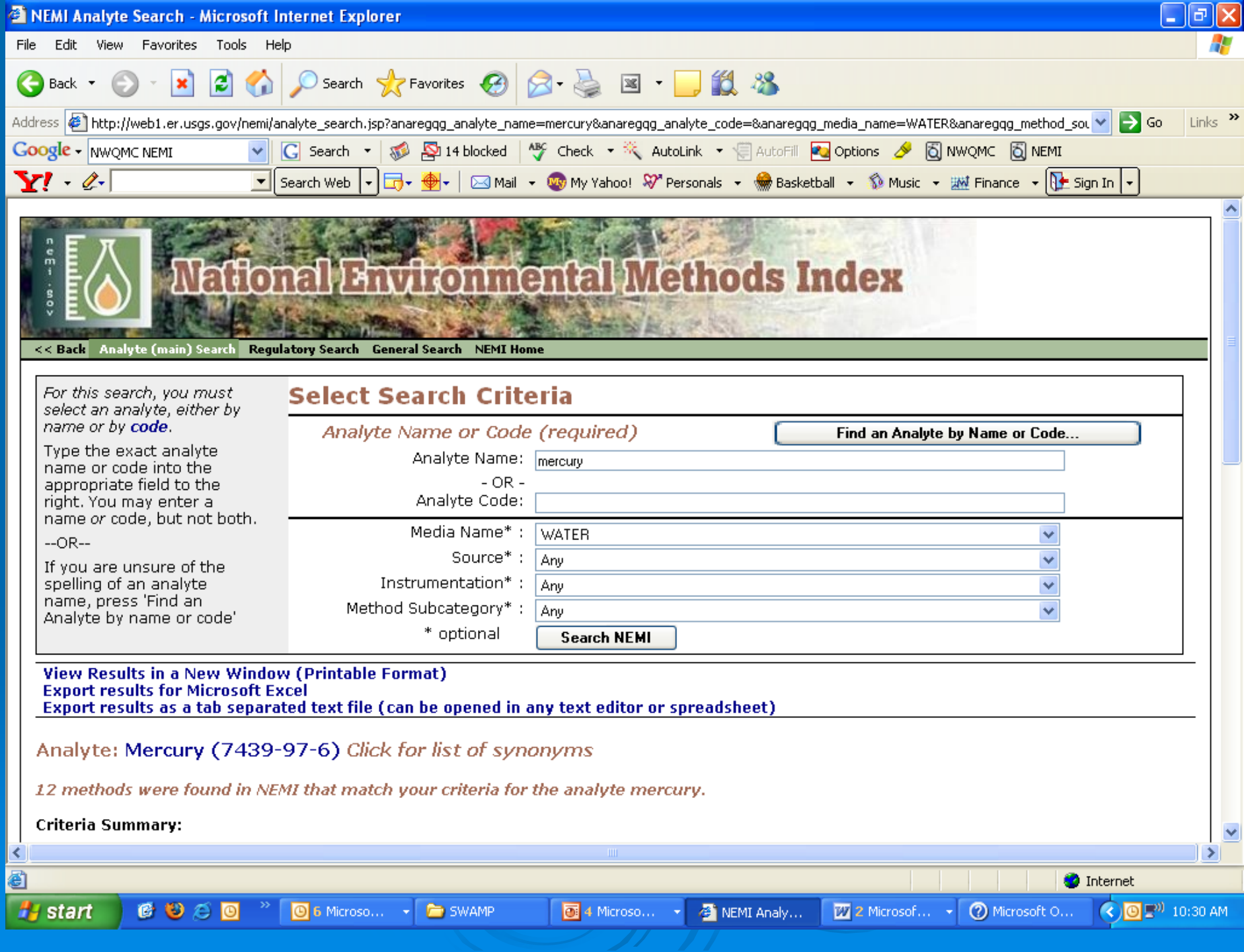
- Use your Monitoring Plan
- Use the SWAMP Template
- Look at other QAPPs or a Program Plan (QAPrP)
- Don’t get too bogged down in every section. For example, “will use lab SOPs for instrument calibration.” Include SOPs as an appendix
- Delegate sections to your partners – lab and field crews
- The QAPP should reflect the scope of the project (i.e., small project, small QAPP)
- Do you need approval prior to sampling?

Cache Creek Example

- Find out about approval process. Regional Board QA Officer.
- Look at course handouts for QAPPs.
- Will use the SWAMP QAMP and CALFED Hg QAPP where possible.
- Get the lab and field crews to help.
- We will need to write our own sections for:
  - **A4 – Project/Task Organization**
  - **A5 – Problem Definition and Background**
  - **A6 – Project/Task Description**
  - **A7 – Quality Objectives and Criteria**
  - **B1 – Sampling Process Design (Experimental Design)**

Method Selection

- Several method options for many analytes
  - EPA
  - ASTM
  - Standard Methods
  - USGS
- Standardized methods based on consensus
  - Field methods
  - Bioassessment methods
- Alternate Methods - Performance Based System
  - Lab or Field SOPs
- National Environmental Methods Index


NEMI Analyte Search - Microsoft Internet Explorer
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Address http://web1.er.usgs.gov/nemi/analyte_search.jsp?anaregqg_analyte_name=mercury&anaregqg_analyte_code=&anaregqg_media_name=WATER&anaregqg_method_sou
Go Links
Google NWQMC NEMI Search 14 blocked Check AutoLink AutoFill Options NWQMC NEMI
Search Web Mail My Yahoo! Personals Basketball Music Finance Sign In
National Environmental Methods Index
<< Back Analyte (main) Search Regulatory Search General Search NEMI Home
For this search, you must select an analyte, either by name or by code.
Type the exact analyte name or code into the appropriate field to the right. You may enter a name or code, but not both.
--OR--
If you are unsure of the spelling of an analyte name, press 'Find an Analyte by name or code'
Select Search Criteria
Analyte Name or Code (required)
Find an Analyte by Name or Code...
Analyte Name: mercury
- OR -
Analyte Code:
Media Name* : WATER
Source* : Any
Instrumentation* : Any
Method Subcategory* : Any
* optional
Search NEMI
View Results in a New Window (Printable Format)
Export results for Microsoft Excel
Export results as a tab separated text file (can be opened in any text editor or spreadsheet)
Analyte: Mercury (7439-97-6) Click for list of synonyms
12 methods were found in NEMI that match your criteria for the analyte mercury.
Criteria Summary:
Internet
start
6 Microso...
SWAMP
4 Microso...
NEMI Analy...
2 Microsof...
Microsoft O...
10:30 AM

- Media Name equals WATER

Method Number (Sort)	Source (Sort)	Method Descriptive Name (Sort)	Detection Level	Detection Level Type	Bias	Precision	Spiking Level	Instrumentation (Sort)	Relative Cost (Sort)
200.8	EPA-NERL	Metals in Waters by ICP/MS	.2 ug/L	MDL	86 % Rec (SL)	13 RSD (SL)	1 ug/L	ICP-MS	$$$
200.7	EPA-NERL	Metals in Water by ICP-AES	7 ug/L	MDL	N/A	N/A		ICP-AES	$$$
1631	EPA-EAD	Mercury in Water Using CVAFS	.0002 ug/L	MDL	N/A	N/A		CVAFS	$$
245.1	EPA-NERL	Mercury by CVAA	.2 ug/L	RNGE	166 % Rec (ML)	89 RSD (ML)	.21 ug/L	CVAA	$$
245.2	EPA-NERL	Mercury by CVAA (Automated)	.2 ug/L	RNGE	N/A	8 RSD (SL)	.5 ug/L	CVAA	$$
D6502	ASTM	Particulate and Dissolved Matter by XRF	1 ug/L	ML	N/A	N/A		XRF	$$
I-1462	USGS-NWQL	Mercury, dissolved, CVFAA	.5 ug/L	RNGE	N/A	30 RSD (ML)	3.46 ug/L	CVAA	$$
I-2462	USGS-NWQL	Mercury, dissolved, CVFAA	.1 ug/L	RL	N/A	32 RSD (ML)	1.87 ug/L	CVAA	$$
I-3462	USGS-NWQL	Mercury, total recoverable, CVFAA	.5 ug/L	RNGE	N/A	N/A		CVAA	$$
I-7462	USGS-NWQL	Mercury, suspended recoverable, CVFAA	.5 ug/L	RL	N/A	N/A		CVAA	$$
I-2464-01	USGS-	Organic plus	5 ng/L	MDL	100 % Rec	N/A	45 ng/L	CVAFS	$

Performance-Based Measurement System

- A set of processes wherein the data needs, mandates, or limitations of a program or project are specified, and serve as criteria for selecting appropriate methods to meet those needs in a cost-effective manner.

- The PBMS allows non-statutory methods to be considered for use in data production.

Demonstration of Method Proficiency

- Perform an MDL Study following 40 CFR part 136
- Compare the following to the mandated program requirements
  - Calibration
  - Calibration verification
  - Initial precision and recovery
  - Analysis of blanks
  - Accuracy assessment
  - Ongoing precision and recovery
- Need Meta Data! – Documentation

What does this mean to my project?

- Supports MQOs that were established prior
- Look in other programs - comparability
- Don’t just rely on EPA methods
  - Can be years behind
  - Focus on regulatory versus monitoring needs
  - Frequently don’t give MDLs needed
- Lab/Field SOPs – Great if lab/field documents meta data
- Use National Environmental Methods Index – understand limitations
- Consult technical experts

Cache Creek Example

- Go to NEMI found no choices for MMHg in water or tissues
- Need MDL for MMHg water 0.020 ng/L
- Only one water method choice:
  - Draft EPA Method 1630 MMHg in Waters
- Lab SOPs
- Consult technical experts
- LOOK AT OTHER PROGRAMS!

Laboratory/Field Crew Selection The Basics

- Have you worked with lab before?
- Is the lab a leader in this analysis?
- Is the lab accredited?
- Do they have a QMP?
- What is proximity to sampling locations?
- What is the lab's reporting format?
- Is there a value-added benefit?

Laboratory/Field Crew Selection Sleuthing

- What is staff turnover?
- How do they train staff?
- How do they achieve MDLs?
- Do they participate in any intercomparison studies?
- What is their backlog?
- Are they subcontracting?
- Is the lab part of a larger program (e.g., SWAMP)?
- Is the organization revenue or journal articles driven?
- How old is instrumentation?

Cache Creek Example

- We know our MQOs and methods
- Time to pick lab and field crew
- We put out a RFP for the analytical work
- Responses include info on lab MDLs, PQLs and RLs – what are all these limits?
- MDL = method detection limit
- PQL = subjective lab choice – 2-5x MDL
- RL = usually project driven, related to regulatory limit or project action limit
- What items do we want to see from lab?

Technical Assistance

- Budget for this
- Use free resources as Regional and State Board
- Use larger programs, go to their meetings
- List specific areas where you might need tech assistance
  - Sampling gear
  - Method selection
  - Species of fish
  - Interpretation of data (Data Quality Assessment)

Cache Creek Example

- We are going to piggy back on SWAMP and the CALFED Hg studies programs
- Try to attend meetings
- We budgeted for our lab to help us in technical assistance
- We budgeted for other technical help

RFP and Contract Language

- The more specific your contract is, the better your outcome
- “Compliant with SWAMP QAMP”?
  - too general
- Attach the MQO table you want met
- Take text from your QAPP, PAEP or Monitoring Plan
- Specify TAT and the consequences (% reduction in payments?)
- Will you pay for samples analyzed outside hold times?
- Will you require any performance tests?
- What about data reporting? Attached reporting forms, field sheets, COC, etc.

What does this mean to my project?

Need to have planning done
before sub-contracting work

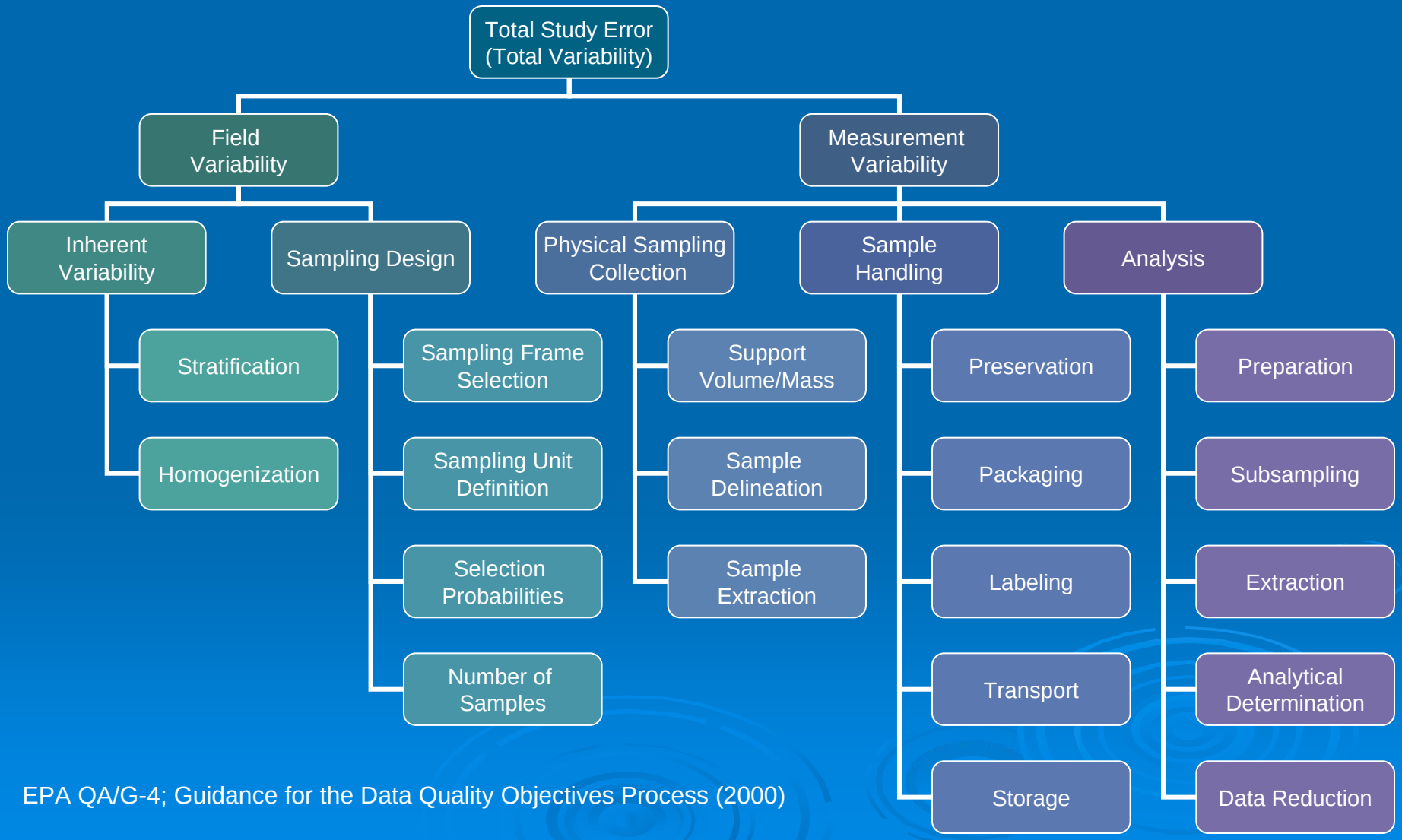
Cache Creek Example

- “Samples shall be analyzed and reported within 60 days from sample collection.”
  - This gives us 30 more days for re-runs still within holding times
- “All samples shall be prepared and analyzed following requirements in Table ## of the QAPP.”
- “If samples are batched with other client samples, the samples for this project will be used as all the QC samples following requirements in Table ##.”

Cache Creek Example

- " The laboratory will run MDL studies following 40 CFR part 136 annually that meet or exceed 0.02 ng/L. Documentation of MDL studies will be on file at the laboratory and available upon request."
- "The laboratory will participate, at the laboratory's cost, in at least one, MMHg water intercomparison study annually."
- "The laboratory shall report all sample results even in the event that QC samples and controls do not meet laboratory and project objectives."
- "The laboratory shall use reporting formats provided by the project and attached herein as appendix C."

Components of Total Study Error



EPA QA/G-4; Guidance for the Data Quality Objectives Process (2000)

Cache Creek Example

- Monthly sampling for 12 month sampling period; two sites sampled for fish tissue concentrations, 10 sites sampled for water concentrations; see MQO tables
- Many RPDs >25% when low concentrations found (close to MDL)
  - Made a mistake in QAPP, no RLs
  - Made a mistake in MQOs, no relation of criteria to concentrations
- Glass bottles not packed properly broke, now may not meet monthly sampling criteria
- Mislabeled samples in lab
- Clean hands-Dirty hands technique
- Reporting error into database caught at end of project

Why use SWAMP's QA/QC?

- Tested MQOs via expert focus groups
- State-of-the-art methods
- Systems for data collection, verification, validation, management, and reporting
- Covers most analyte/matrix combinations in addition to field measurements, toxicity testing and bioassessment studies
- Infrastructure and tools for others
- Peer-reviewed
- COMPARABILITY

SWAMP QA Program Coordination with Others

- Non-Point Source Program
- CALFED/CBDA Science Program
- CA universities and colleges (research)
- US EPA R9 OW
- SFEI
- SCCWRP
- US EPA Office of Environmental Information's Quality Staff (Washington, D.C.)
- NWQMC
- Ag.-Waiver Program
- TMDL
- Regulated Community
- SWRCB DFA
- SWRCB OIT

Take Home Messages

- Set Goals: Use systematic planning, link type of data to project goal
- Save Resources: Leverage off existing programs or larger projects
- Successful Implementation: Use the RFP, Contract, & QAPP to implement QA/QC
- Useful Product: Collect data of known and documented quality that is application-appropriate and that is comparable with data from other efforts

The Quality Assurance Research Group at Moss Landing Marine Laboratories

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