Center for Health, Work & Environment
colorado school of public health

NOVEMBER 2023

DROUGHT, HEAVY METALS AND WATER QUALITY

SAN LUIS VALLEY, COLORADO

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Table of Contents

CONTENTS

A WORD FROM KATHY JAMES

It is with great pleasure that we present this report on our collaborative efforts with the San Luis Valley Ecosystem Council, Rio Grande Water Conservation District, and the CSU SLV Agriculture Research Center to spearhead a comprehensive water sampling study, aimed at evaluating the impact of drought on water quality in our beloved Valley.

The objective of our 5-year study is to investigate the impact of drought on groundwater quality and quantity. Over the past 18 months, a community-wide well water sampling effort has characterized water quality parameters such as metal content and water hardness. This well sampling effort combined with historical water quality data will be utilized in geochemical/physical models to provide a comprehensive overview of the effects of drought on the quality of our water resources. In the spring, we will host 2-3 town halls open to the community to discuss these results and answer any questions. In the meantime, feel free to reach out to us by the contact information listed below.

I am pleased to acknowledge the invaluable contributions of community members who have played pivotal roles in making this study possible. To Chris Canaly, Shirley Romero-Otero, Anna Lee Vargas, Augusto Basterrachea, Joni Adelman, and all community participants - your commitment to the well-being of our community and strengthening the bond between academia and the community has fostered a shared commitment to the sustainability of our precious water resources. To the Rio Grande Water Conservation District, CSU SLV Research Center, Chavez Southwest Market, Conejos County Public Health, Costilla County Public Health, Villa Grove Trading, and Crestone Mercantile and Grocery - we wouldn't have been able to coordinate the collection of samples without you.

This report is a testament to the power of community-driven research, where the collective efforts of dedicated individuals and organizations converge for learning. As we navigate the complexities of water management in the San Luis Valley, I am confident that the insights presented in this report will serve as a valuable resource for informed decision-making and collaborative action.

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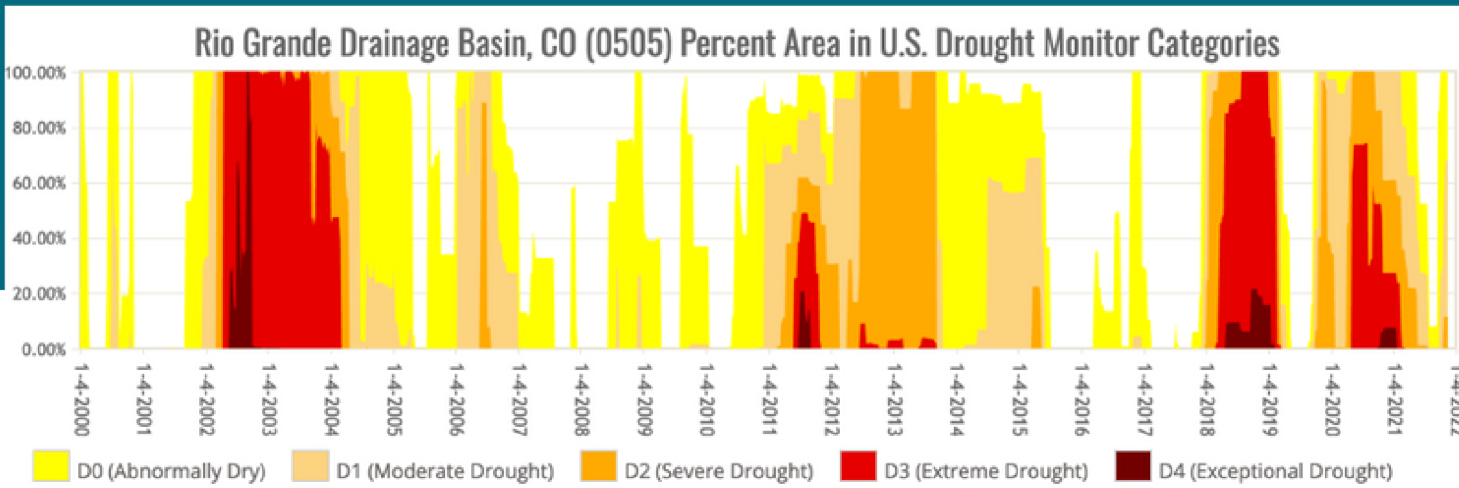


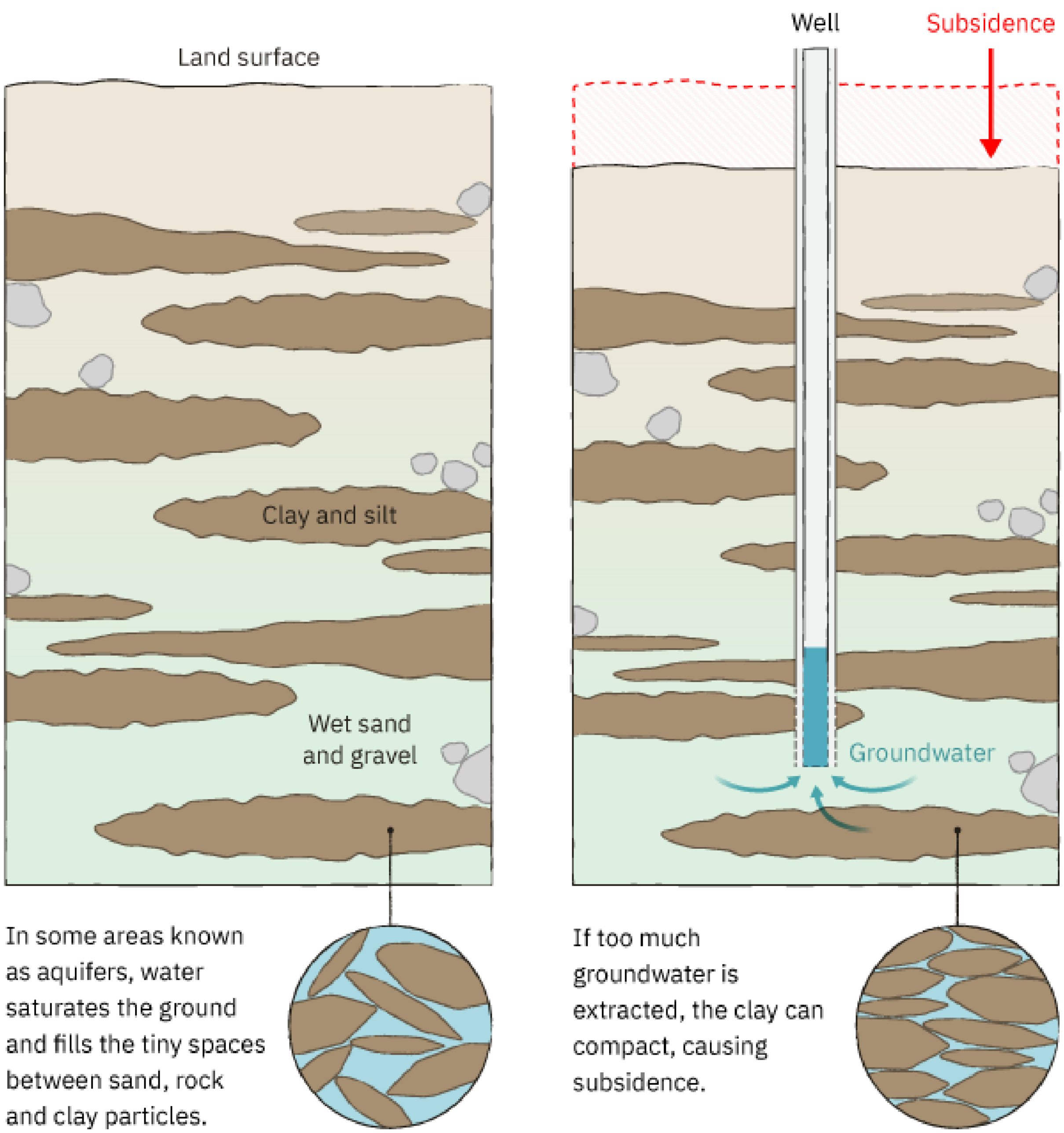
WHY THE SAN LUIS VALLEY?

The San Luis Valley is a region rich in history and nature. Its characteristics as a high intermountain valley are due to the formation of the San Juan and Sangre de Cristo Mountains. During the uplift and volcanic activity that formed these ranges, many elements were raised to the surface level of the earth’s crust. Some elements are commonly found in water (e.g. iron, zinc, calcium) and pose little risk to health, whereas others like heavy metals (e.g. arsenic, lead, uranium) are known to have adverse health effects. Over time, these metals naturally accumulated into the present layers of clay and alluvial soil beneath the valley floor.

The ecology of the SLV has led to the development of longstanding communities, agriculture practices, and tourism unique to its characteristics - all of which has been supported by the balanced use of water resources. Historic drought conditions have been present in the SLV for the past two decades. Decreased precipitation, increased groundwater usage, earlier snowmelt, and other factors have caused a disturbance to the balance. With naturally occurring aquifer recharge no longer counteracting the demand on the Rio Grande Aquifer system, the region risks subsidence. This occurs when the water deprived subsurface layers of earth compacts, preventing water from re-entering the once porous sub-terrain (see figure on next page).

As water scarcity becomes an increasing concern, multiple factors are compounding the severity of the issues at hand. Our team consists of scientists across multiple institutions who are investigating the imacts of climate, drought, and water quality on human health. While we know from past research that metals can have a negative impact on health, there is still much that we don't know. Additionally, recent research from the San Joaquin Valley, California has found that subsidence may causing an increase in the amount of heavy metals in groundwater. Our mission is to better our understanding of how the environment is impacting health, and to engage with the San Luis Valley communities to raise awareness of these risks.

How Groundwater Extraction Can Cause Land to Sink



Source: United States Geological Survey

By Eleanor Lutz / The New York Times

EPA REGULATIONS

The Environmental Protection Agency (EPA) is responsible for maintaining and enforcing national standards to protect the environment and human health. Under the Primary Drinking Water Regulations, the agency has esablished regulatory containment levels for a variety of drinking water contaminants. While municipal water districts are responsible for monitoring the water supply for these contaminants and addressing them appropriately, their responsibility does not extend to the water used by private-well owners. Neither the EPA nor local water municpalities have jurisdiction over privatly owned wells.

In the following pages, we will compare the aggregated results from the heavy metals analysis of submitted samples to the Maximum Containment Level (MCL) and Maximum Containment Level Goal (MCLG) set by the EPA.

MCL - The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using best treatment and technology available. These are enforceable standards.

MCLG - The level of a contaminant in drinking water which is believed to cause no known health risk. MCLGs allows for a margin of safety and are non-enforceable public health goals.

PRIMARY DRINKING WATER STANDARDS

SECONDARY DRINKING WATER STANDARDS

PROJECT OVERVIEW

PHASE I

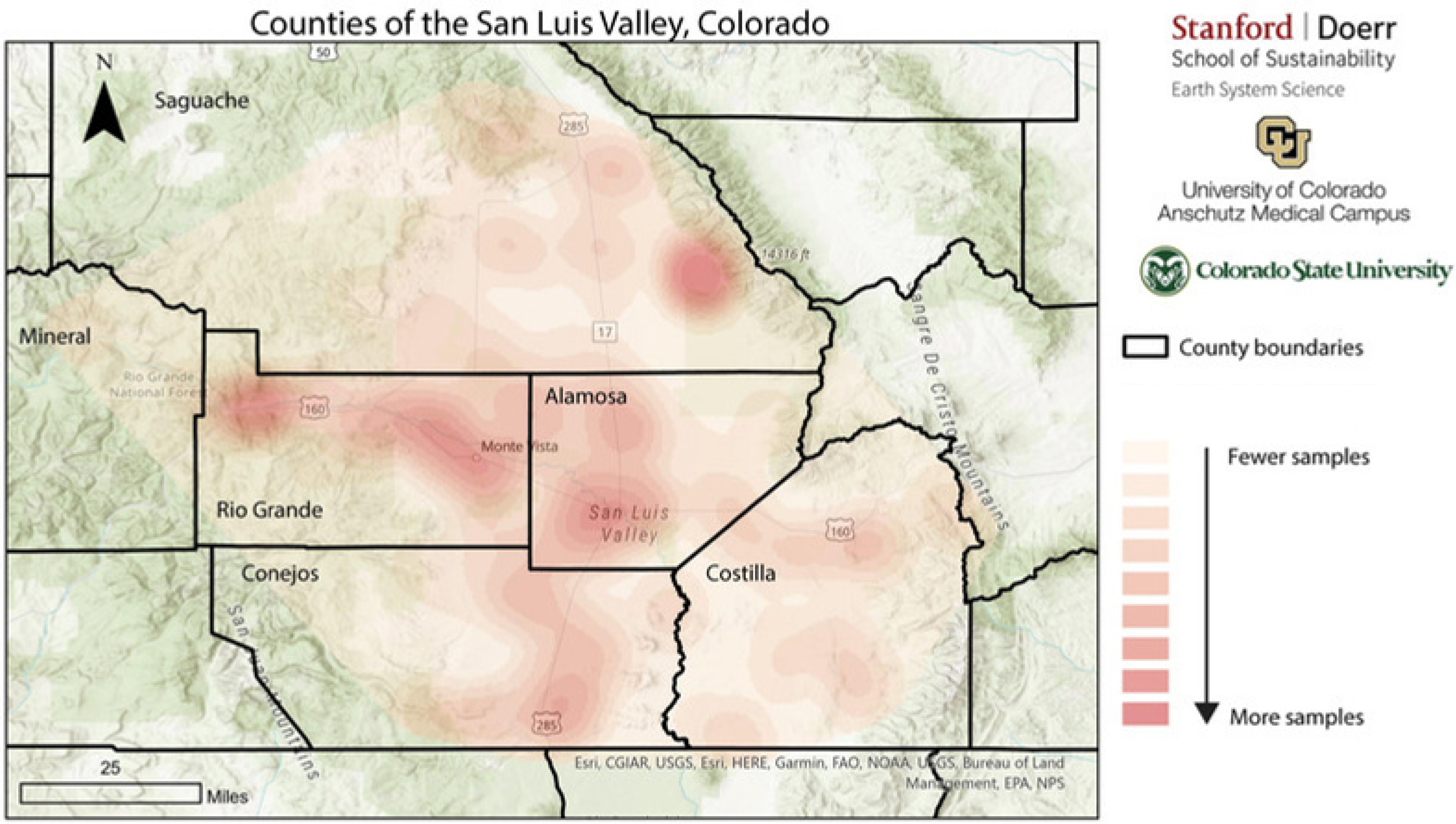
In the first phase of this multi-year project, our objectives were to engage with the community and facilitate a regional sampling of private wells. We received overwhelming support from the community and were thrilled to provide results reports to each participant. This information will be used to create geospatial models to identify trends related to regional drought and predict future levels of metals in groundwater. Eventually, we aim to use these models to further investigate health effects associated with exposure to heavy metals.

PHASE II

In Phase II, our focus is shifting to assess longitudinal differences associated with annual weather patterns and investigating drivers of geochemistry. Forty-three Phase I participants were selected for Phase II based on geographic location and water chemistry. Phase II involves quarterly sample collection from their well over the next couple of years. Quarterly samples will provide information on seasonal changes in metals and extended anlayses on isotopes and elements that determine water age will be done.

PHASE I

JUNE '22 - SEPTEMBER '23



736 private-well owners in the SLV signed-up to have their water tested

Samples submitted:

150 from Alamosa

86 from Costilla

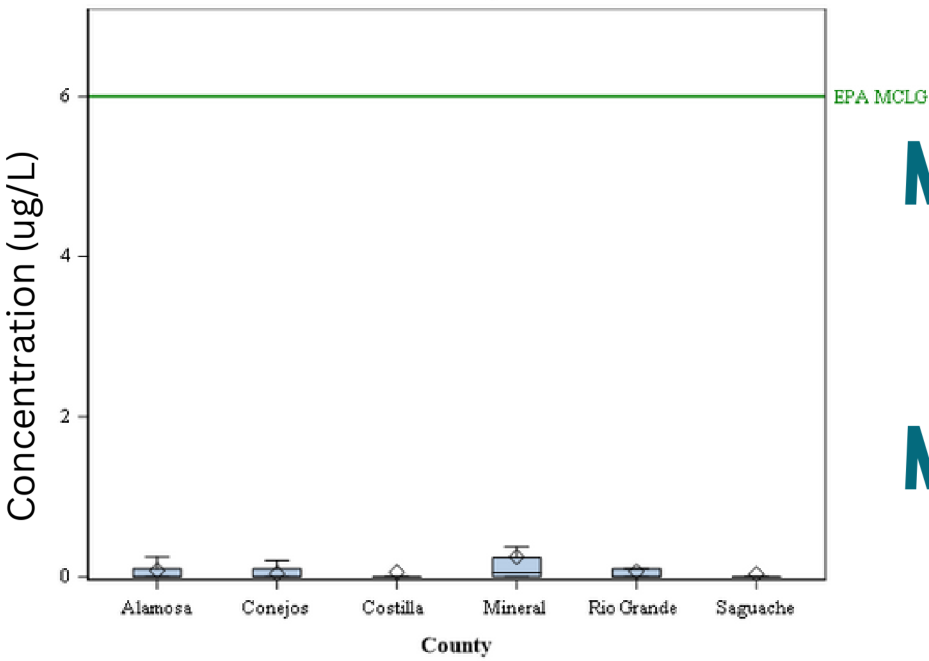
184 from Rio Grande

119 from Conejos

8 from Mineral

158 from Saguache

ANTIMONY



MCL: 6 ug/L

0% OF SAMPLES ARE ABOVE THE MCL

MCLG: 6 ug/L

0% OF SAMPLES ARE ABOVE THE MCLG

Antimony (Sb) is naturally present in the earth's crust. While Sb in the aquifer system is mostly likely from element deposits originating the region's geologic formation, Sb in groundwater closer to the surface could be a result of discharge from petroleum refineries; fire retardants; and discarded ceramics, electronics, and solder.

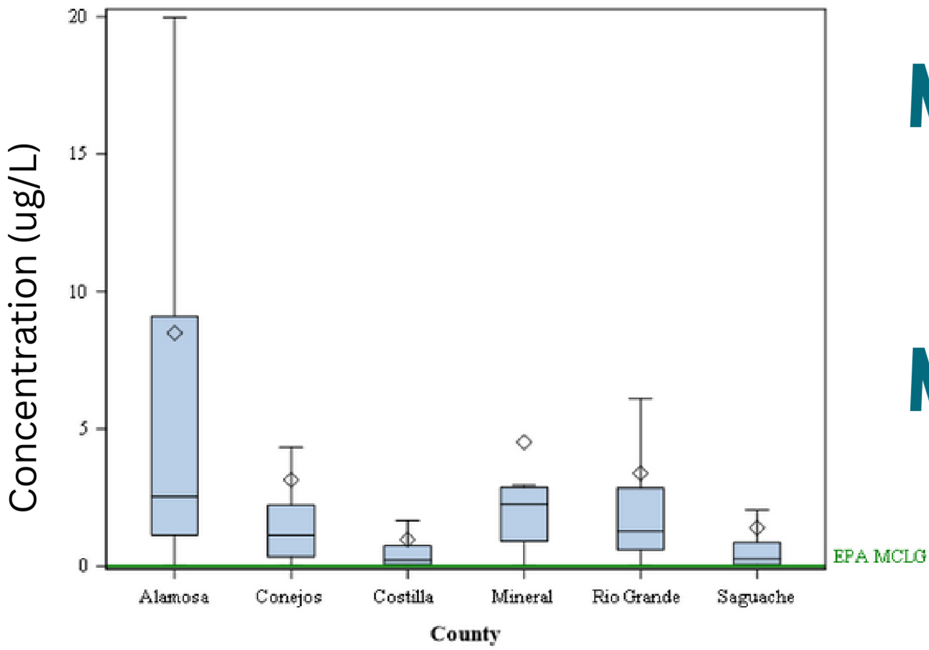
Long term exposure to high levels of Sb through drinking water may increase blood cholesterol, and decrease blood sugar.

Within the samples that were analyzed, 72.1% had no detectable amounts of Sb. A further 22.4% had detectable levels of Sb, but were low enough that our lab was unable to collect an exact measurement.

Exposure to Sb can be reduced by limiting the use of well water for cooking and regular consumption. Of note, young children may still experience limited exposure from bathing due to open-mouth and hand-mouth behavior. Please see the section on household filters.

Notes: The EPA reports MCLs in mg/L while we report results in ug/L. Exposure and health effect information provided by the Environmental Protection Agency. Detailed information can be found from the Agency for Toxic Substances and Disease Registry. Please consult your primary care provider for concerns about your indivisual health, including personal medical history or prescription/supplement regimens.

ARSENIC



MCL: 10 ug/L

8.5% OF SAMPLES ARE ABOVE THE MCL

MCLG: 0 ug/L

94.8% OF SAMPLES ARE ABOVE THE MCLG

Arsenic (As) is naturally present in the earth's crust. While As in the aquifer system is mostly likely from element deposits originating the region's geologic formation, As in groundwater closer to the surface could be a result from water runoff over soil where lead arsenate pesticides were used decades ago, or from glass/electronic production waste runoff.

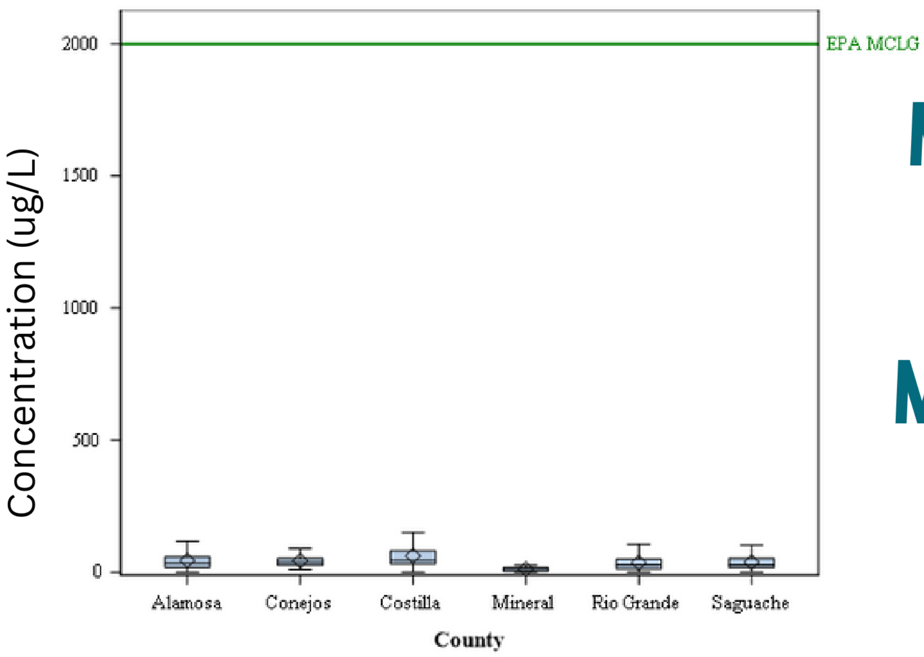
Long term exposure to high levels of As through drinking water may cause cardiovascular disease, diabetes, skin lesions, and risk of cancer.

Most samples that were analyzed only contained a very small amount of As. While a large percent contained levels above the MCLG, 70.2% measured less than 2 ug/L, and 51% measured less than 1 ug/L.

Exposure to As can be reduced by limiting the use of well water for cooking and regular consumption. Of note, young children may still experience limited exposure from bathing due to open-mouth and hand-mouth behavior. Please see the section on household filters.

Notes: The EPA reports MCLs in mg/L while we report results in ug/L. Exposure and health effect information provided by the Environmental Protection Agency. Detailed information can be found from the Agency for Toxic Substances and Disease Registry. Please consult your primary care provider for concerns about your indivisual health, including personal medical history or prescription/supplement regimens.

BARIUM



MCL: 2000 ug/L

0% OF SAMPLES ARE ABOVE THE MCL

MCLG: 2000 ug/L

0% OF SAMPLES ARE ABOVE THE MCLG

Barium (Ba) is naturally present in the earth's crust. While Ba in the aquifer system is mostly likely from element deposits originating the region's geologic formation, Ba in groundwater closer to the surface could be a result of discharge from drilling waste or metal refineries.

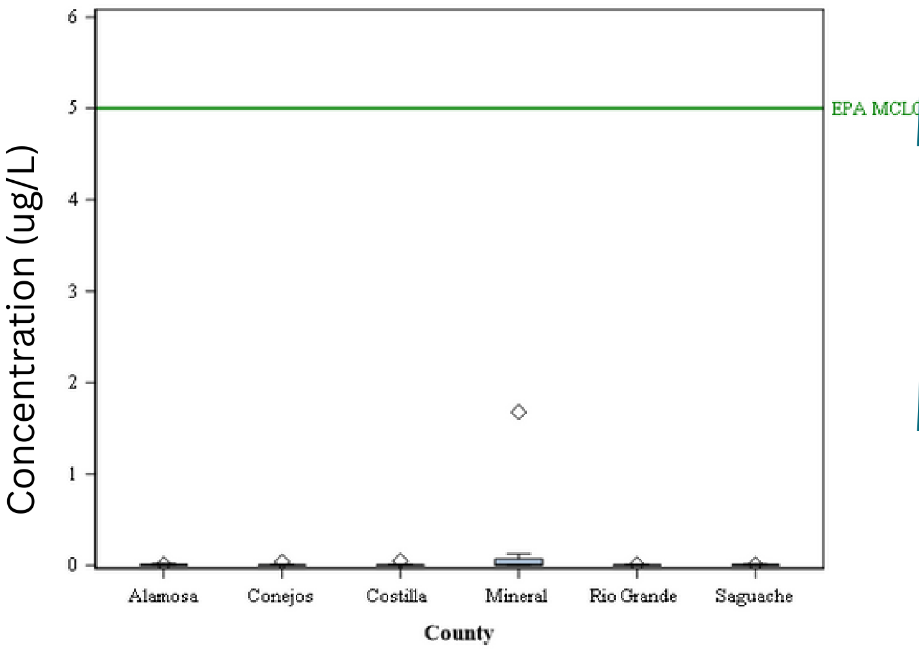
Long term exposure to high levels of Ba through drinking water may increase blood pressure.

Within the samples that were analyzed, 92.2% had levels less than 100 ug/L.

Exposure to Ba can be reduced by limiting the use of well water for cooking and regular consumption. Of note, young children may still experience limited exposure from bathing due to open-mouth and hand-mouth behavior. Please see the section on household filters.

Notes: The EPA reports MCLs in mg/L while we report results in ug/L. Exposure and health effect information provided by the Environmental Protection Agency. Detailed information can be found from the Agency for Toxic Substances and Disease Registry. Please consult your primary care provider for concerns about your indivisual health, including personal medical history or prescription/supplement regimens.

CADIUM



MCL: 5 ug/L

<0.01% OF SAMPLES ARE ABOVE THE MCL

MCLG: 5 ug/L

<0.01% OF SAMPLES ARE ABOVE THE MCLG

Cadmium (Cd) is naturally present in the earth's crust. While Cd in the aquifer system is mostly likely from element deposits originating the region's geologic formation, Cd in groundwater closer to the surface could be a result of discharge from metal refineries, or runoff from waste batteries and paints. Cd may also enter your water from old galvanized pipes used for household plumbing.

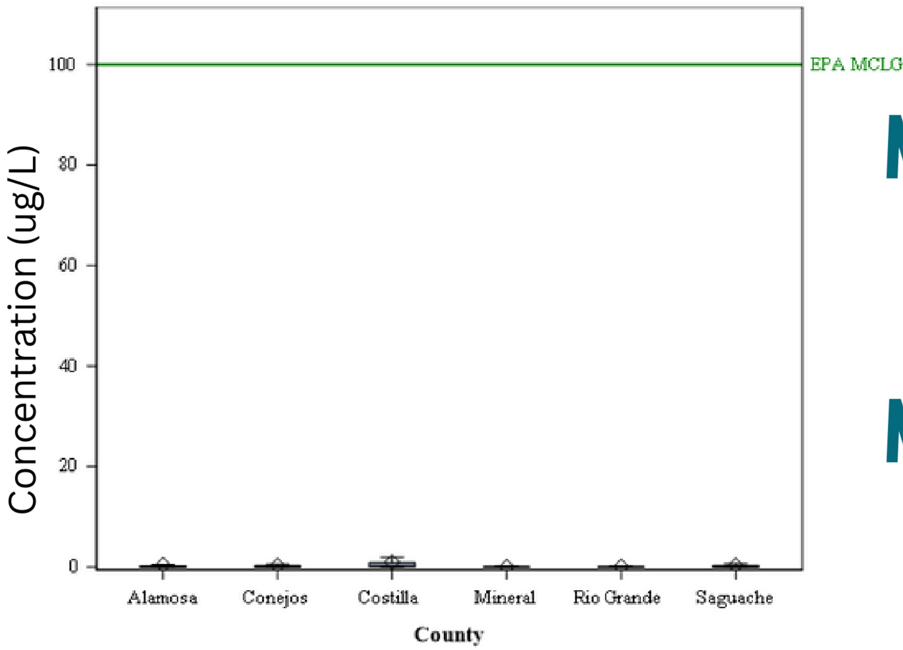
Long term exposure to high levels of Cd through drinking water may result in kidney damage and weaken bone strength.

Within the samples that were analyzed, 58.7% had no detectable amounts of Cd. A further 17.3% had detectable levels of Cd, but were low enough that our lab was unable to collect an exact measurement.

Exposure to Cd can be reduced by limiting the use of well water for cooking and regular consumption. Of note, young children may still experience limited exposure from bathing due to open-mouth and hand-mouth behavior. Please see the section on household filters.

Notes: The EPA reports MCLs in mg/L while we report results in ug/L. Exposure and health effect information provided by the Environmental Protection Agency. Detailed information can be found from the Agency for Toxic Substances and Disease Registry. Please consult your primary care provider for concerns about your indivisual health, including personal medical history or prescription/supplement regimens.

CHROMIUM



MCL: 100 ug/L

0% OF SAMPLES ARE ABOVE THE MCL

MCLG: 100 ug/L

0% OF SAMPLES ARE ABOVE THE MCLG

Chromium (Cr) is naturally present in the earth's crust. While Cr in the aquifer system is mostly likely from element deposits originating the region's geologic formation, Cr in groundwater closer to the surface could be a result of discharge from steel and pulp mills.

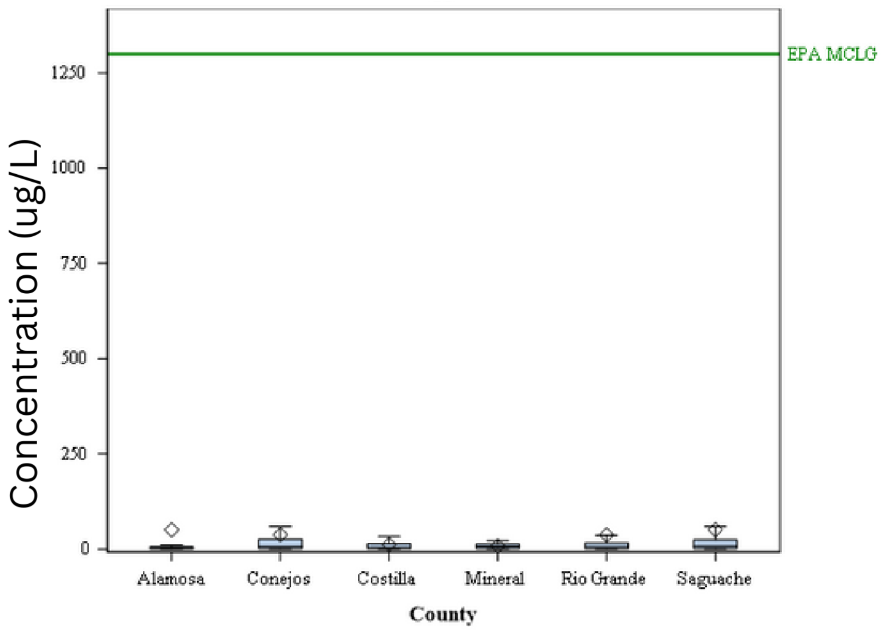
Research on long term exposure to high levels of Cr through drinking water is limited.

Within the samples that were analyzed, 25.8% had no detectable amounts of Cr. Furthermore, 98% measured at less than 5 ug/L.

Exposure to Cr can be reduced by limiting the use of well water for cooking and regular consumption. Of note, young children may still experience limited exposure from bathing due to open-mouth and hand-mouth behavior. Please see the section on household filters.

Notes: The EPA reports MCLs in mg/L while we report results in ug/L. Exposure and health effect information provided by the Environmental Protection Agency. Detailed information can be found from the Agency for Toxic Substances and Disease Registry. Please consult your primary care provider for concerns about your indivisual health, including personal medical history or prescription/supplement regimens.

COPPER



MCL: 1300 ug/L

<0.01% OF SAMPLES ARE ABOVE THE MCL

MCLG: 1300 ug/L

<0.01% OF SAMPLES ARE ABOVE THE MCLG

Copper (Cu) is naturally present in the earth's crust. While Cu in the aquifer system is mostly likely from element deposits originating the region's geologic formation. Cu may also enter your water from old materials used for household plumbing.

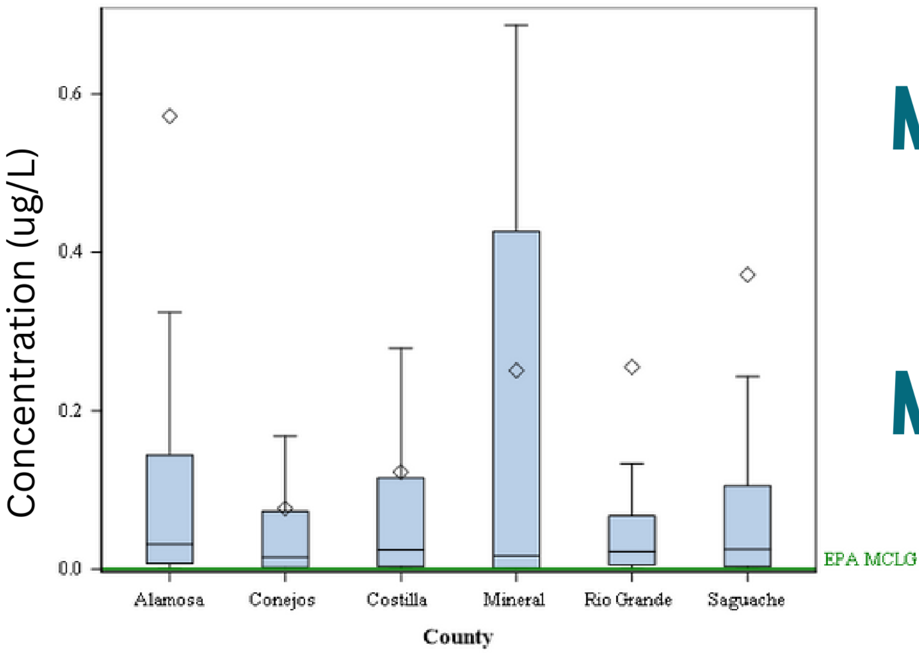
Short term exposure to high levels of Cu may cause gastrointestinal distress. Long term exposure to high levels of Cu through drinking water may cause liver or kidney damage. People with Wilson's Disease should consult their care provider if Cu levels in their water exceed the MCL.

Within the samples that were analyzed, 92.9% had levels less than 100 ug/L.

Exposure to Cu can be reduced by limiting the use of well water for cooking and regular consumption. Of note, young children may still experience limited exposure from bathing due to open-mouth and hand-mouth behavior. Please see the section on household filters.

Notes: The EPA reports MCLs in mg/L while we report results in ug/L. Exposure and health effect information provided by the Environmental Protection Agency. Detailed information can be found from the Agency for Toxic Substances and Disease Registry. Please consult your primary care provider for concerns about your indivisual health, including personal medical history or prescription/supplement regimens.

LEAD



MCL: 15 ug/L

<0.01% OF SAMPLES ARE ABOVE THE MCL

MCLG: 0 ug/L

85.9% OF SAMPLES ARE ABOVE THE MCLG

Lead (Pb) is naturally present in the earth's crust. While Pb in the aquifer system is mostly likely from element deposits originating the region's geologic formation. Pb is also known to enter the water supply from the corrosion of older household plumbing.

Exposure of Pb to children has been shown to cause delays in physical and mental development. Children may experience permanent deficits in attention and learning.

For adults, long term exposure to high levels of Pb through drinking water may cause kidney problems and/or high blood pressure.

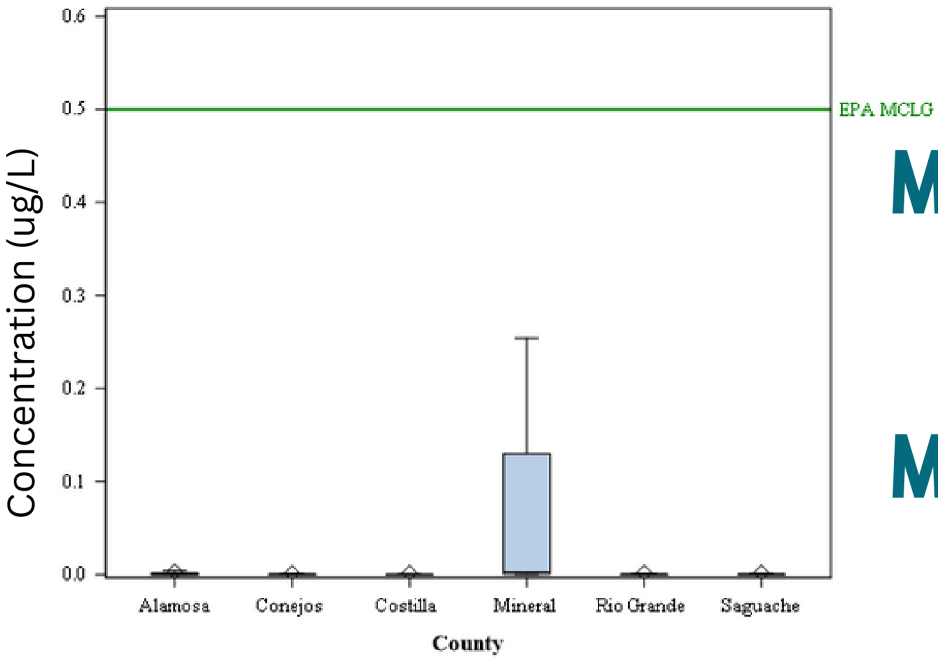
Most samples that were analyzed contained a extremely small amount of Pb.

While we see a large percent of samples above the MCLG, 94.9% measured less than 1 ug/L, 91.7% measured less than 0.5 ug/L, and 87.6% measured less than 0.25 ug/L.

Exposure to Pb can be reduced by limiting the use of well water for cooking and regular consumption. Of note, young children may still experience limited exposure from bathing due to open-mouth and hand-mouth behavior. Please see the section on household filters.

Notes: The EPA reports MCLs in mg/L while we report results in ug/L. Exposure and health effect information provided by the Environmental Protection Agency. Detailed information can be found from the Agency for Toxic Substances and Disease Registry. Please consult your primary care provider for concerns about your indivisual health, including personal medical history or prescription/supplement regimens.

THALLIUM



MCL: 2 ug/L

<0.01% OF SAMPLES ARE ABOVE THE MCL

MCLG: 0.5 ug/L

<0.01% OF SAMPLES ARE ABOVE THE MCLG

Thallium (Tl) is naturally present in the earth's crust. While Tl in the aquifer system is mostly likely from element deposits originating the region's geologic formation, Tl in groundwater closer to the surface could be a result of leaching from ore-processing sites, or discharge from electronic; glad; or drug factories.

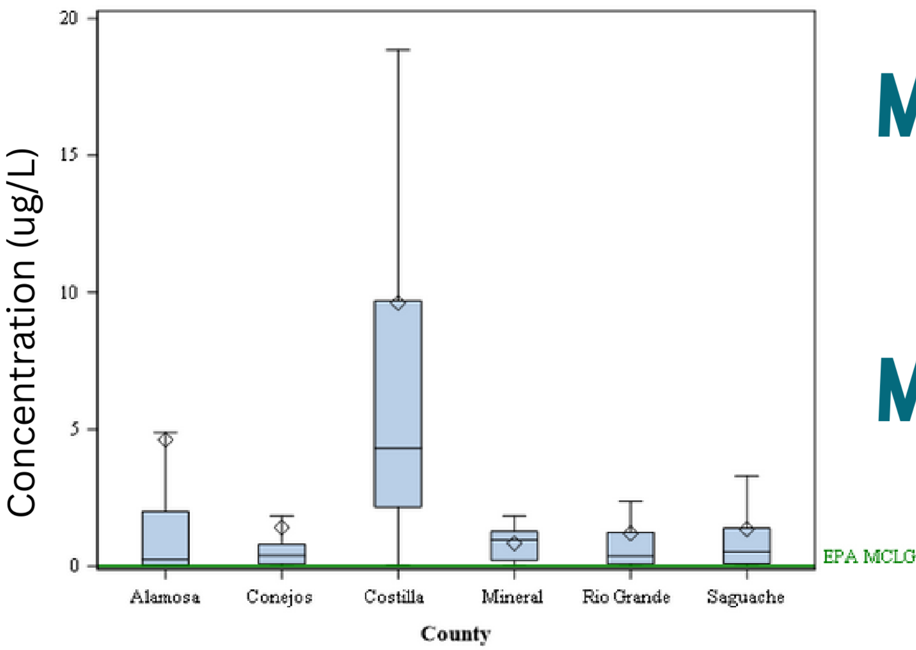
Long term exposure to high levels of Tl through drinking water may cause hair loss; changes in blood pressure; or kidney, intestine, or liver problems.

Within the samples that were analyzed, 64%% had no detectable amounts of Tl. A further 17.9% had detectable levels of Tl, but were low enough that our lab was unable to collect an exact measurement.

Exposure to Tl can be reduced by limiting the use of well water for cooking and regular consumption. Of note, young children may still experience limited exposure from bathing due to open-mouth and hand-mouth behavior. Please see the section on household filters.

Notes: The EPA reports MCLs in mg/L while we report results in ug/L. Exposure and health effect information provided by the Environmental Protection Agency. Detailed information can be found from the Agency for Toxic Substances and Disease Registry. Please consult your primary care provider for concerns about your indivisual health, including personal medical history or prescription/supplement regimens.

URANIUM



MCL: 30 ug/L

2.1% OF SAMPLES ARE ABOVE THE MCL

MCLG: 0.0 ug/L

99.1% OF SAMPLES ARE ABOVE THE MCLG

Uranium (U) is naturally present in the earth's crust. While U in the aquifer system is mostly likely from element deposits originating the region's geologic formation.

Long term exposure to high levels of U through drinking water may cause increased risk of cancer and kidney damage.

Most samples only contained a very small amount of U. While we see a large percent of samples with levels above the MCLG, 88.2% measured less than 5 ug/L, and 61.9% measured less than 1 ug/L. and 87.6% measured less than 0.25 ug/L.

Exposure to U can be reduced by limiting the use of well water for cooking and regular consumption. Of note, young children may still experience limited exposure from bathing due to open-mouth and hand-mouth behavior. Please see the section on household filters.

Notes: The EPA reports MCLs in mg/L while we report results in ug/L. Exposure and health effect information provided by the Environmental Protection Agency. Detailed information can be found from the Agency for Toxic Substances and Disease Registry. Please consult your primary care provider for concerns about your indivisual health, including personal medical history or prescription/supplement regimens.

SUPERFUND SITES

Improper disposal of many materials can have serious, long-term consequences for the environment and human health. In 1980, Congress passed the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) to create a program (i.e. Superfund) tasked with facilitating the remediation of environmental contamination.

Mining activity has a rich history in both mountain ranges surrounding the San Luis Valley. Two former mining sites have been classified as a Superfund site under EPA to facilitate remediation efforts to mitigate the known metals contamination including water systems, both ground and surface. Summitville Mine is no longer under Superfund and cleanup is now overseen by state government. Listed below are environmental contaminates known to be associated with each site:

	**Nelson Tunnel**	Arsenic, Cadmium, Lead, Zinc
	**Summitville Mine**	Aluminum, Arsenic, Cadmium, Chromium, Copper, Cyanide, Iron, Lead, Manganese, Mercury, Nickel, Silver, Zinc,

While these are currently the only recognized superfund sites within the region, improper waste disposal or irresponsible mining practices have the potential to contaminate nearby water sources - including surface and groundwater.

WHAT NOW?

Identifying a health risk is the first step in promoting public health. If you have elevated metal in your water, or want to take extra precautions, what's next?

MUNICIPAL WATER

By law, municipal water districts are required to monitor and remediate any elevated contaminants identified by the National Drinking Water Standards. Folks living within the boundaries of these muncipalities may consider municpal water as an alternative to water from the well.

ION EXCHANGE

There are two main types of ion exchange filters - cation and anion. Cation filters can remove minerals that impact water hardness, as well as barium, radium, and strontium. Anion filters can remove contaminants including arsenic, chromium, cyanide, nitrate, perchlorate, PFAS, sulfate, and uranium.

This device can be connected to a single fixture (e.g. under the sink) and usually cost $350 or more. Less waste water is generated than RO systems.

REVERSE OSMOSIS

A reverse osmosis (RO) filter is a device that is connected to a single fixture (e.g. under the sink). These devices can remove contaminants such as lead, volatile organic compounds, PFAS, arsenic, bacteria, and viruses.

RO devices usually cost $150 or more, require filter replacement, and create 5 gallons of water waste per one gallon of drinkable water.

DISTILLED WATER

Distillation devices have the potential to remove a wide range of impurities and water contaminants. Price ranges due to specification, but can start at around $150.

While our project focuses on heavy metals, there are many other health hazards that can be associated with drinking water. It is important to do your own research to identify a solution that best address the needs of your household water. The Center for Disease Control & Prevention (CDC) and EPA provide additional information on identifying other health hazards, and appropriate water filters and treatment options.

CDC INFORMATION

bit.ly/CDCWaterFilter

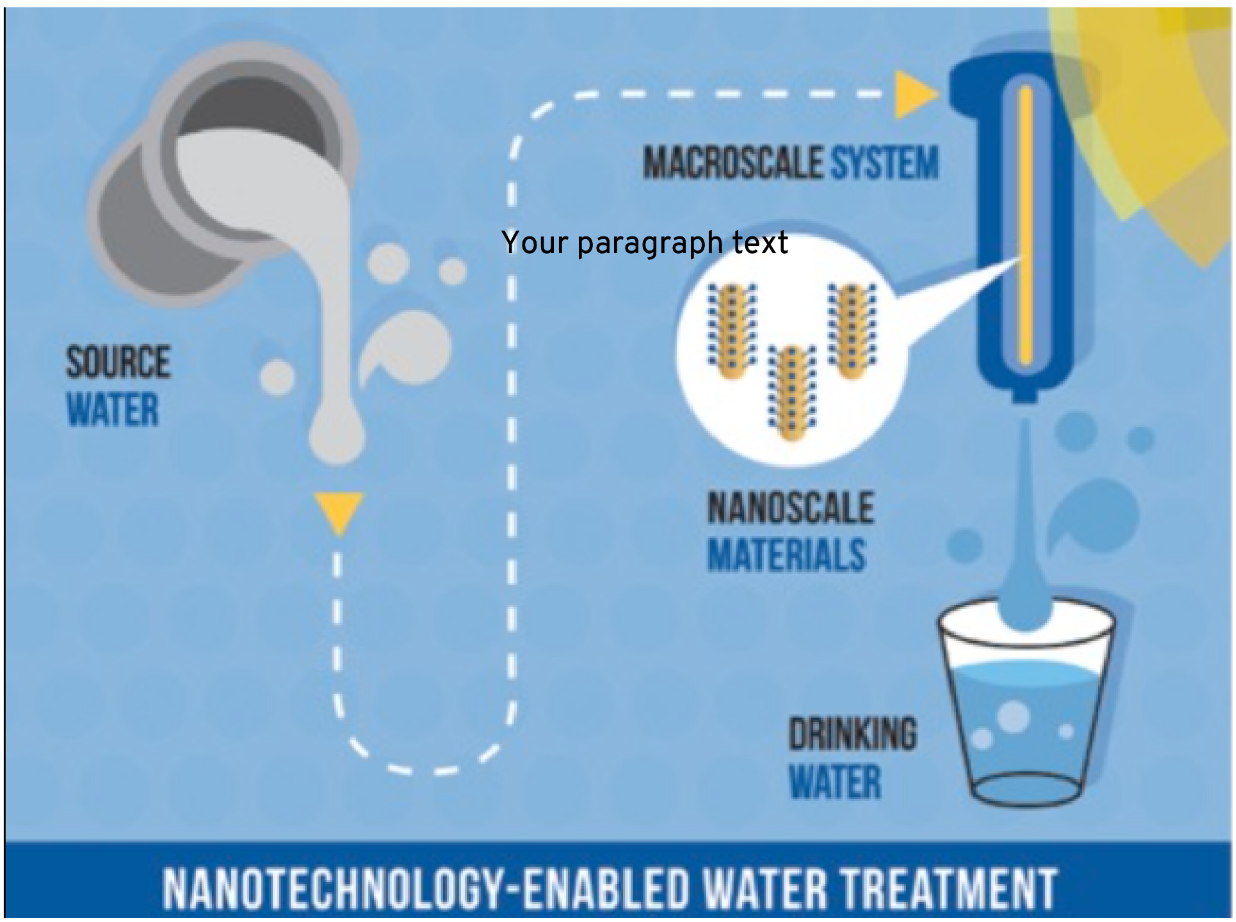
EPA INFORMATION

bit.ly/EPAWaterFilter

FILTER RESEARCH IN SLV

Dr. James and CU-Anschutz Medical Campus is partnering with Arizona State University School of Engineering to develop water filtration technology that removes metals from drinking water.

The engineering team at Arizona State University led by Dr. Paul Westerhoff, is developing technology that will remove metals including arsenic, manganese, uranium, and lead using a economical and sustainable process. Dr. Westerhoff's team has launched several test filters throughout the SLV to evaluate efficiency for widespread use.



https://westerhoff.engineering.asu.edu/2016/12/nano-research-makes-the-cover-of-es-nano/

FREQUENTLY ASKED QUESTIONS

What is “ug/L”?

ug/L stands for micro-grams per liter. It is the unit used to measure used by the lab equipment to measure for metals. There are 1,000 micgrograms in a milligram, and 1,000 milligrams in a gram.

What’s the difference between “detectable” and “measurable”?

The machines used by the lab to analyze for metals are designed to measure extremely small amounts, however, they do have their limits. “Measureable” means that the machine was able to put a number to the amount. “Detectable” means that the machine could identify the presence of a metal, but wasn’t able to determine a specific number.

Why are the MCL and MCLG often the same?

Due to legislation, the EPA is limited in the number of new water quality standards they can introduce in a calendar year. Once these standards are set, they are also difficult to change. MCLGs are a way to recognize the need to “go above and beyond” the standard to protect health. Lead and Arsenic are great examples. While evidence has show they can have negative health effects, changing these standards is a slow process.