INTERPRETING LAB REPORTS AND QA/QC

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PLWC

Region VI Pretreatment Association 35th Annual Workshop
August 8, 2019

Before we begin…

Data Use*

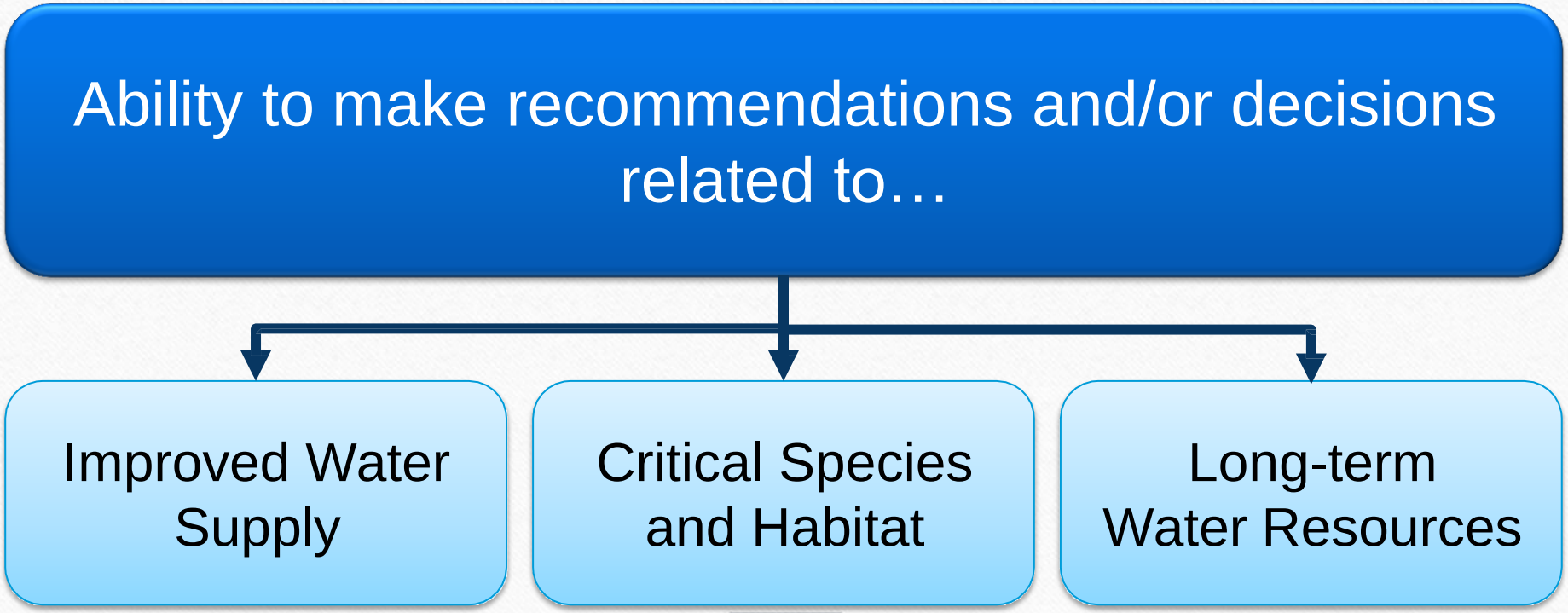
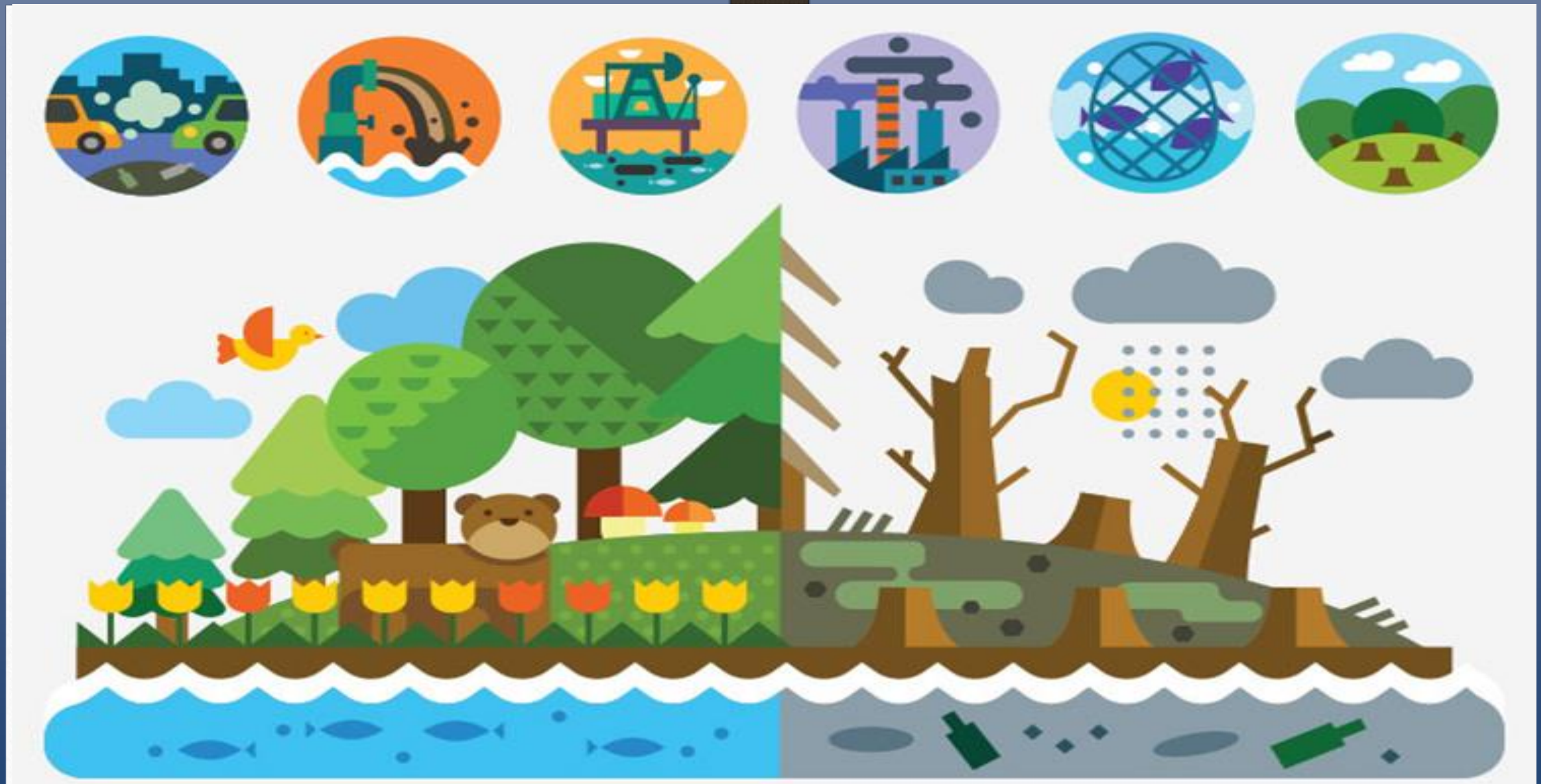


*Diagram courtesy of Marine Pollution Studies Laboratory at the Moss Landing Marine Laboratories



Terms

- Batch
- Calibration
- Data validation
- Matrix
- Continuing Calibration Validation
- Surrogate

QC Terms

- Detection Limits (DL)
- Reporting Limits (RL)
- Non-detect
- Qualifiers
- Method Blanks
- Laboratory Control Sample (LCS)
- Matrix Spike / Matrix Spike Duplicate (MS/MSD)
- Accuracy
- Precision
- Control and Warning Limits

Qualifiers

- B – Contamination in associated method blank
- S – Recoveries that are not within QC limits
- R – RPD of duplicate analysis exceeds QC limit
- J – Result is above the method detection limit, but below the reporting limit
- E – Result is above the calibration range
- H – Sample analysis time exceeded holding time listed for test within its method

Units of Measurement

- mg/L = mg/kg = ppm
- µg/L = µg/L = ppb
- ng/L = ng/kg = ppt
- CFU = colony forming units

Laboratory Considerations

- Certification
- Personnel
- Instrumentation
- Reports
- QA/QC
- Recommendations

Laboratory Reports

- Cover Letter
- Report Contents
- Definitions
- Case Narrative
- Laboratory Results
- Sample Summary
- Dates Report
- Quality Control Results
- Receiving Check List
- Chain of Custody

Case Narrative

- Sample Receipt
- Holding Times
- Preservation
- QA/QC Criteria
- Comments
- Subcontracted
- Additional Information

Chain-of-Custody (COC)

- Essential
- Sections
  - Client and Project Information
  - Sample Information
  - Analyses Requested Information
  - Turnaround Time (TAT) and Reporting Requests
  - Chain of Custody from Field to Lab

POTW Contact

Name

Address

City/State/Zip

Phone:

Email:

POTW Contact:

Project Name/CODE:

Sampling Site:

Pollutant Parameters - Metals are as Total - 40 CFR Part 136 Methods Required Unless Specified Otherwise.

Meter Readings

End

Start

Gal.

MGD

Grab Samples Relinquished by: | Company: | Date | Time | Grab Samples Received by: | Company:

Grab Sampler (Name and Signature)

Composite Samples Relinquished by: | Company: | Date | Time | Composite Samples Received by: | Company:

Composite Sampler (Name and Signature)

Temperature (°C):

pH (S.U.):

Remarks

Disposal Date

Analyst

Relinquished by: | Company: | Date | Time | Received by: | Company: | Disposal Date | Date | Time

Analyst

Grab Samples Relinquished by: | Company: | Time

Notes:

Composite Samples Relinquished by: | Company:

Type of Container (G = glass; P = plastic)

PO #:

Relinquished by: | Company: | Time

Preservation

Arkansas Analytical Inc.
8100 National Dr.
Little Rock, AR 72209
PHONE: 501-455-3233
FAX: 501-455-6118

CHAIN OF CUSTODY RECORD

CLIENT INFORMATION	BILLING INFORMATION	Project Description	Turnaround Time	Preservation Codes:
Paragould, Light, Water & Cable	Paragould, Light, Water, & Cable	Effluent Sample	1 Day (100%)	1. Cool 4 Degrees Centigrade / 4. Thiosulfate for Dechlorination
601 Grant Lane	P.O. Box 9		2 Day (50%)	2. Sulfuric Acid (H_2SO_4), pH < 2 / 5. Hydrochloric Acid(HCl)
Paragould, AR 72450	Paragould, AR 72450	Reporting Information	3 Day (25%)	3. Nitric Acid (HNO_3), pH < 2 / 6. Sodium Hydroxide (NaOH), pH > 12
PO #: 9519LE		Telephone: 870-239-7795	5 Day (Normal)	TEST PARAMETERS
Attn: Lisa Ellington		Fax: 870-239-7791	Preservative Code:	1,6 / 1,2 / 1,3 / 1
		Email: lellington@paragould.com	Bottle Type:	P / GA / P / G

Steve Parker, Tiffani Newsom, Colin Hesh
Sampler(s) Signature

Steve Parker, Tiffani Newsom, Colin Hesh
Sampler(s) Printed

Field Number	SAMPLE COLLECTION Date/s	Time/s	Grab	Comp	Number of Bottles	Sample Matrix	SAMPLE IDENTIFICATION/ DESCRIPTION	Cyanide	Total Phenolics	MSW18 Metals-200.8(Sb, As, Ba, Be, Cd, Cr, Pb, Mo, Ni, Se, Ag, Tl, Zn)	**Low Level Hg (SUBCONTRACT)**						Arkansas Analytical Work Order Number
	04/02/2019	8:30 AM					*Effluent - Grab #1										19040998
	04/02/2019	10:57 AM		X	2	Water	*Effluent - Grab #2	X	X								01
	04/02/2019	2:56 PM					*Effluent - Grab #3										
	04/03/2019	7:19 AM					*Effluent - Grab #4										02
	04/02/19 to 04/03/19	7:30 AM to 7:30 AM		X			Effluent Composite			X — 02							
	04/02/2019	8:07 AM	X		1	Water	**Effluent-Grab #1 FLOW (MG) = 4.205				X						
	04/02/2019	10:49 AM	X		1	Water	**Effluent-Grab #2 FLOW (MG) = 2.611				X	03					
	04/02/2019	2:50 PM	X		1	Water	**Effluent-Grab #3 FLOW (MG) = 3.697				X						
	04/03/2019	7:12 AM	X		1	Water	**Effluent-Grab #4 FLOW (MG) = 3.587				X						
	04/02/19 to 04/03/19	8:07 AM to 7:12 AM	X		1	Water	Effluent Field Blank				X — 04						

1. Relinquished by: (Signature)	Date/Time	2. Received by: (Signature)
Steve Parker	4/3/19 9:00	URS
3. Relinquished by: (Signature)	Date/Time	4. Received by lab: (Signature)
UPS	4-4-19 1534	Amanda Jobe

SAMPLE CONDITION UPON RECEIPT IN LAB

1. CUSTODY SEALS:	✓ Yes	No
2. CONTAINERS CORRECT:	✓ Yes	No
3. COC/LABELS AGREE:	✓ Yes	No
4. RECEIVED ON ICE:	✓ Yes	No
5. TEMPERATURE ON RECEIPT:	2 °C	
6. TEMPERATURE GUN ID:	IR#7 2	

FOR COMPLETION BY LAB ONLY

REMARKS / SAMPLE COMMENTS

Low Level Hg to be subcontracted to Mercury One LTD

Effluent sample grab(s) will be provided from and composited by client on site.

**Effluent samples to be composited by lab per flows provided by client.

*SDG number changed - 4/12/19 (8)

Revision 3
5/4/18

Sample Summary

Lab Number:	1808026-01
Date/Time Collected:	8/1/19 @ 7:45 AM
Sample Matrix:	Water, Soil
Sample Name:	Location

Sample Receipt Information

Custody Seals	✔
Containers Correct	✔
COC/Labels Agree	✔
Received On Ice	✔
Temperature on Receipt	5.0°C

Quality Management System

- Quality assurance
  - Set of activities for ensuring quality in laboratory processes
  - Aims to prevent inconsistencies in laboratory processes
  - Managerial tool
- Quality control
  - Set of activities for ensuring quality in laboratory results
  - Aims to identify and correct issues in laboratory results
  - Corrective tool

QA/QC Measures

- Internal Checks
  - Field blanks
  - Field duplicates
  - Lab replicates
  - Spike samples
  - Calibration blank and standards
- External Checks
  - External field duplicates
  - Split samples
  - Independent lab analysis of duplicates
  - Knowns
  - Unknowns

Quality Assurance

- Instrumentation
- Reagents
- Water
- SOPs
- Calibration
- Standard curves
- QC checks
- Safety

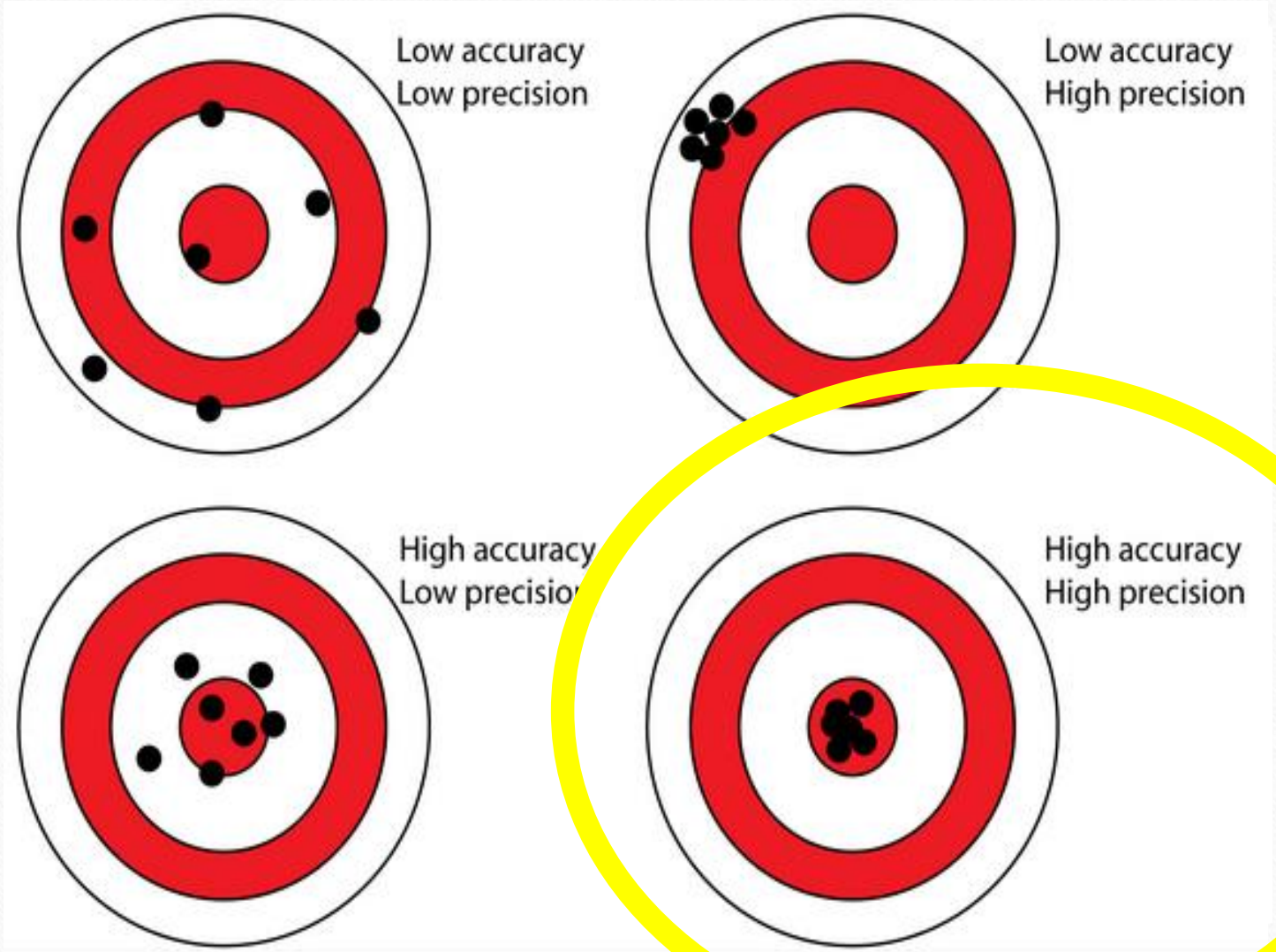
Quality Control

- Accuracy and Precision
  - Blank
  - Matrix spike
  - Duplicate samples
  - Charts

$$\%\ \text{Accuracy} = \left\{ \frac{\text{actual}}{\text{expected}} \right\} \text{X } 100$$

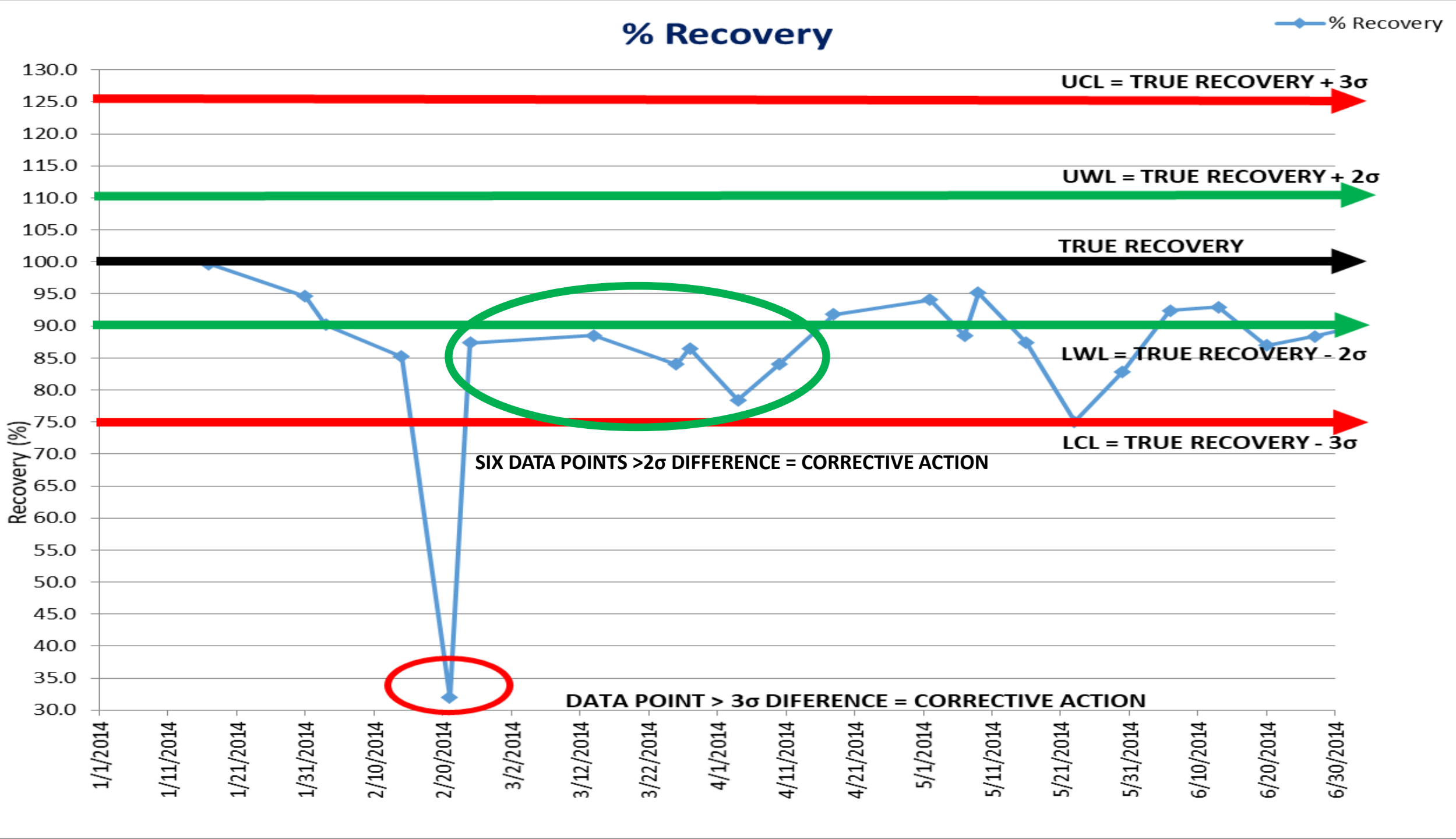
$$\%\ \text{RPD} = \left\{ \left| \frac{\text{difference of values}}{(\text{average of values})} \right| \right\} \text{X } 100$$

Accuracy vs. Precision



Control Chart

- Graphical representation of QC data
- Sections
  - Central line
  - Upper and lower warning limits
  - Upper and lower control limits
- Out of control signals


% Recovery
% Recovery
130.0
125.0
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
Recovery (%)
UCL = TRUE RECOVERY + 3σ
UWL = TRUE RECOVERY + 2σ
TRUE RECOVERY
LWL = TRUE RECOVERY - 2σ
LCL = TRUE RECOVERY - 3σ
SIX DATA POINTS >2σ DIFFERENCE = CORRECTIVE ACTION
DATA POINT > 3σ DIFERENCE = CORRECTIVE ACTION
1/1/2014
1/11/2014
1/21/2014
1/31/2014
2/10/2014
2/20/2014
3/2/2014
3/12/2014
3/22/2014
4/1/2014
4/11/2014
4/21/2014
5/1/2014
5/11/2014
5/21/2014
5/31/2014
6/10/2014
6/20/2014
6/30/2014

ANALYTICAL QUALIFIERS

Qualifier	Description
EDL	Result was non-detect at an elevated detection limit due to one or more of the following: Sample Matrix, Sample Dilution, or Limited Sample Volume.
EX	Result exceeds DAILY MAXIMUM and/or MONTHLY AVERAGE
EX2	The result exceeds the TCLP limit .
J	At client request, J-Values are reported J-Values are considered "estimated" results as they are below the limit of quantitation yet above the method detection limit (MDL)
N	Insufficient Sample Weight as Required by Method
T40	The ambient temperature exceeded 23 +/- 2 oC during the TCLP rotation process

Quality Control Qualifiers

Qualifier	Description
E20	Sample used as "parent" for the associated analytical batch
%D3/S-01	Surrogate failed to recover within acceptance criteria (%D3/S-01)
E1	Results associated with this surrogate were qualified as "estimated" (E1)
B	Present in the Associated Blank
B1	Present in Blank, but Not In the Sample
%D2 / E5	Laboratory Control Spike (LCS) and/or Laboratory Control Spike Duplicate (LCSD) failed to recover with acceptance criteria (%D2). Associated results were qualified as "estimated“
%D1	Matrix Spike (MS) and/or Matrix Spike Duplicate (MSD) failed acceptance criteria
MBA	Failed criteria due the high concentration of analyte in the parent sample
MBI	Failed criteria due an interference in the parent sample
%D3	Quality Control Surrogate failed acceptance criteria
NREC	Quality Control Surrogate failed

Calibration Qualifiers

Qualifier	Description
CR	Result above highest calibration standard, but within linear calibration range
Est3	Result at the instrument was above the concentration of the highest standard in the calibration curve
E2-F	Second Source Verification Failure
E5	Estimated result due to Quality Control failure
E7	Internal Standard Response Failure
E11	Initial Calibration Minimum Response Factor Failure
E21	CCV Low
E-01	CCV High
E35	Low Level CCV Failure

Analytical Results

Total Metals	Units	Result	Qualifier(s)	Date/Time Analyzed	Batch	Method
Cadmium	µg/L	<0.260		7/27/2018 15:21	B807332	EPA 200.8, Rev. 5 (1994)
Chromium	µg/L	**0.526**		7/27/2018 15:21	B807332	EPA 200.8, Rev. 5 (1994)
Copper	µg/L	**7.41**		7/27/2018 15:21	B807332	EPA 200.8, Rev. 5 (1994)
Lead	µg/L	<0.260	E35	7/27/2018 15:21	B807332	EPA 200.8, Rev. 5 (1994)
Nickel	µg/L	**3.19**		7/27/2018 15:21	B807332	EPA 200.8, Rev. 5 (1994)
Silver	µg/L	<0.260		7/27/2018 15:21	B807332	EPA 200.8, Rev. 5 (1994)
Zinc	µg/L	**45.2**		7/27/2018 15:21	B807332	EPA 200.8, Rev. 5 (1994)

*E35: Estimated Result Due to Low Level CCV Failure

Analytical Results

Acid Compounds	Units	Result	Qualifier(s)	Date/Time Analyzed	Batch	Method
2,4-Dichlorophenol	µg/L	<9.43		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
2,4-Dimethylphenol	µg/L	<9.43	E5*	8/6/18 @ 18:23	B808107	EPA 625 (mod.)
2,4-Dinitrophenol	µg/L	<47.2		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
Pentachlorophenol	µg/L	<4.72		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
Phenol	µg/L	**18.2**		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
2-Fluorophenol [surr]	%	31.0		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
Phenol-d5 [surr]	%	26.8		8/6/18 @ 18:23	B808107	EPA 625 (mod.)

*E5: Estimated Result Due to Quality Control Data

Analytical Results

Acid Compounds	Units	Result	Qualifier(s)	Date/Time Analyzed	Batch	Method
2,4-Dichlorophenol	µg/L	<9.43		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
2,4-Dimethylphenol	µg/L	<9.43	E5*	8/6/18 @ 18:23	B808107	EPA 625 (mod.)
2,4-Dinitrophenol	µg/L	<47.2		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
Pentachlorophenol	µg/L	<4.72		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
Phenol	µg/L	**18.2**		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
2-Fluorophenol [surr]	%	31.0		8/6/18 @ 18:23	B808107	EPA 625 (mod.)
Phenol-d5 [surr]	%	26.8		8/6/18 @ 18:23	B808107	EPA 625 (mod.)

*E5: Estimated Result Due to Quality Control Data

Analytical Results

Acid Compounds	Units	Result	Qualifier(s)	Date/Time Analyzed	Batch	Method
2,4-Dichlorophenol	µg/L	<50	EDL*	7/30/19 @ 20:20	B907520	EPA 625 (mod.)
2,4-Dimethylphenol	µg/L	<50	EDL*	7/30/19 @ 20:20	B907520	EPA 625 (mod.)
2,4-Dinitrophenol	µg/L	<250	EDL*	7/30/19 @ 20:20	B907520	EPA 625 (mod.)
Pentachlorophenol	µg/L	<25	EDL*	7/30/19 @ 20:20	B907520	EPA 625 (mod.)
Phenol	µg/L	<50	EDL*	7/30/19 @ 20:20	B907520	EPA 625 (mod.)
2-Fluorophenol [surr]	%	32.4		7/30/19 @ 20:20	B907520	EPA 625 (mod.)
Phenol-d5 [surr]	%	25.6		7/30/19 @ 20:20	B907520	EPA 625 (mod.)

*EDL: Result was non-detect at an elevated detection limit due to one of more of the following: Sample Matrix, Sample Dilution, or Limited Sample Volume.

Quality Control Results

Analyte	BLK	LCS / LCSD	MS/ MSD	Dup	RPD	Qualifiers
Cadmium	<0.260 µg/L	103% / NA	98.9% / 99.9%		1.01%	
Chromium	<0.260 µg/L	103% / NA	102% / 101%		1.22%	
Copper	<0.260 µg/L	103% / NA	103% / 103%		0.20%	
Lead	<0.260 µg/L	101% / NA	100% / 99.3%		1.05%	
Nickel	<0.260 µg/L	102% / NA	103% / 103%		0.07%	
Silver	<0.260 µg/L	102% / NA	115% / 110%		0.67%	
Zinc	<20.8 µg/L	105% / NA	105% / 105%		0.04%	

Instrument calibration and quality control samples performed at or above frequency specified in analytical method.

Metals by Method by SW846 /6010C

Sample: 123456-7
Client Sample ID: 3/22/18
Matrix: Liquid
Remarks:
Analyzed Date: 4/6/2018
Prepared by Method: 3005A, 3010A

Type: Grab

Collected: 3/23/2018 12:00

Sample result for Cadmium is < 0.050 mg/L

Analytical Results

Analyte	DF	Result	LOD	LOQ	Units	Q
Cadmium	1	ND	0.0027	0.050	mg/L	U
Chromium	1	ND	0.0034	0.050	mg/L	U
Copper	1	0.070	0.0031	0.050	mg/L	
Lead	1	ND	0.0050	0.050	mg/L	U
Nickel	1	0.080	0.0071	0.050	mg/L	
Zinc	1	0.060	0.0050	0.050	mg/L	

Cadmium result is not detected above the Method detection limit (MDL)

ANALYTICAL RESULTS

Lab Number: 1901148-01

Sample Name:
Date/Time Collected: 1/9/19 6:52
Sample Matrix: Water

Wet Chemistry	Units	Result	Qualifier(s)	Date/Time Analyzed	8atch	Method
Cyanide (total)	mg/L	< 0.010		1/14/19 7:51	8901194	SM 4500-CN 8,E-2011
Phenolics	mg/L	< 0.00500		1/14/19 8:26	8901195	EPA 420.1-1978

ANALYTICAL RESULTS

Lab Number: 1901148-02

Sample Name:
Date/Time Collected: 1/9/19 8:01
Sample Matrix: Water

Total Metals	Units	Result	Qualifier(s)	Date/Time Analyzed	8atch	Method
Antimony	ug/L	< 2.08		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Arsenic	ug/L	0.794		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
8eryllium	ug/L	< 0.260		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Cadmium	ug/L	< 0.260		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Chromium	ug/L	0.481		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Copper	ug/L	3.34		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Lead	ug/L	< 0.260		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Molybdenum	ug/L	15.0		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Nickel	ug/L	1.62		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Selenium	ug/L	< 2.08		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Silver	ug/L	< 0.260		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Thallium	ug/L	< 0.260		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)
Zinc	ug/L	37.8		1/15/19 12:53	8901213	EPA 200.8, Rev. 5.4(1994)

QUALITY CONTROL RESULTS

Wet Chemistry — Batch: B804254 (Water)

Prepared: 17-Apr-18 08:23 By: SP — Analyzed: 17-Apr-18 08:23 By: SP

Analyte	BLK	LCS / LCSD	MS / MSD	Dup	RPD	Qualifiers
Phenolics	<0.00500 mg/L	78.8% / NA	88.4% / 94.0%		6.25%	

Total Metals — Batch: B804264 (Water)

Prepared: 17-Apr-18 13:05 By: HF — Analyzed: 17-Apr-18 17:28 By: HF

Analyte	BLK	LCS / LCSD	MS / MSD	Dup	RPD	Qualifiers
Antimony	<2.08 ug/L	89.8% / NA	92.7% / 92.2%		0.518%	
Arsenic	<0.260 ug/L	97.7% / NA	107% / 105%		1.72%	
Beryllium	<0.260 ug/L	94.4% / NA	83.3% / 80.1%		3.93%	
Cadmium	<0.260 ug/L	110% / NA	98.7% / 95.3%		3.56%	
Chromium	<0.260 ug/L	100% / NA	96.2% / 92.6%		3.76%	
Copper	<0.260 ug/L	99.6% / NA	93.9% / 90.5%		3.72%	
Lead	<0.260 ug/L	106% / NA	97.1% / 95.6%		1.53%	
Molybdenum	<0.260 ug/L	88.0% / NA	107% / 104%		2.72%	
Nickel	<2.08 ug/L	96.5% / NA	93.7% / 89.6%		3.99%	
Selenium	<2.08 ug/L	89.8% / NA	104% / 99.6%		4.46%	
Silver	<0.260 ug/L	106% / NA	98.3% / 96.3%		2.00%	
Thallium	<0.260 ug/L	110% / NA	101% / 99.6%		1.85%	
Zinc	<20.8 ug/L	108% / NA	101% / 97.1%		2.63%	

Wet Chemistry — Batch: B804285 (Water)

Prepared: 18-Apr-18 09:52 By: SP — Analyzed: 18-Apr-18 09:52 By: SP

Analyte	BLK	LCS / LCSD	MS / MSD	Dup	RPD	Qualifiers
Cyanide (total)	<0.010 mg/L	107% / 109%	108% / NA		1.55%	

All Analysis performed according to EPA approved methodology when available :
SW 846, Revised December, 1995; EPA 600/4-79-020, Revised March, 1983; Standard Methods
Instrument calibration and quality control samples performed at or above frequency specified in analytical method.


COMMON CAUSES OF LABORATORY ERROR
Analyst does not understand responsibilities
Equipment not properly maintained or calibrated
No written procedures or written procedures not followed
QC not performed or outside range
Samples not accurately obtained or preserved
Improper handling or reporting data
Chemicals not stored properly or expired
Training not done or not completed

Laboratory Error Management

Awareness

Communicate

ACTION

Investigate

Laboratory Rules of Conduct

- **Ethics**
- **Integrity**
- **Fraud**

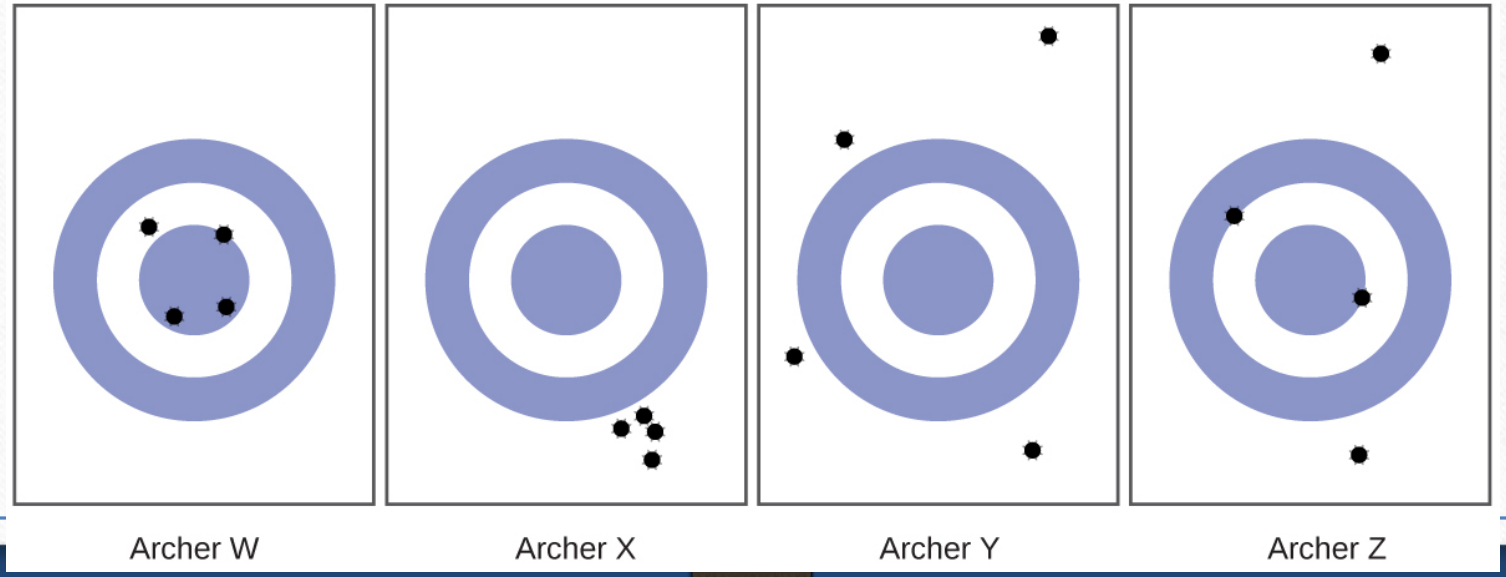
Improper Lab Practices

- Failure to analyze samples
- Failure to conduct specified analytical steps
- Manipulation of the sample prior to analysis
- Manipulation of results during analysis

Any incorrect information should be crossed out with a single line, initialed, and dated. The correct information should be added as close as possible to the incorrect information and should include a reason for the change. All information should be legible.

Accuracy and Precision

- Consider the results of the archery contest shown in the figure below.
  - Which archer is most precise?
  - Which archer is most accurate?
  - Who is both least precise and least accurate?



Accuracy & Precision: Time to Practice!

- A beaker is known to contain 47.3 mL of dichloromethane (a common solvent in organic labs). Abby measures the volume two times and obtains values of 48 mL and 47 mL. Billy measures the volume two times and obtains values of 40 mL and 47 mL. Who is more accurate? Who is more precise?
- Candy and Dave each measure the mass of a piece of filter paper. Candy takes two measurements, with values of 1.13g and 1.15 g. Dave takes two measurements, with values of 1.00g and 1.67g. The actual mass of the filter paper is 1.34 g. Who is more accurate? Who is more precise?
- Erik and Frank are each asked to determine the length of a paperclip. Erik is given a small ruler with each millimeter marked. Frank is given a meter stick with no additional markings. Who would you expect to be more accurate in their measurements? Why?

Accuracy & Precision: More Practice!

- Classify the following sets of measurements as accurate, precise, both, or neither.
  - Checking for consistency in the weight of a beaker with an actual weight of 25.00 g: 17.27 g and 13.05 g
  - Testing the volume of a batch of 25-mL pipettes: 27.02 mL and 26.99 mL
  - Determining the concentration of a chemical (actual = 18 N): 19.7 N and 18.9 N

Accuracy and Precision

Which Dispenser is most accurate? Precise?

Volume (mL) of Dispensers (actual volume = 296 mL)

Dispenser #1	Dispenser #2	Dispenser #3
283.3	294.2	296.1
284.1	296.0	295.9

THANK YOU!

Contact Information

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