WATER CHEMISTRY: OUR EVERYDAY CHALLENGE

Chemistry Teachers Workshop

September 21, 2024

RETEGO

Introduction

Recent incidents of leaching lead and copper in various drinking water systems in the U.S. has raised public health awareness on the quality of tap water within our communities.

These incidents highlight the necessity for water providers to have the capability to analyze water with a rapid and precise method to ensure the supply of high-quality potable water.

The Bountiful Utah Water Department participated in a case study with RETEGO Labs to evaluate rapid methodologies to test lead/copper, scale/corrosion water qualities and to evaluate the RETEGO TTR field spectrometer.

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Introduction

Determining the propensity of water to either **Spontaneously Scale** or **Cause Corrosion** is one of the key factors used to determine if Lead and/or Copper may leach into drinking water.

Extensive testing is conducted by local water utility districts and is maintained (for the most part) well within the guidelines established by the EPA and Local regulatory agencies. This helps ensure water quality at the “Property Limits”.

The use of “Point of Entry” and/or “Point of Use” filters, conditioners and softeners can (and does) modify the basic chemistry of the water supply ***often with negative results***.

Scale and Corrosion

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Predicting Scale and Corrosion

Water, having a scaling factor, can lead to mineral scale formation. That scale layer can become a breeding point for bacteria. Monitoring the scaling chemistries of your process / industrial waters is a key factor in assuring that proper scale prevention steps are adequate and being maintained.

Advanced instrumentation such as the RETEGO TTR-2 will provide accurate and precise results for the monitoring of industrial waters. Having the capability of attaining results within minutes in the lab or field allow for improved decisions on water quality concerns and scale-biofilm awareness. The operator is provided with reliable QA/QC valid results and data about water throughout their processes.

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Predicting Scale and Corrosion

A number of recent studies by the USEPA, NSF and other international NGO’s, have determined that water treated by Water Softeners utilizing resin bed ion exchange do not contribute to scaling and corrosion. We agree with the findings represented by the published documents we've examined and the conclusions reached by the data set represented.

However, a number of communities are experiencing an inordinate amount of premature corrosion failures of water heaters and plumbing fixtures. As a result a number of manufacturers have withdrawn, or are considering withdrawing, from the affected markets.

Why?

Predicting Scale and Corrosion

As we examined the available data and the detailed reports one constant emerged. The basic Chemical makeup of the water in the reports did not match the typical makeup of the water in the affected communities. Simple changes in the pH, alkalinity and calcium dramatically affect the corrosion related characteristics of the water.

In a nutshell, if your water is within the parameters described in the reports mentioned above, a typical ion resin exchange water softener will not cause corrosion within your piping systems, including your water heater. If your water does not fall within that narrow range your piping systems may be at risk of ***intolerable levels of corrosion***.

Predicting Scale and Corrosion

Predicting scale and corrosion is a key part of the Lead/Copper rule.

The next few slides represent a recent study of a mid-sized hotel water system. This hotel was constructed within the last two years and has already experienced failure of 2 large water heaters and has noticed pitting and corrosion of their dishwashers, laundry equipment and fixtures.

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Predicting Scale and Corrosion

By utilizing the RETEGO TTR we were able to model the conditions on-site within 20 minutes.

Comparable testing conducted by the water softener representative took over 1 week before results were returned.

Combining the various scale/corrosion indices into one report allows for a clearer understanding of the problem.

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Feed Data

TTR

File Report Eng

Connection | Setup | Instrument Check | Analysis | Reporting | Scale Index | Aggressive Index

Scaling Index Calculation or Determination

Langelier Saturation Index (LSI)
Pukorius Scale Index (PSI)
Ryznar Stability Index (RSI)

Timer

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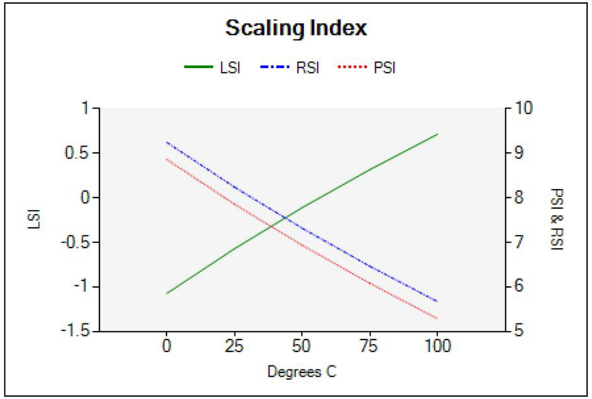
Instructions: Samples can be obtained using the test kit disposables and the buttons below, or data can be entered directly into their respective result cells.

Ca	tALK	pH	SO4	X	T
(as CaC03)	(as CaC03)	(pH Units)	(Sulfate)	(Halide)	(degrees C)
118.5	102.2	7.1	267.8	5	20

LSI	PSI	RSI	AI	DIC	TDS (Est)	
-0.7	8.1	8.4	11.3	25	438.9	(mg/L)

> 2	< 5	< 5		Heavy Scale
0.5 - 2.0	5 - 6	5 - 6		Light Scale
-0.5 - 0.5	6 - 7	6 - 7	> 12	Little Scale or Corrosion
-2 - -0.5	7 - 7.5	7 - 7.5	10 - 11.9	Corrosion
< -2	7.5 - 9	7.5 - 9	< 10	Heavy Corrosion
	> 9	> 9		Intolerable Corrosion



Generate Report

☑ Report Scale Index on Summary Report

NOTE: The LSI, RSI and PSI Scale Index calculations are designed to be predictive tools for calcium carbonate scale. (These index calculations won't predict calcium phosphate, calcium sulfate, silicate or magnesium silicate scales.) They are designed to predict scale formation in untreated waters but can't predict how quickly they might form. Experience will dictate which index is the most useful to the user's particular situation or system.

Feed Data

LSI	PSI	RSI	*AI*	*DIC*	*TDS (Est)*	
-0.7	**8.1**	**8.4**	11.3	25	438.9	(mg/L)

> 2	< 5	< 5	Heavy Scale
0.5 - 2.0	5 - 6	5 - 6	Light Scale
-0.5 - 0.5	6 - 7	6 - 7	Little Scale or Corrosion
-2 - -0.5	7 - 7.5	7 - 7.5	Corrosion
< -2	7.5 - 9	7.5 - 9	Heavy Corrosion
	> 9	> 9	Intolerable Corrosion

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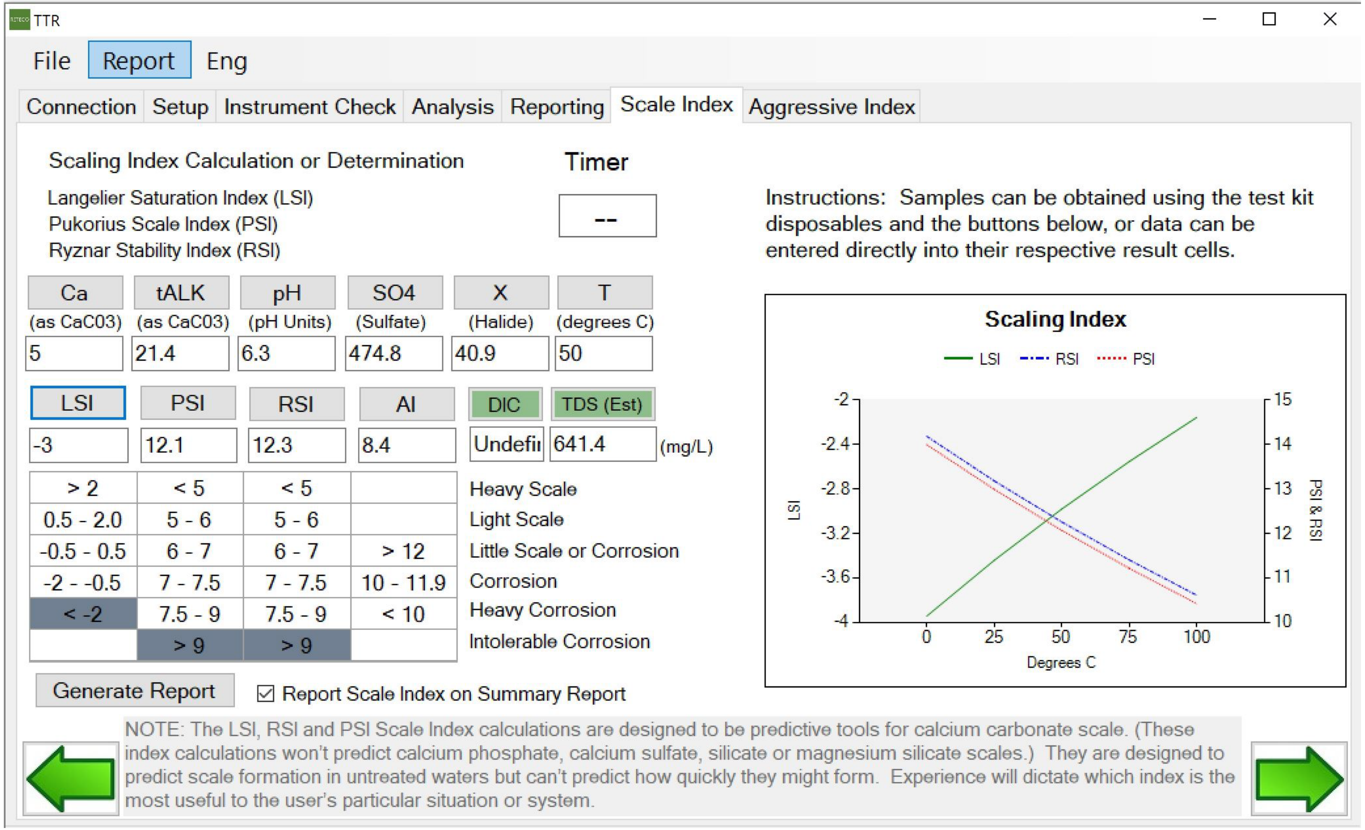
Post Softener



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Post Softener

LSI	PSI	RSI	*AI*	*DIC*	*TDS (Est)*	
-3.0	**12.1**	**12.3**	8.4	(7)	641.4	(mg/L)

> 2	< 5	< 5	Heavy Scale
0.5 - 2.0	5 - 6	5 - 6	Light Scale
-0.5 - 0.5	6 - 7	6 - 7	Little Scale or Corrosion
-2 - -0.5	7 - 7.5	7 - 7.5	Corrosion
< -2	7.5 - 9	7.5 - 9	Heavy Corrosion
	> 9	> 9	Intolerable Corrosion

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Post Softener

LSI	PSI	RSI	*AI*	*DIC*	*TDS (Est)*	
-3.0	**12.1**	**12.3**	**8.4**	(7)	641.4	(mg/L)

> 2	< 5	< 5	Heavy Scale
0.5 - 2.0	5 - 6	5 - 6	Light Scale
-0.5 - 0.5	6 - 7	6 - 7	Little Scale or Corrosion
-2 - -0.5	7 - 7.5	7 - 7.5	Corrosion
< -2	7.5 - 9	7.5 - 9	Heavy Corrosion
	> 9	> 9	Intolerable Corrosion

Aggressiveness Index:
AI > 12, Water is non-aggressive

AI = 10 - 11.9, Water is moderately aggressive

AI < 10, Water is very aggressive

Lead / Copper Study

Bountiful (Utah) Area Schools

Bountiful Summary

We prepared a binder as a summary of our testing results on the water quality at the 16 Schools that are within the Bountiful Water District (Including SDJH and Boulton that are on the border with SDWD).

The dates and times that all samples were collected and tested is noted on each of the individual reports.

The tests averaged 45 minutes to complete.

Bountiful Summary

The overall water quality at the “End of Pipe” in all locations was good and comparing the data with publicly available water quality reports shows that it is consistent with those published records.

Trace amounts of Copper were detected at Bountiful High, Millcreek and LJ Muir. All were below the EPA MCLG of 1.3 mg/L.

The pH levels at Washington Elementary and Mueller Park seemed a bit low so we retested the samples with 2 separate methods in our lab and obtained similar results.

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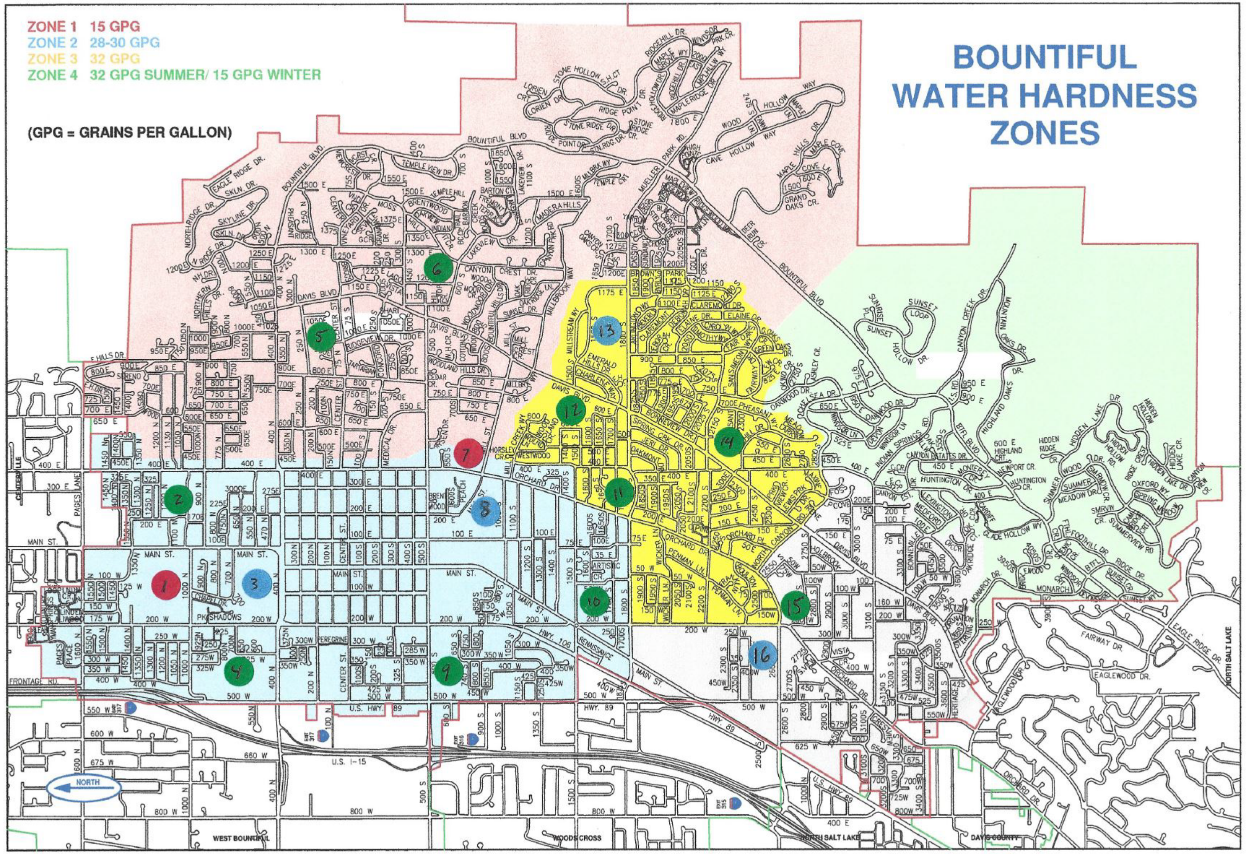
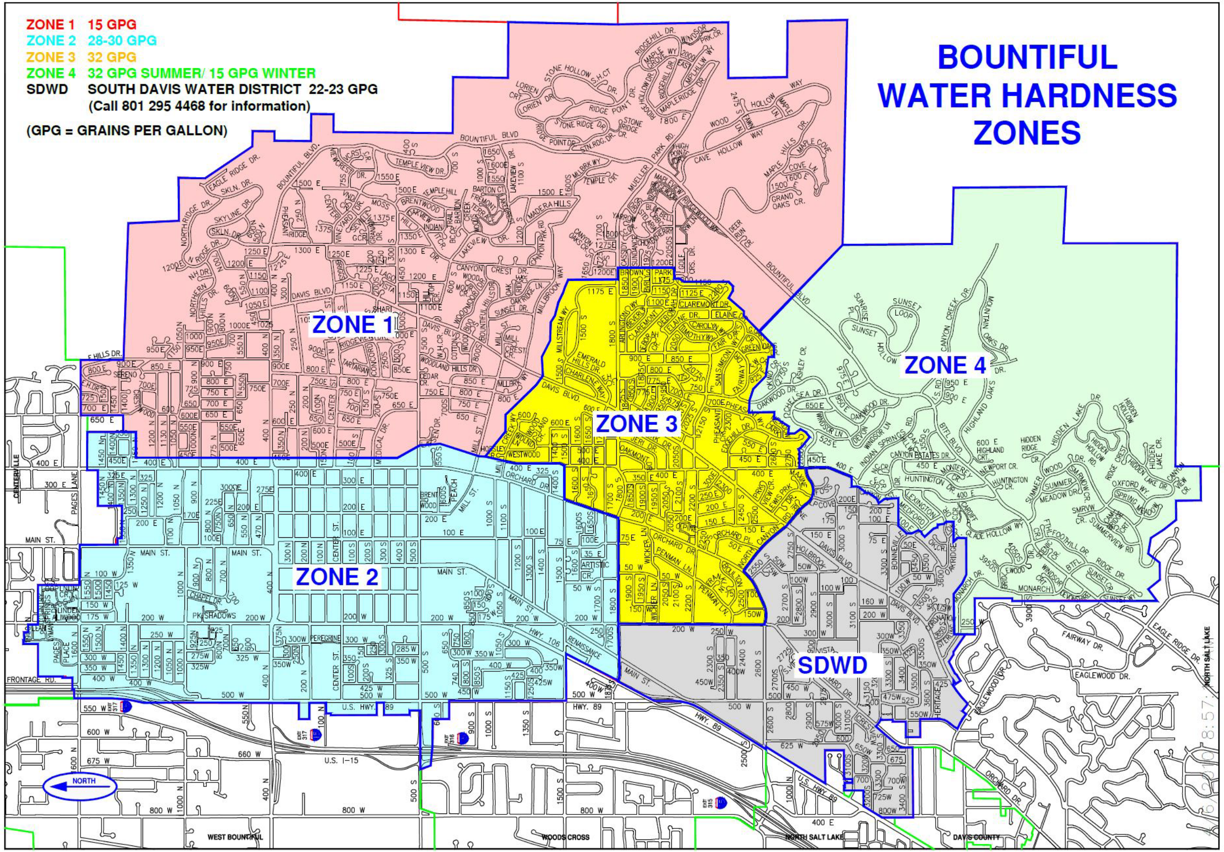


ZONE 1 15 GPG
ZONE 2 28-30 GPG
ZONE 3 32 GPG
ZONE 4 32 GPG SUMMER/ 15 GPG WINTER
(GPG = GRAINS PER GALLON)
BOUNTIFUL WATER HARDNESS ZONES

RETEGO


ZONE 1 15 GPG
ZONE 2 28-30 GPG
ZONE 3 32 GPG
ZONE 4 32 GPG SUMMER/ 15 GPG WINTER
SDWD SOUTH DAVIS WATER DISTRICT 22-23 GPG
(Call 801 295 4468 for information)
(GPG = GRAINS PER GALLON)
BOUNTIFUL WATER HARDNESS ZONES
ZONE 1
ZONE 2
ZONE 3
ZONE 4
SDWD
NORTH

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Bountiful Study by Zone

		Zone 1	Zone 1	Zone 2	Zone 2	Zone 2	Zone 2	Zone 2	Zone 2	Zone 2	Zone 2	Zone 3	Zone 3	Zone 3	Zone 3	SDWD	SDWD
Parameter	Units	Hannah Holbrook	Oak Hills Elementary	Bountiful Elementary	Bountiful High School	Bountiful Junior High	Meadowbrook Elementary	Millcreek Junior High	Tolman Elementary	Viewmont High School	Washington Elementary	LJ Muir Elementary	Mueller Park Junior High	Saint Olaf's School	Valley View Elementary	Boulton Elementary	South Davis Junior High
Calcium as CaCO3	mg/L	147.4	159.3	95.7	165.2	67.6	58.5	109.3	106.6	49.5	33.1	82.7	82.3	47.3	93.7	56.2	37.4
Alkalinity - Total (as CaCO3)	mg/L	105.4	134.9	178.3	145.2	210.7	181.6	216.9	180.9	173.1	190.8	194.6	212.5	185.1	189.4	169.3	204.0
pH	units	6.7	6.7	6.9	7.6	6.7	6.6	6.6	6.6	6.8	6.4	6.5	6.3	6.8	6.5	6.6	7.0
Sulfate	mg/L	26.4	22.5	23.1	83.5	56.7	34.9	29.9	28.3	56.8	22.5	36.1	51.4	45.3	37.7	14.9	29.3
Chloride	mg/L	64.5	70.3	158.2	122.7	219.1	245.4	289.6	286.8	226.6	215.5	269.3	229.8	246.1	230.2	152.8	175.0
Chlorine, Active (aCl)	mg/L	0.3	0.2	0.3		0.2	0.2	0.3	0.4	< 0.2	0.3	0.4	0.2	0.3	0.4	0.4	0.4
Chlorine, Total (tCl)	mg/L	0.3	0.3	0.2		0.2	< 0.2	0.3	0.3	0.2	< 0.2	0.5	0.2	< 0.2	0.3	0.6	0.3
Copper (Cu)	mg/L	< 0.1	< 0.1	< 0.1	0.6	< 0.1	< 0.1	0.2	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Lead (Pb)	µg/L	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb	< 11 ppb
LSI	calc	-0.8	-0.7	-0.6	0.0	-0.9	-1.1	-0.7	-0.9	-1.1	-1.6	-1.0	-1.2	-1.0	-0.9	-1.2	-0.9
PSI	calc	7.5	7.2	7.3	7.4	7.2	7.6	6.7	7.2	7.9	8.1	7.0	7.1	7.7	7.0	7.7	7.8
RSI	calc	8.3	8.1	8.2	7.5	8.4	8.9	8.0	8.5	8.9	9.5	8.4	8.7	8.8	8.3	8.9	8.7
AI	calc	10.9	10.9	10.8	11.8	10.6	10.3	11.0	10.8	10.4	9.9	10.4	10.4	10.4	10.4	10.3	10.7
DIC	calc	30	38	45	31	64	55	73	64	48	84	70	88	49	68	52	50
TDS (Calc)	mg/L	259.3	296.0	479.3	457.3	646.6	630.4	731.3	685.8	617.2	580.4	682.7	659.0	647.2	618.7	451.9	540.3
TDS (Probe)	mg/L	236.0	252.0	616.0	320.0	648.0	644.0	659.0	659.0	617.0	606.0	630.0	645.0	604.0	655.0	510.0	548.0

LSI	PSI	RSI	Description
> 2	< 5	< 5	Heavy Scale
0.5 - 2.0	5 - 6	5 - 6	Light Scale
-0.5 - 0.5	6 - 7	6 - 7	Little Scale or Corrosion
-2.0 - -0.5	7 - 7.5	7 - 7.5	Corrosion
< -2	7.5 - 9	7.5 - 9	Heavy Corrosion
	> 9	> 9	Intolerable Corrosion

AI > 12: Water is Non-Aggressive

AI = 10 - 11.9: Water is Moderately Aggressive

AI < 10: Water is Very Aggressive

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Health Effects of Low Levels of Lead in the Blood of Children

- Behavior and learning problems
- Lower IQ and hyperactivity
- Slowed growth
- Hearing problems
- Anemia
- In rare cases, ingestion of lead can cause:
  - Seizures
  - Coma
  - and even Death

Health Effects of low levels of lead in Pregnant Women

- Reduced growth of the fetus
- Premature birth
- Lead can also be transmitted through breast milk

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Health Effects of low levels of lead in Adults

Cardiovascular effects

- increased blood pressure
- hypertension

Decreased kidney function

Reproductive problems

- in both men and women

Sources of Lead

Materials used for supply pipes for service lines and premise plumbing

- lead pipe
- lead-based solder
- brass materials used in faucets and fittings

Naturally Occurring

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Water Quality Factors Affecting Release of Lead and Copper

- Alkalinity, pH, & Dissolved Inorganic Carbon (DIC)
- Corrosion inhibitors
- Hardness (calcium and magnesium)
- Buffer Intensity
- Dissolved oxygen (DO)
- Oxidation reduction potential (ORP)
- Ammonia, chloride, and sulfate
- Natural organic matter (NOM)
- Iron, aluminum, and manganese

Accuracy and Precision

Comparison of RETEGO's TTR against NELAC PTRL

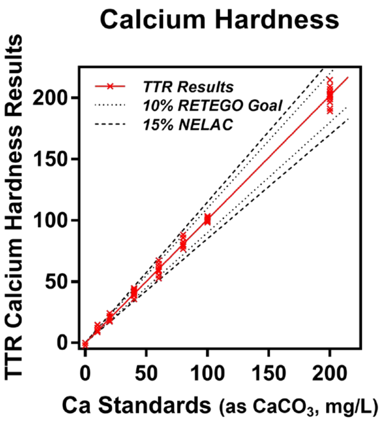
"Fast is fine, but accuracy is everything."

Wyatt Earp

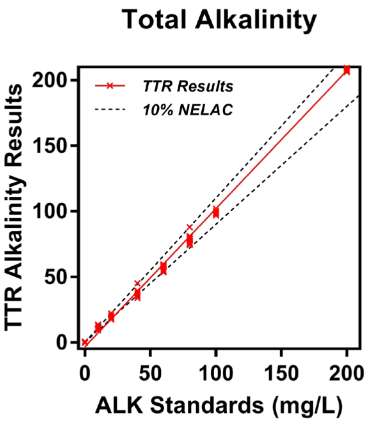
The robustness of the RETEGO TTR-2 is proven to be statistically viable in both accuracy and precision. As illustrated on the following slides, when utilizing NELAC analytical approved methods in comparison studies against four random TTR-2s, the TTR-2 demonstrated to have achieved linear results against those protocols.

QA/QC requirements can be achieved with confidence in any of the RETEGO Vial Chemistries.

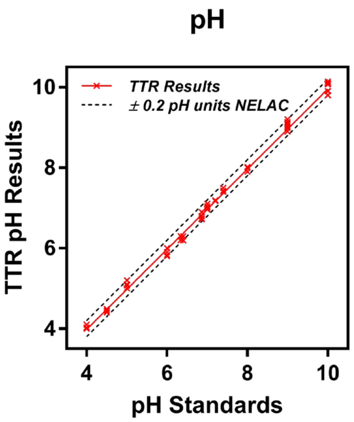
Comparison of RETEGO's TTR against NELAC PTRL



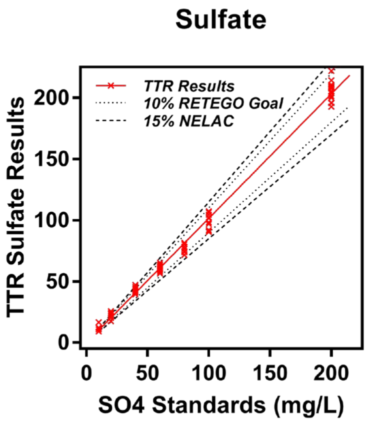
NELAC PTRL ±15% @ 64 mg/L
TTR ± 10% 60-200 mg/L



NELAC PTRL ±10% @ 22 mg/L
TTR ± 10% 20-200 mg/L



NELAC ± 0.2 pH units (5-10)
TTR ± 0.2 pH units (4-10)



NELAC PTRL ±15% @ 21 mg/L
TTR ± 10% 10-200 mg/L

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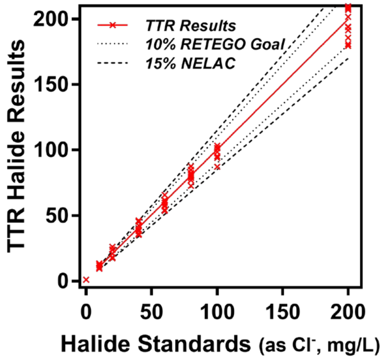
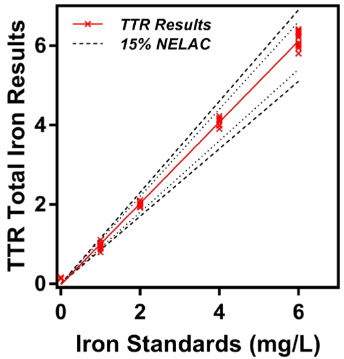
Comparison of RETEGO's TTR against NELAC PTRL

Halides (as Chloride)



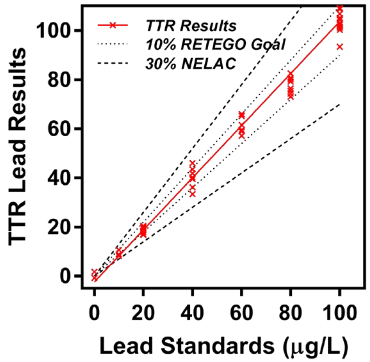
NELAC PTRL ±15% @ 17 mg/L
TTR ± 10% 10-200 mg/L

Total Iron



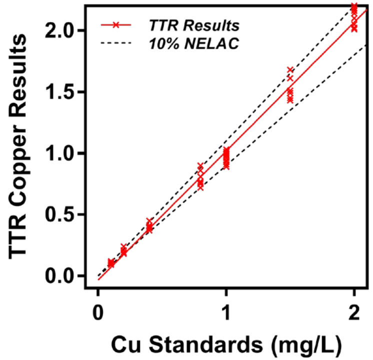
NELAC PTRL ±15% @ > 250 µg/L
TTR ± 10% 1-6 mg/L

Lead



NELAC PTRL ±30% @ 3.5 µg/L
TTR ± 12% 10-100 µg/L

Total Copper



NELAC PTRL ±10% @ 45 µg/L
TTR ± 10% 0.2-2 mg/L

Utah Schools and HB -21

How does your school stack up?

Utah Lead and Copper Rule

Utah H.B. 21 School and Child Care Center Water Testing Requirements

Search WaterLink for the results for your school

In Summary

Corrosion Control and water stability is complex

Corrosion and/or Scale can be exacerbated by on-site filtration or conditioning

Accurate, Precise and Timely water quality parameters are necessary to predict scale and corrosion

Simple tests for pH and Hardness do not provide enough information to predict corrosion

Who we are

THE RETEGO (Re-tea-go: Latin for reveal or uncover) method for measuring critical water parameters is based on more than 20 years of scientific experience in the treatment and monitoring of water.

Our tests are conducted on-site and deliver fast, accurate and precise water monitoring within minutes without the need for specialized training or liquid reagent handling.

All sample results are digitally processed, allowing immediate electronic report distribution.

Who we are

Christopher Lloyd, PhD (Chemistry – University of Utah 1996)

Chris is a founding partner of RETEGO Labs LLC and currently serves as our Vice President of Technology. In this position Chris is responsible for the technical development of the RETEGO instrumentation and chemical tests. His familiarity with hydraulic fracturing gel chemistries has enabled him to develop new anti-corrosion and scale cleaning oilfield treatment chemicals, optimize chemical water treatment processes, and implement hydrogen sulfide treatments and bioremediation protocols and analysis to mitigate oil spills.

Leslie Douglas Merrill, President – RETEGO Labs LLC

Les Merrill is a founding partner of RETEGO Labs LLC and currently serves as President. With over 30 years of experience in water treatment Les identified the need for accurate and timely water quality information. Prior to the formation of RETEGO Les was a founding member and served as Vice President of Project Development for 212 Resources. Mr. Merrill participated in the development of key processes and technology associated with 212’s water treatment unit and is one of the individuals named as a co-inventor in 212’s Intellectual Property. Mr. Merrill played a crucial role in 212’s early recognition of the water management challenges facing the oil and gas sector.

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Les Merrill
801-209-5460
lmerrill@retegolabs.com