

Introduction to **Water** **Science**

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NUESTRA CASA



About Me

B.S. Environmental Engineering

University of California, Merced, Spring 2023

Research Interests:

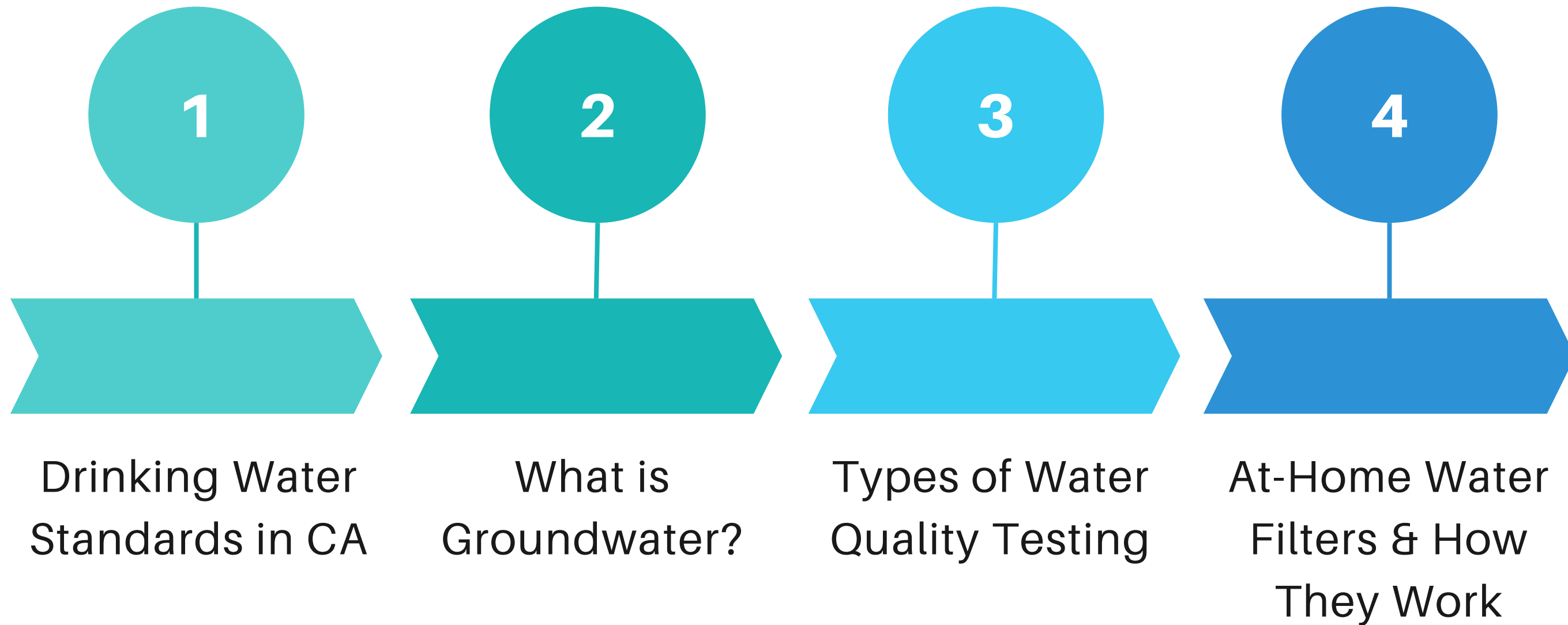
Equitable Water Infrastructure in California
(Focus in rural and agricultural communities)



Stanford
School of Engineering &
Doerr School of Sustainability
Civil & Environmental Engineering

TABLE OF CONTENTS

Introduction to Water Science



*Drinking
Water
Standards
in CA*



WHO DETERMINES DRINKING WATER STANDARDS?

Drinking Water Standards in CA



WATER QUALITY STANDARDS

Drinking Water Standards in CA

FEDERAL STANDARDS

EPA sets legal limits on **90 contaminants** in drinking water.

Microbial
Contaminants

Chemical
Contaminants

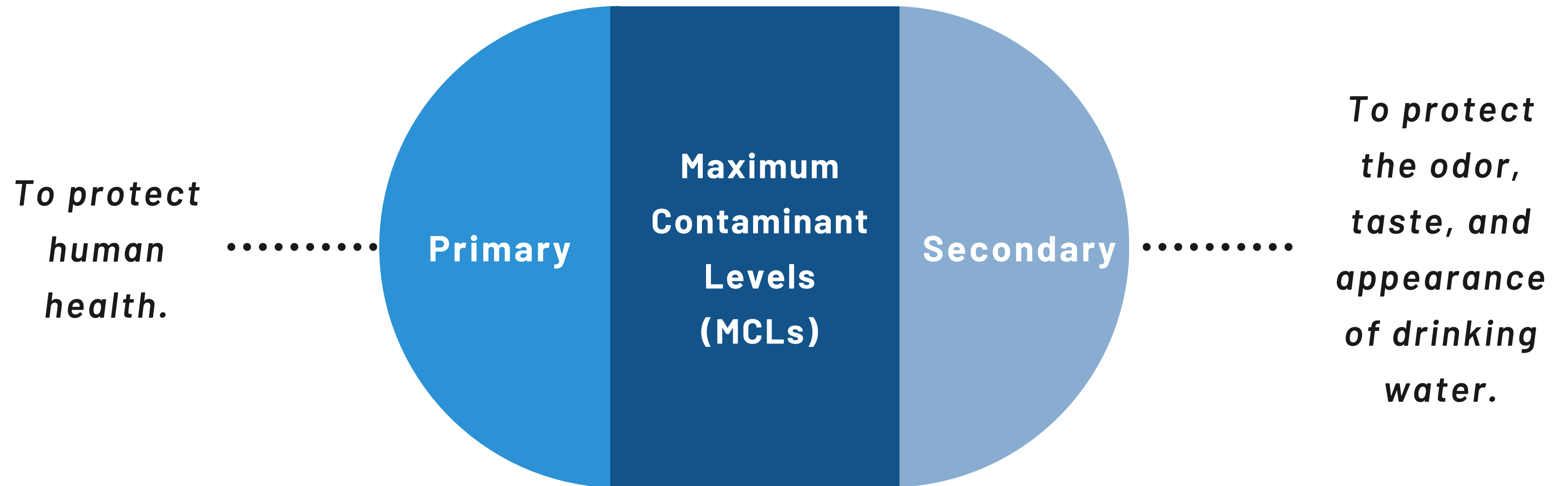
SAFE DRINKING WATER ACT (SDWA)

Allows states to set & enforce additional water quality standards.

Must be at a minimum of U.S. EPA standards.

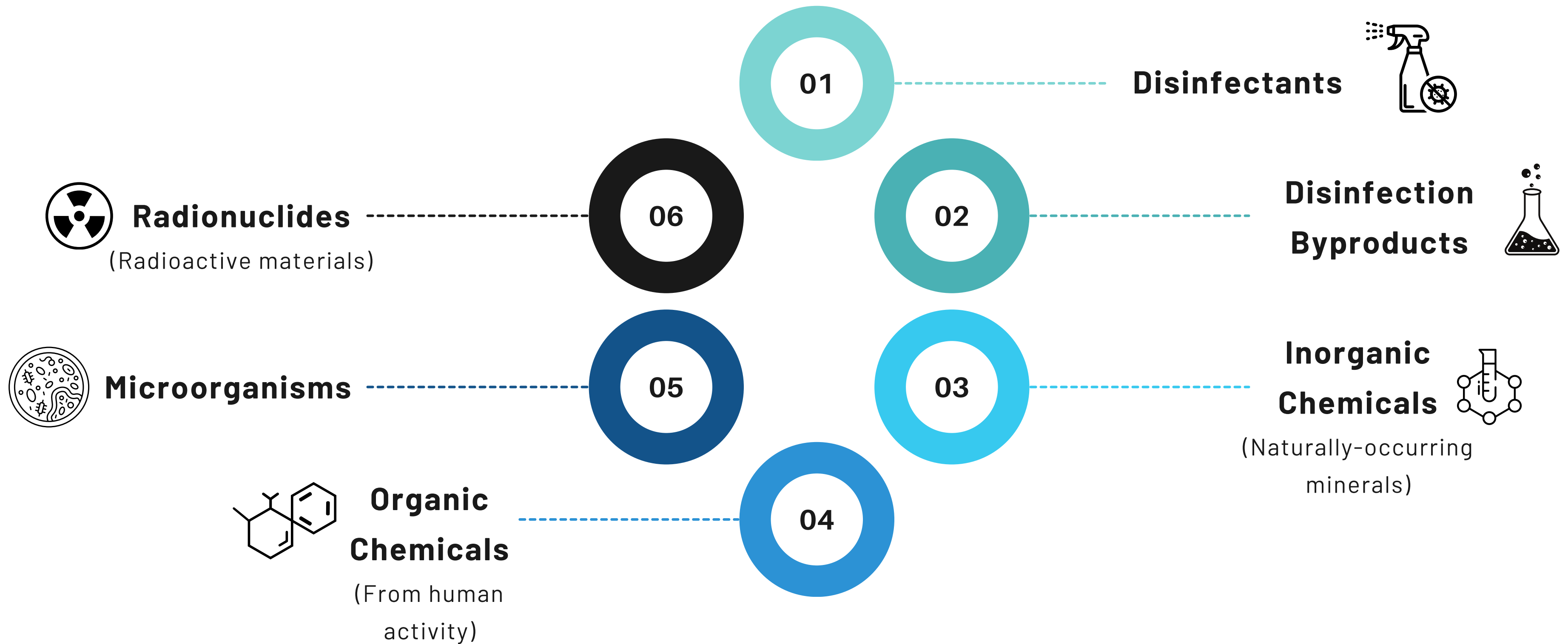
HOW WATER QUALITY IS MEASURED

Drinking Water Standards in CA



PRIMARY MCL CATEGORIES

Drinking Water Standards in CA



PRIMARY MCL CATEGORIES

Drinking Water Standards in CA

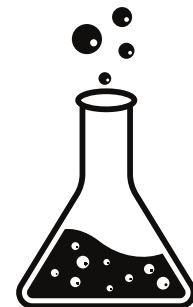
Notable Contaminant(s)

Chlorine



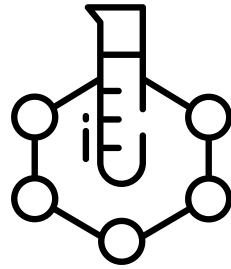
DISINFECTANT

Chlorite



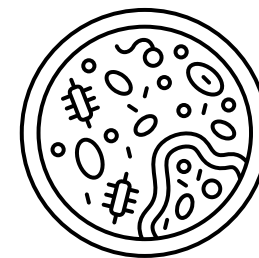
DISINFECTION
BYPRODUCT

Arsenic,
Lead,
Mercury



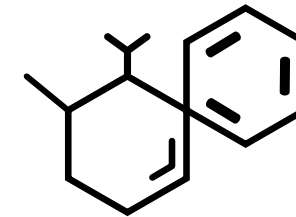
INORGANIC
CHEMICAL

Total
Coliform
Bacteria



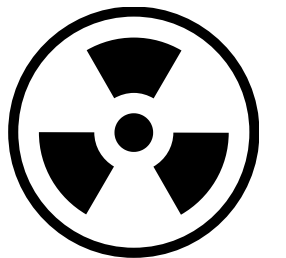
MICRO-
ORGANISM

Benzene



ORGANIC
CHEMICAL

Uranium,
Radium



RADIO-
NUCLIDES

SECONDARY MCL CATEGORIES

01

Some Metals

02

Color

03

Odor

04

*Total Dissolved
Solids (TDS)*

05

*Specific
Conductance (EC)*

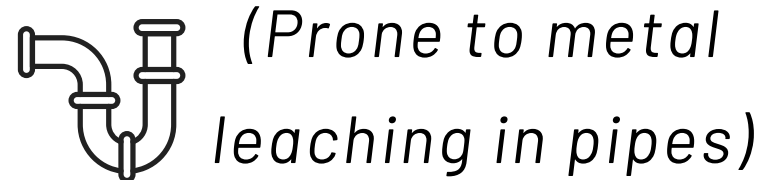
Drinking Water Standards in CA

AESTHETIC ONLY (NO MCL OR SMCL)

Drinking Water Standards in CA

WATER HARDNESS*

Soft



Slightly

Hard

Moderately

Hard

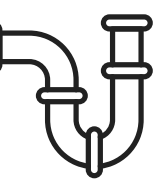
Hard



Skin feels dry or irritated

Very Hard

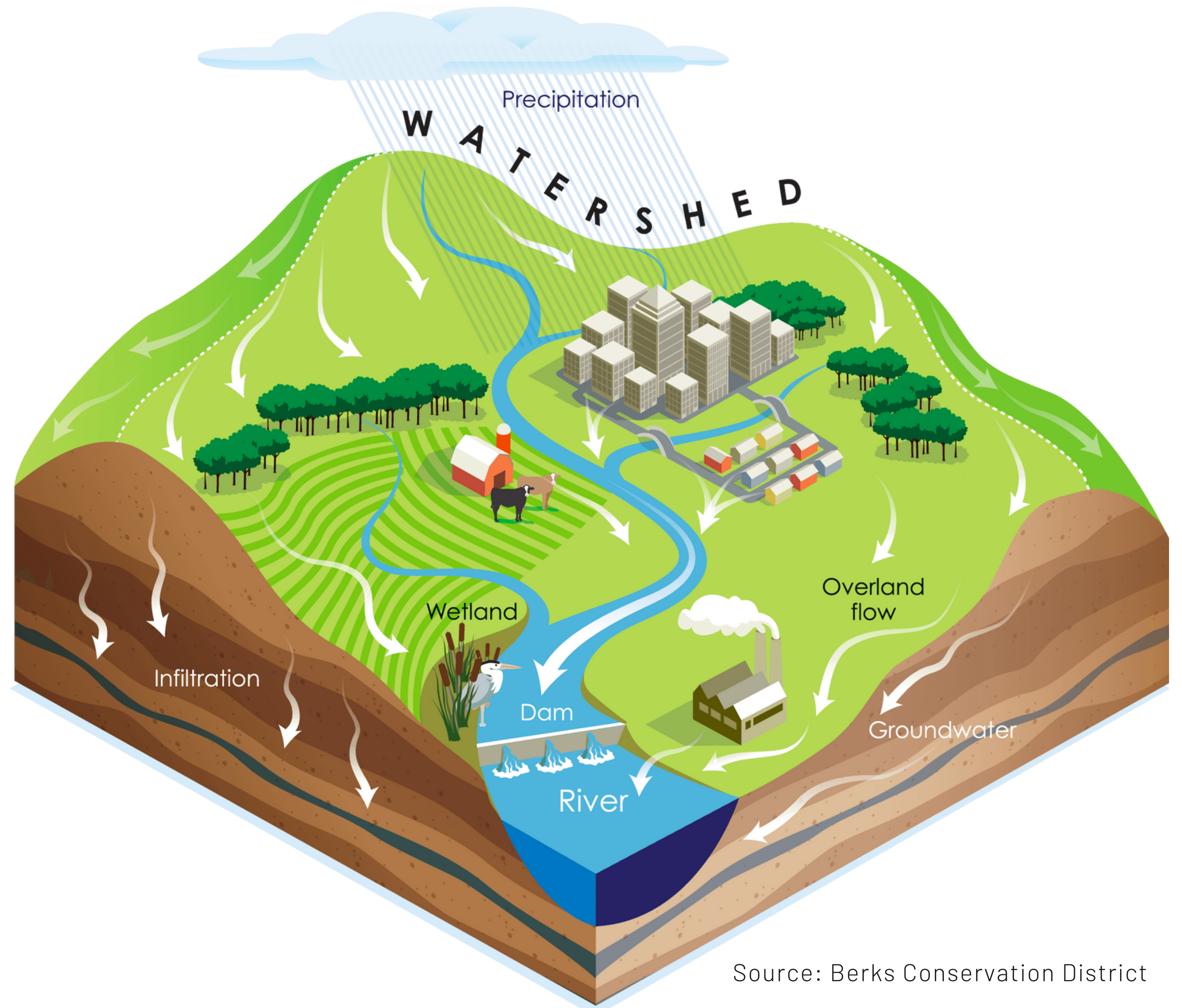
(Limescale build up, clogged pipes, low flow)



***Can cause unfavorable effects on skin and hair, but nothing that impacts health.**

Drinking Water
Standards in CA

HOW DO CONTAMINANTS END UP IN OUR WATER?



Source: Berks Conservation District



Questions?

Content Summary:

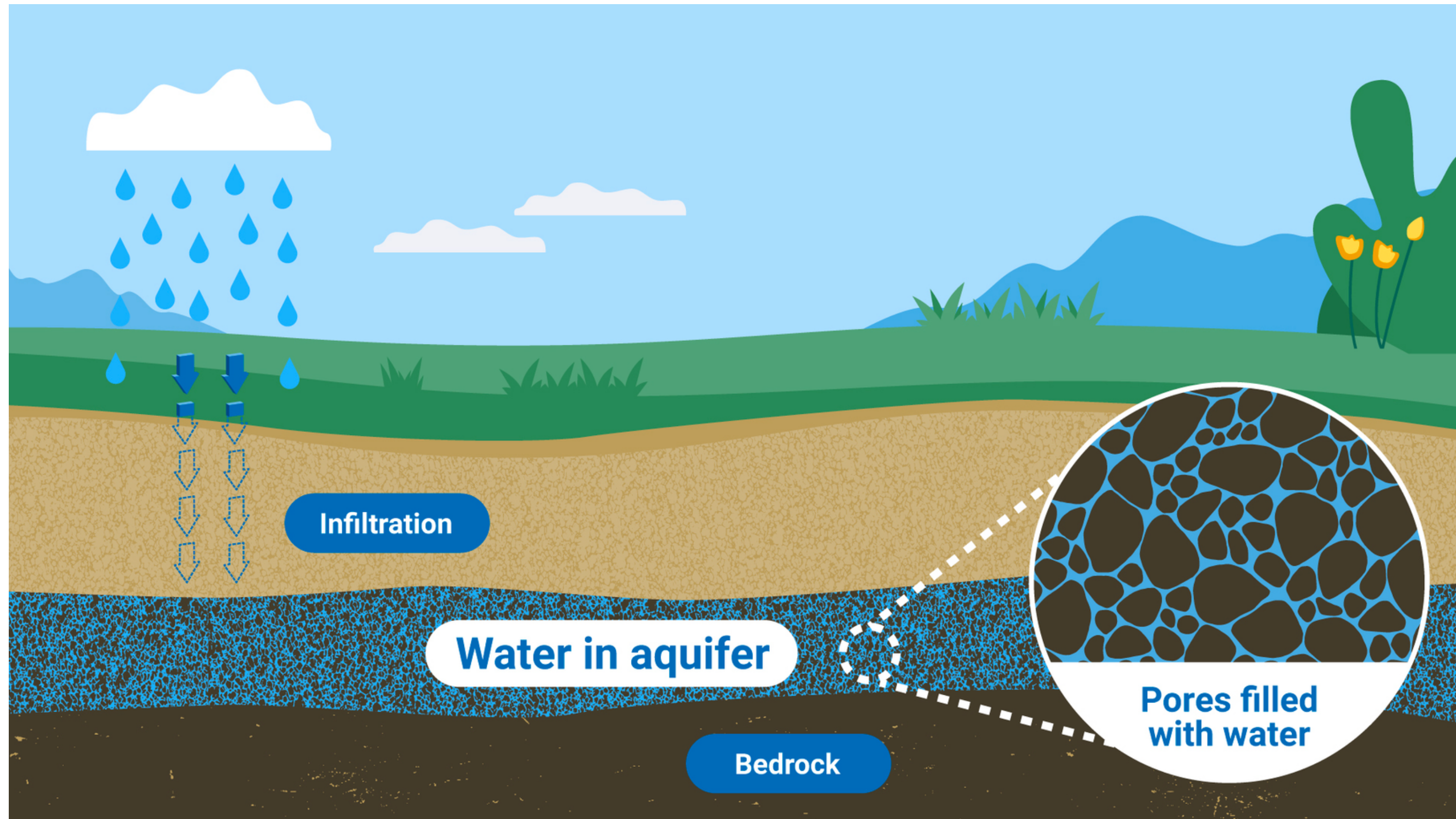
1. Who determines US & CA drinking water standards?
2. Federal water quality standards
3. How we measure water quality:
primary and secondary MCLs
4. How contaminants end in our water

What is Groundwater?



GROUNDWATER

What is Groundwater?



GROUNDWATER IN CALIFORNIA

What is Groundwater?



- One of the main sources of water for the state (40% in wet year, and 60% in a dry year).
- **Main Problem:** groundwater overuse, subsidence, and not recharging groundwater supplies fast enough.
- **Additional Issues:** groundwater contamination (especially in rural and low-income communities) due to fertilizer usage in agriculture--“forever chemicals”

Sources: DWR, USGS, NRDC



Questions?

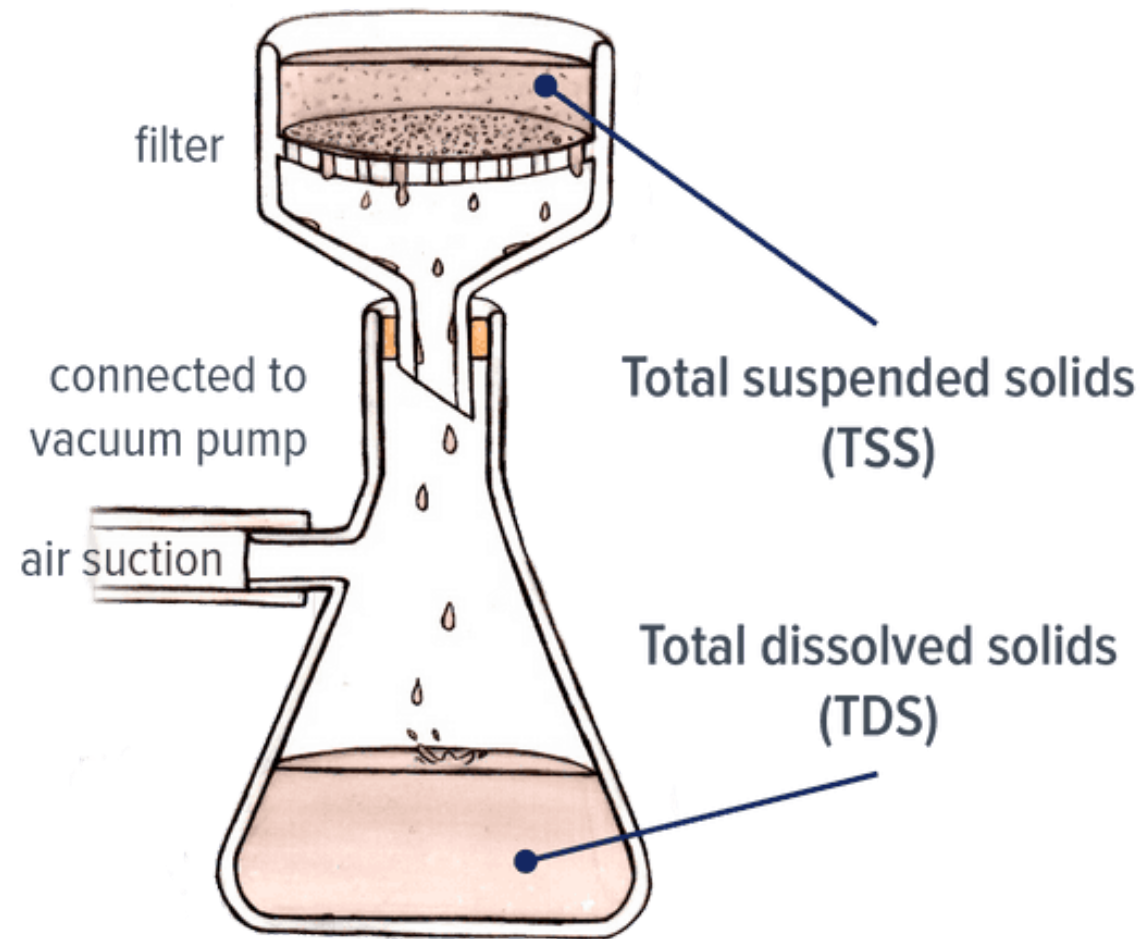
Content Summary:

1. How does surface water become groundwater?
2. Why is groundwater usage such a big issue?

Types of Water Quality Testing



COMMON WATER QUALITY TESTS



PHYSICAL TESTING

- Color
- Turbidity*
- Total solids
- Dissolved solids**
- Suspended solids***
- Odor
- Taste



*Cloudiness of water (low turbidity means clear)

**Solid particles that can pass through a 2-micron filter.

***Solids in a liquid that cannot pass through a 2-micron filter (larger than DS).

Performed pre & post-treatment at wastewater treatment plants.

COMMON WATER QUALITY TESTS

CHEMICAL TESTING

- pH
- Hardness
- Certain Chemicals
- Biocides*
- B.O.D.**



*Chemicals that kill bacteria/viruses

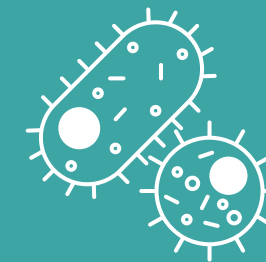
**Biochemical oxygen demand: represents how much oxygen is needed to break down organic matter in water

Performed pre & post-treatment at wastewater treatment plants.

COMMON WATER QUALITY TESTS

BACTERIOLOGICAL TESTING

- Harmful organisms from fecal contamination.



ADDITIONAL TESTING

Using wastewater-based epidemiology to detect pathogens in wastewater.



Questions?

Content Summary:

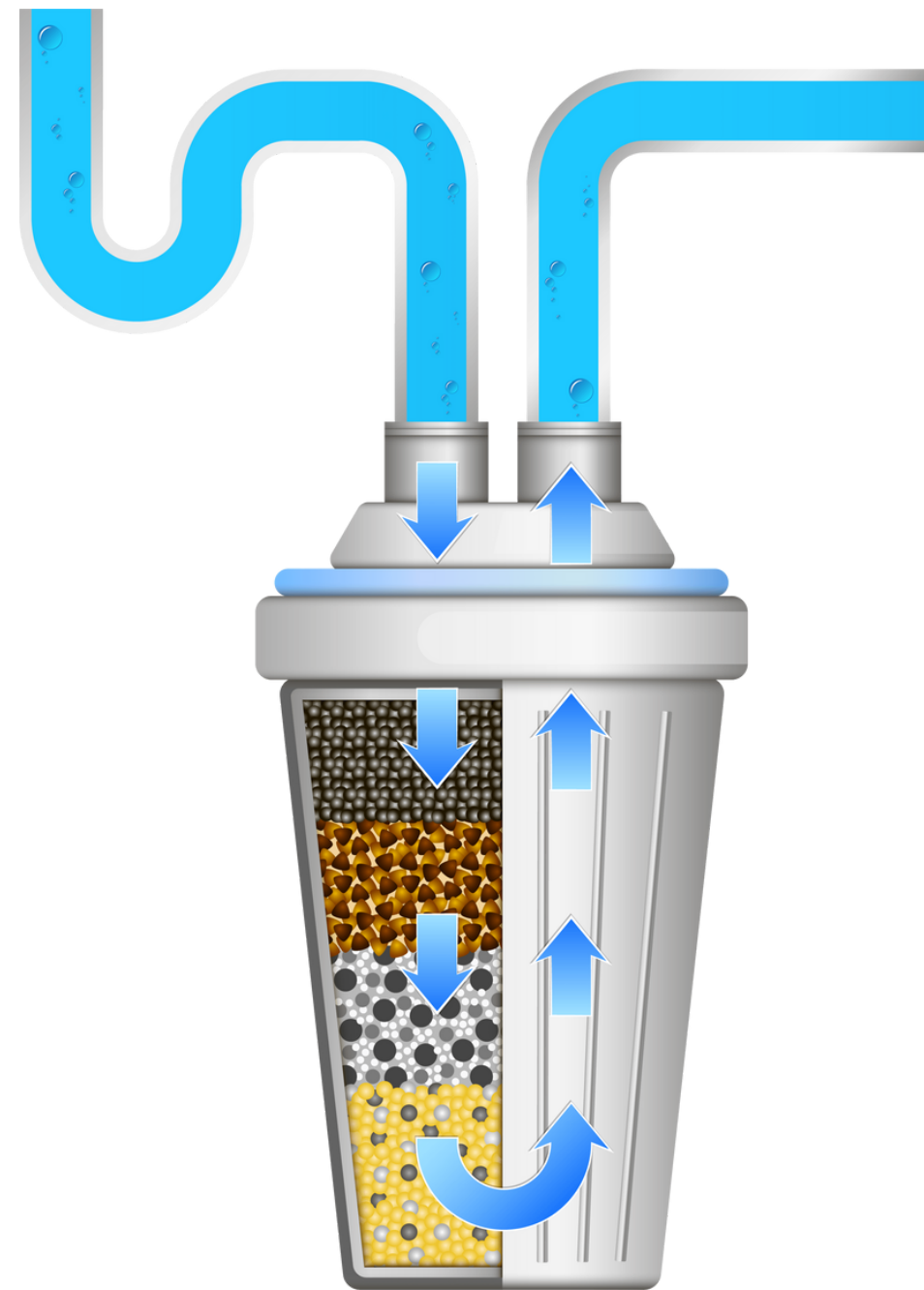
1. Types of water quality tests:
physical, chemical, and
bacteriological

At-Home Water Filtration Systems



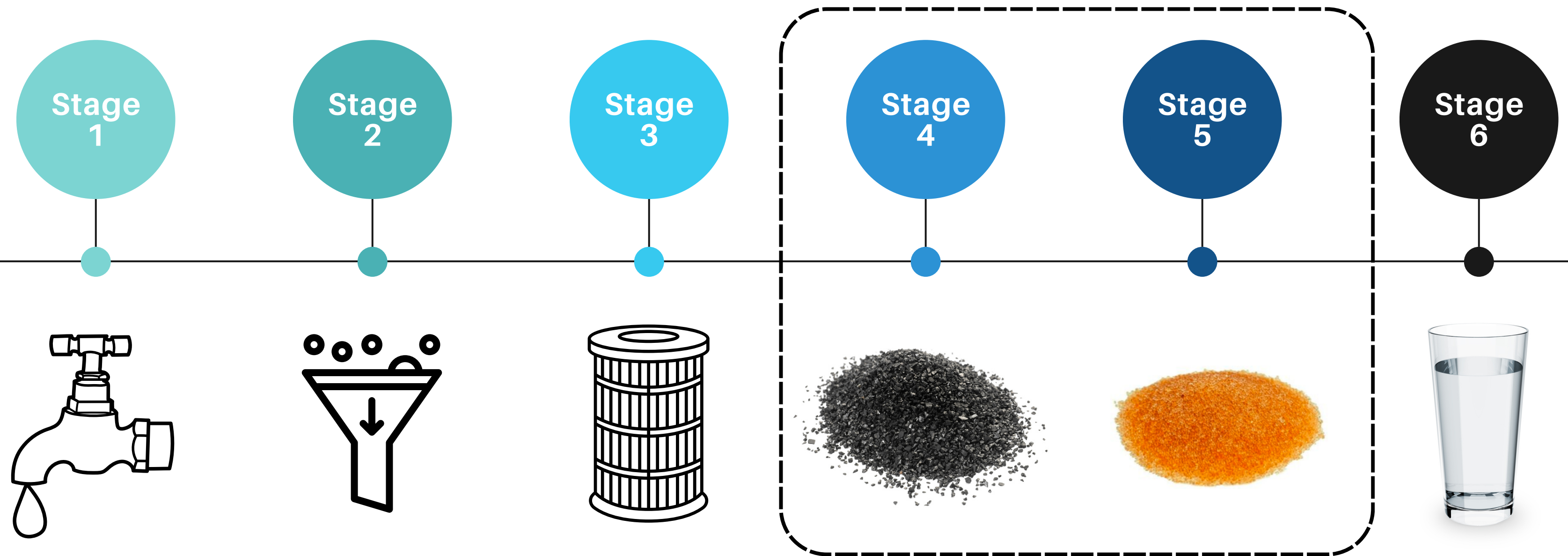
HOW DO AT-HOME WATER FILTERS WORK?

At-Home Water Filters



HOUSEHOLD WATER FILTRATION PROCESS

At-Home Water Filters



*Depends on the filter brand.

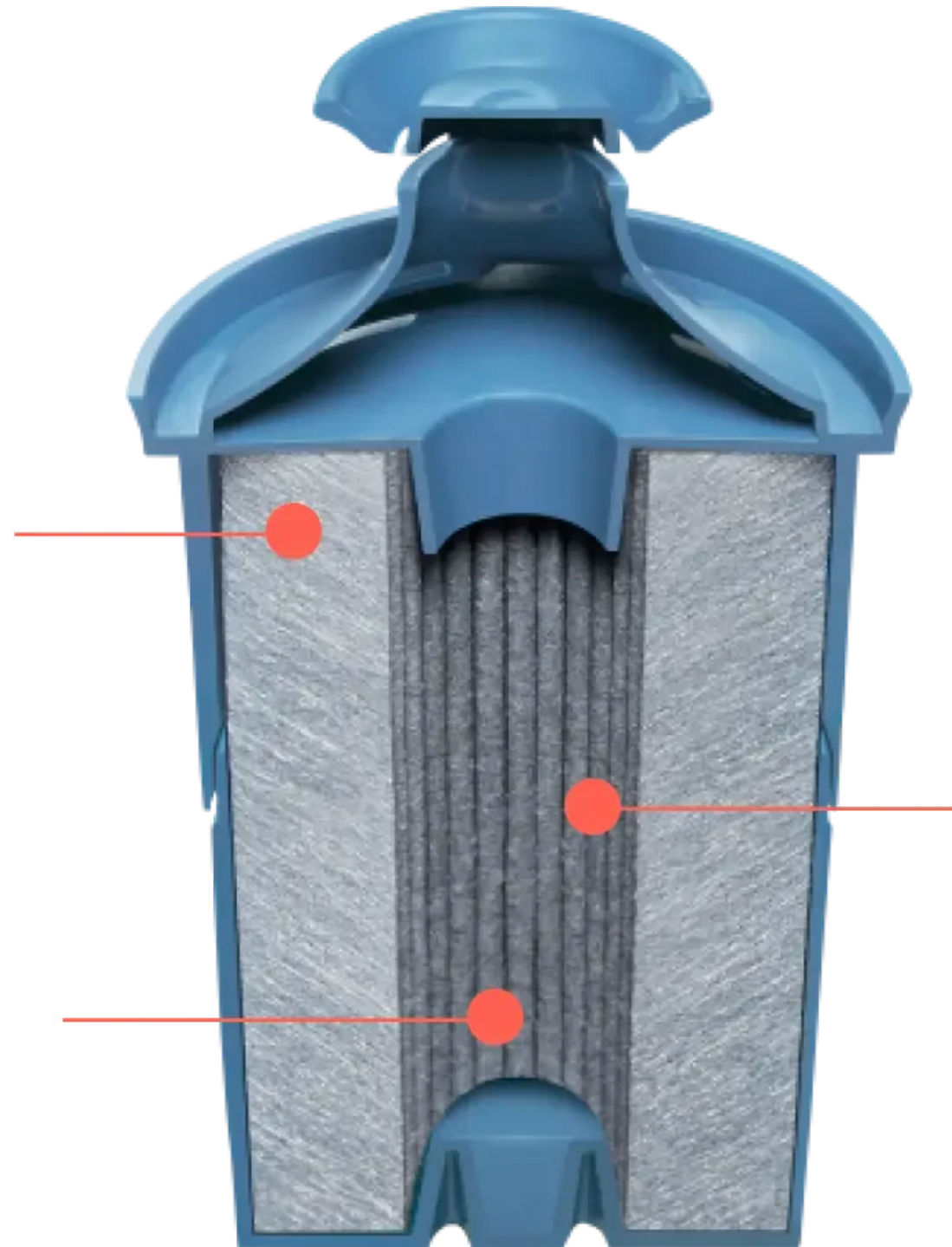
Source: Brita

BRITA FILTER EXAMPLE

At-Home Water Filters

Activated carbon reduces chlorine taste and odor

Absorbents in filter help to reduce 99% of lead**



Fibrous matrix holds active ingredients to prevent black flecks

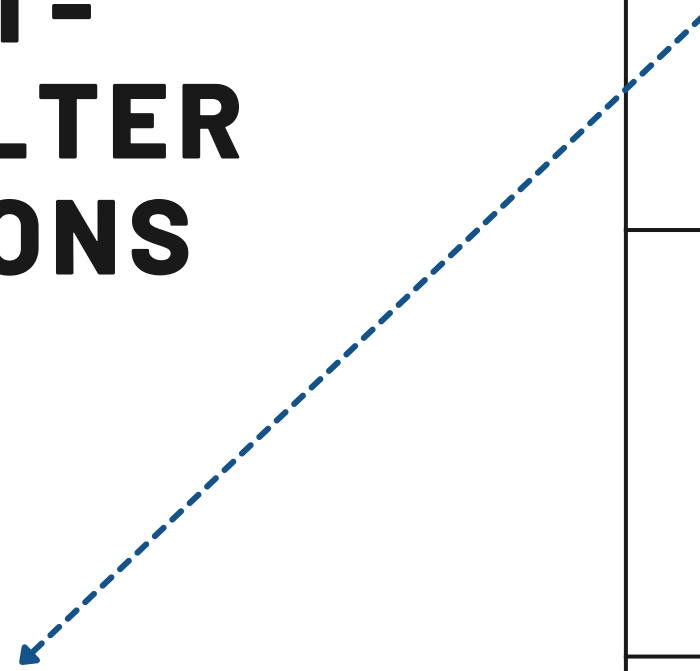
Source: Brita

At-Home Water
Filters

CRITERIA FOR AT-HOME WATER FILTER RECOMMENDATIONS

Local Issues:

- Discolored water
- Milky/Cloudy
- White and Black Particles
- Sandy



A	Available locally (Target in East Palo Alto or Amazon)
B	Removes SMCL/aesthetics of concern
C	Can hold at least 6 cups a time
D	Affordable filter cost/affordable yearly maintenance

PREFACE:

1. Brita, PUR and ZeroWater are the most common water filters available on the market.
2. All 3 are National Sanitation Foundation (NSF) certified--an extra step past FDA certification.

COMMONLY AVAILABLE AT-HOME WATER PITCHERS

At-Home Water Filters

BRITA

Product Name	Capacity	Cost (w/ Standard Filter)	Cost (w/ Elite Filter)
Denali	6 cups	\$18.89	\$32.49
Tahoe	10 cups	\$38.99	\$40.99
Stream	12 cups	\$55.99	
Ultramax (dispenser)	27 cups	\$37.99	\$49.99

Sources: Target, Brita

COMMONLY AVAILABLE AT-HOME WATER PITCHER FILTERS

At-Home Water Filters

BRITA FILTERS

	Filter Type	Maximum Filter Life	Contaminants Removed	Single Cost	Annual Maintenance Cost
*	Standard	2 Months	Chlorine (taste and odor), copper, cadmium and mercury	\$17.99 (3 pack) \$29.99 (6 pack)	\$30-36/yr
**	Elite	6 Months	Chlorine (taste and odor), cadmium, 99% of lead, mercury, class I particulates (0.5-<1 micron), asbestos and benzene.	\$34.99 (2 pack)	\$35/yr
*	Stream	2 Months	Chlorine (taste and odor), class IV particulates (50-80 microns) and 1, 2, 4 - trichlorobenzene	\$18.99 (3 pack)	\$38/yr

*2 months~40 gallons

**6 months~120 gallons

COMMONLY AVAILABLE AT-HOME WATER PITCHERS

At-Home Water Filters

PUR

Product Name	Capacity	Cost
PUR Pitcher	7 cups	\$19.49
PUR Pitcher	11 cups	\$29.99
PUR Dispenser	30 cups	\$35.99

Sources: Target, PUR

COMMONLY AVAILABLE AT-HOME WATER PITCHER FILTERS

At-Home Water Filters

PUR FILTERS

Filter Type	Maximum Filter Life	Contaminants Removed	Cost	Annual Maintenance Cost
* PUR Water Pitcher Replacement Filter	2 Months	Chlorine, mercury, copper, zinc, benzene, cadmium, class IV particles (50-80 micrometers)	\$19.99 (3 Pack) \$39.99 (6 Pack)	\$40/yr
* PUR Plus Water Pitcher Replacement Filter	2 Months	Microplastics, chlorine, mercury, copper, benzene, cadmium, zinc, class I particles (0.5-<1 micrometers)	\$24.99 (3 Pack)	\$50/yr

COMMONLY AVAILABLE AT-HOME WATER PITCHERS

At-Home Water Filters

ZEROWATER

Product Name	Capacity	Cost
ZeroWater Pitcher	7 cups	\$20.49
ZeroWater Dispenser	22 cups	\$24.99
ZeroWater Dispenser	32 cups	\$39.99

Sources: Target, PUR

COMMONLY AVAILABLE AT-HOME WATER PITCHER FILTERS

At-Home Water Filters

ZEROWATER FILTERS

Filter Type	Maximum Filter Life	Contaminants Removed	Cost	Annual Maintenance Cost
ZeroWater Filter	<1 month (15 gallons)	ZeroWater's 5 Stage Ion Exchange Filter is the only pour-through water filter certified by NSF to reduce PFOA/PFOS, lead, and chromium + 99% better at removing contaminants than leading brands	\$34.99 (2 Pack) \$59.99 (4 Pack) \$89.99 (6 Pack)	\$180-210/yr

FINAL RECOMMENDATION

At-Home Water Filters

Brita Pitcher w/ Elite Filter

1. **Longest maximum filter life** (requires less thought about replacement).
2. **Removes contaminants of interest** including small particulates.
3. **Generally affordable** option, comparable to PUR and other Brita prices.
4. Does not require pre-soak like standard filter.

Source: Consumer Reports 2023, Target

Presentation Summary

1. What is a MCL? What is the difference between a primary and secondary MCL?
2. What is groundwater?
3. What are the main three types of water quality testing?
4. How does an at-home water filter work?

Resources

Access the Site Below



COMMUNITY WATER CENTER
EL CENTRO COMUNITARIO POR EL AGUA

Your Water Data



Discover where your water comes from based on your address. Learn about water quality and water supply in your area and how to get involved with local water issues.

California Water Data



Use our web mapping tool for a deeper dive into California's many water data layers. Features include the ability to overlay data layers like Drought Scenarios and print reports.

Thank you!



Questions?

Email me: cymedina@stanford.edu

<http://berkscd.com/watersheds/>

<https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations>

[https://www.cdc.gov/healthywater/drinking/public/regulations.html#:~:text=The%20Safe%20Drinking%20Water%20Act%20\(SDWA\)%20was%20passed%20by%20Congress,suppliers%20who%20enforce%20those%20standards.](https://www.cdc.gov/healthywater/drinking/public/regulations.html#:~:text=The%20Safe%20Drinking%20Water%20Act%20(SDWA)%20was%20passed%20by%20Congress,suppliers%20who%20enforce%20those%20standards.)

<https://www.brita.com/why-brita/better-water/>

<https://www.brita.com/better-water/how-do-brita-filters-work/#:~:text=Our%20Brita%C2%AE%20Faucet%20Filters,carbon%20block%20traps%20smaller%20contaminants.>

<https://www.fao.org/3/X5624E/x5624e05.htm>

<https://www.epa.gov/laws-regulations/summary-safe-drinking-water-act>

<https://www.iaea.org/newscenter/news/pollution-and-sustainability-of-groundwater>

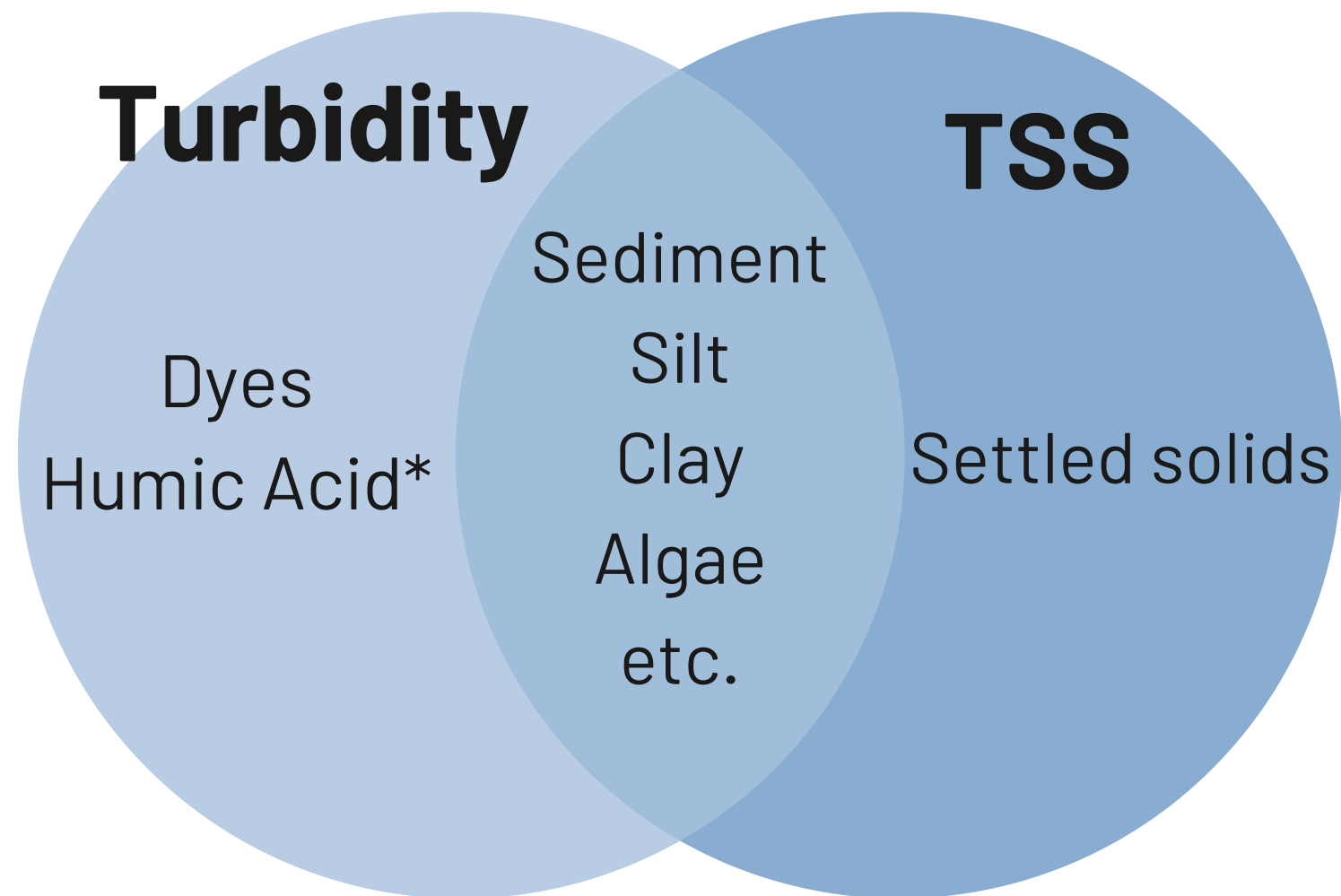
<https://www.hyperfiltration.in/blogs/2022/04/20/tds-total-dissolve-solids/>

<https://www.hyperfiltration.in/blogs/2022/04/08/what-is-turbidity/>

Appendix

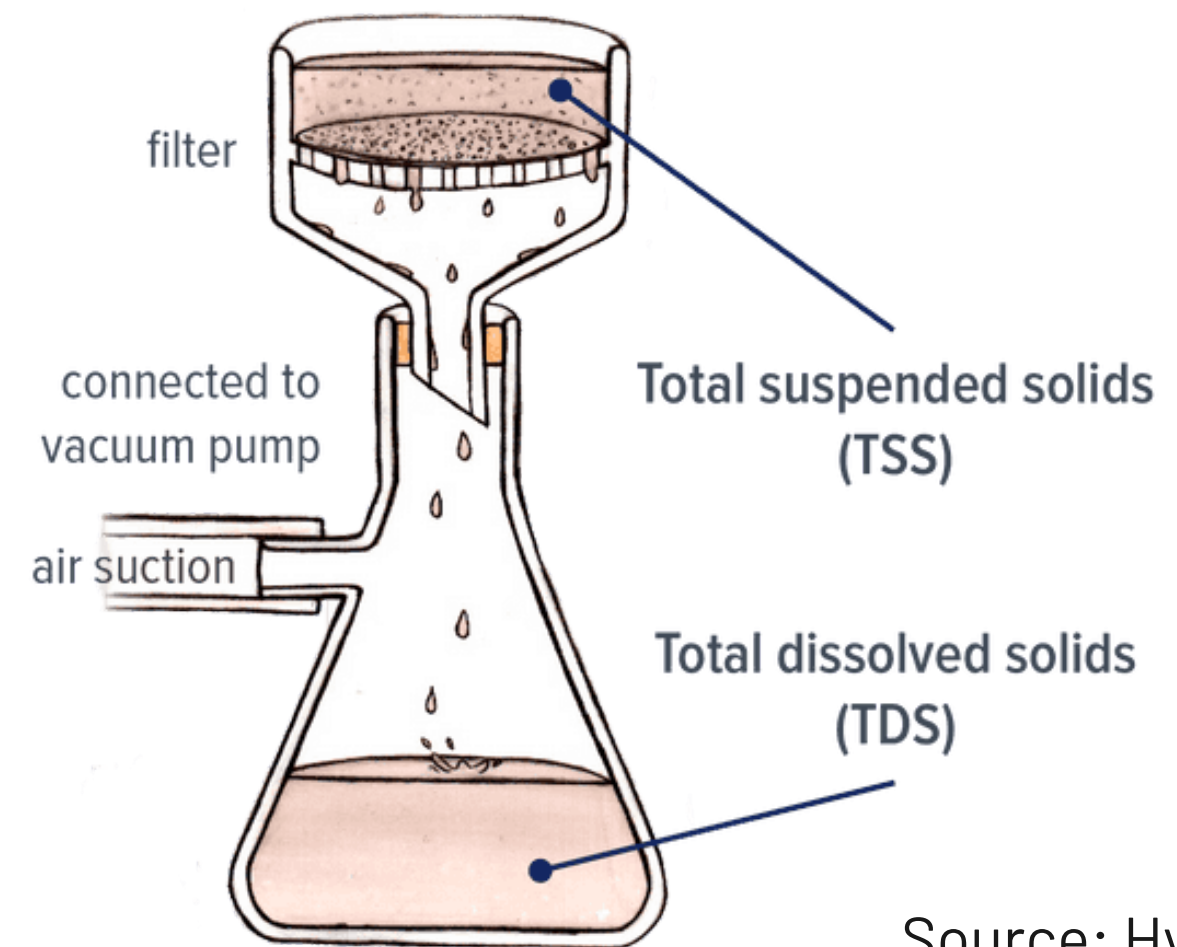
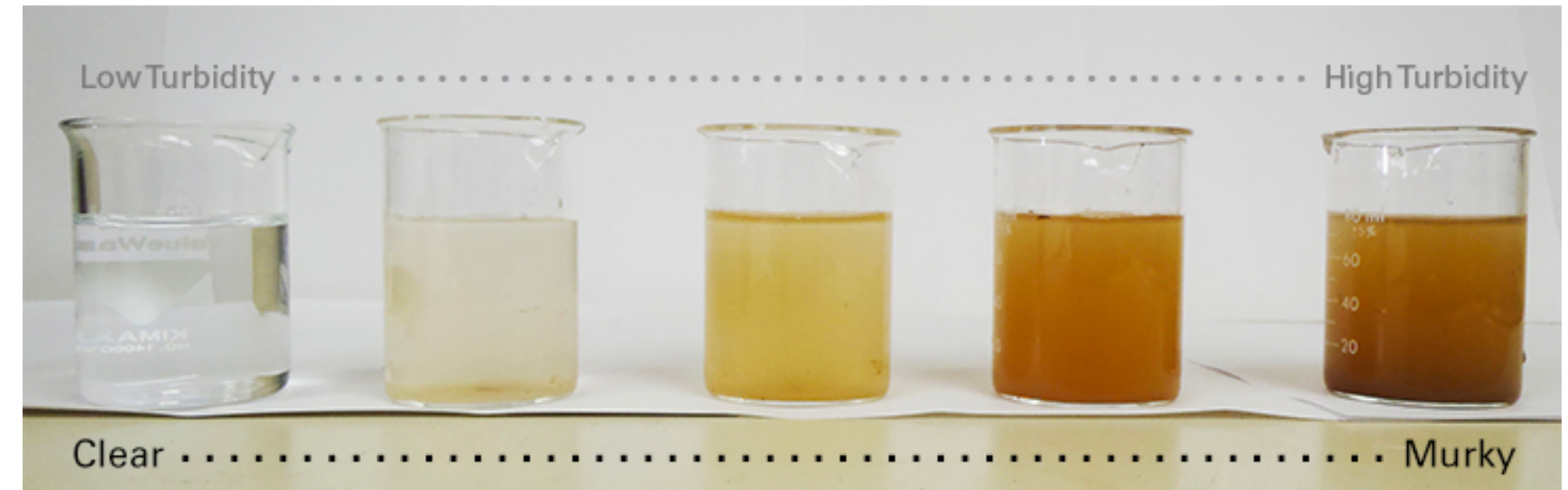
TURBIDITY, TSS AND WATER COLOR

What is Groundwater?



Adapted from WestLab

*Humic acid: yellow to brown/black color--naturally occurring organic substance from soil, decaying plants and found in freshwater



Source: Hyperfiltration