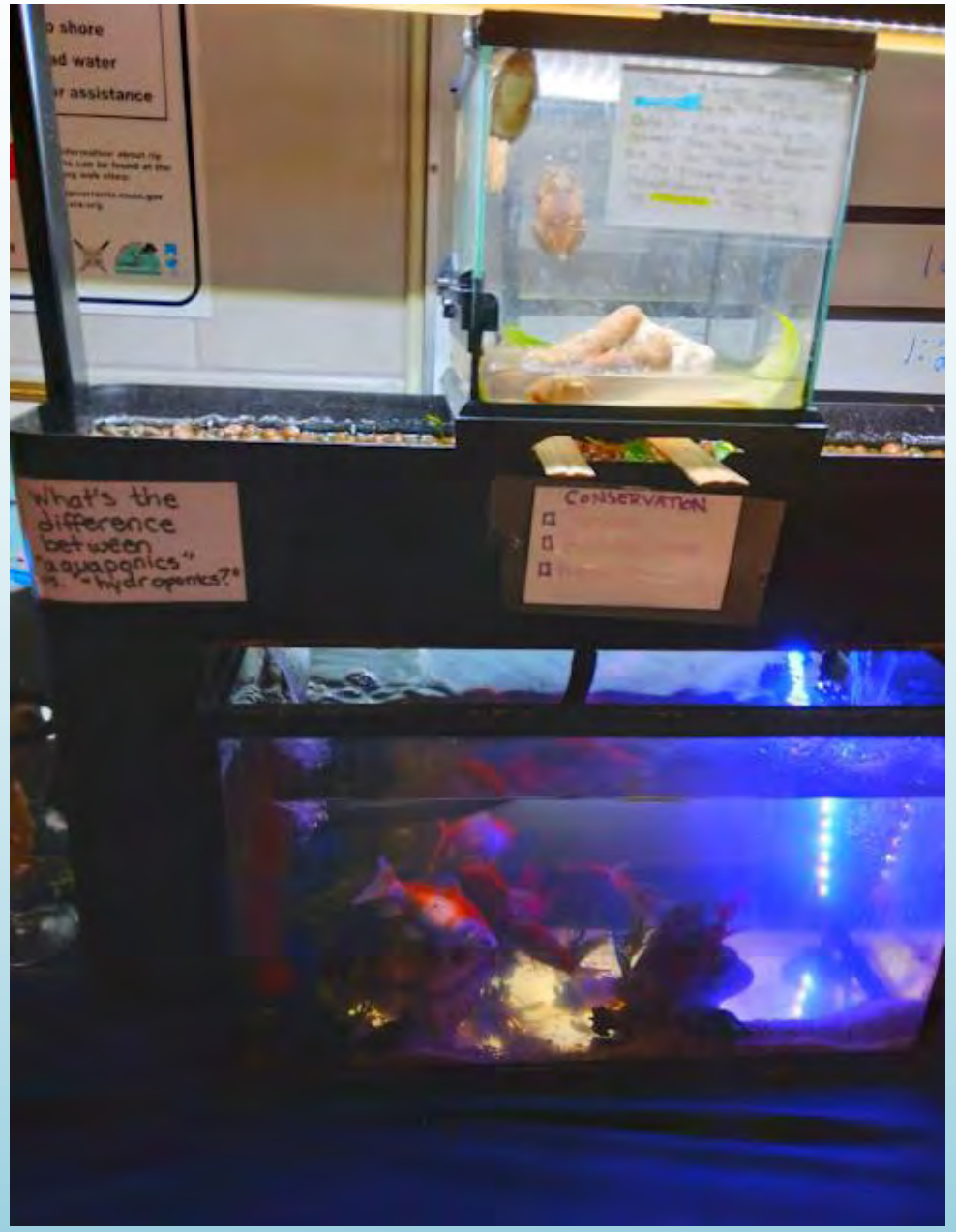
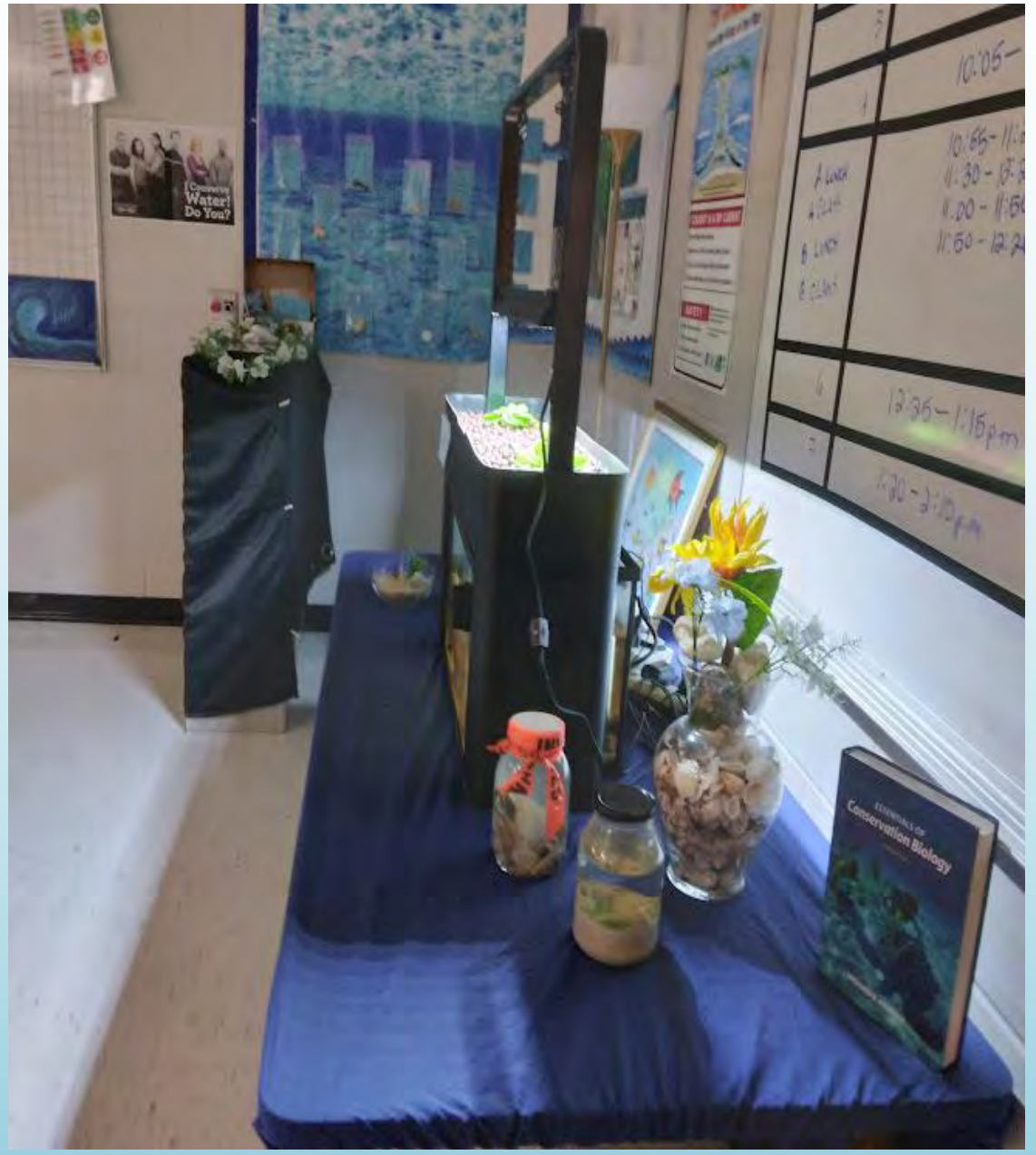
Water Conservation in the Science Classroom

MRS. KINGDOM


shore
water
assistance
What's the difference between "aquaponics" vs. "hydroponics?"
CONSERVATION


Conserving Water! Do You?
Conservation Biology

Water Conservation

- As described in “Water Matters,” conservation of water means “to use it wisely and to not be wasteful.”
- Water conservation is important for today and in the future.
- “More than 90% of our freshwater supply is found in aquifers.” (*Tampa Bay Times and the Southwest Florida Water Management District, 2022*)
  - Aquifers hold water because of their spongy layer.
- As the population increases, more people have to share water.

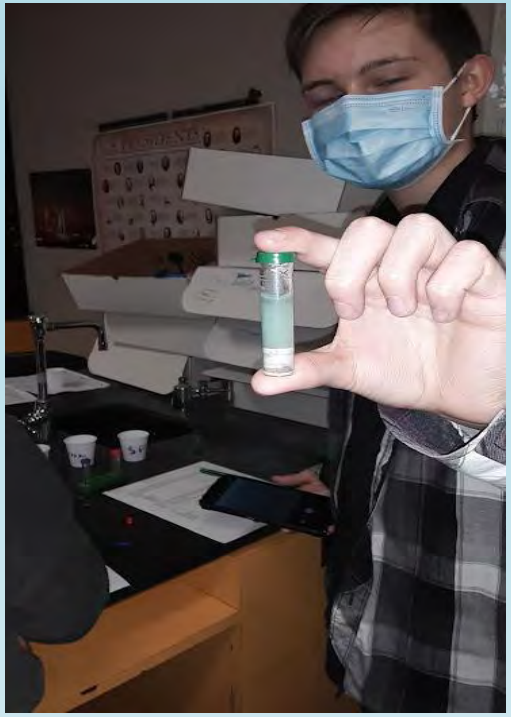
Why is Fresh Water in Short Supply?

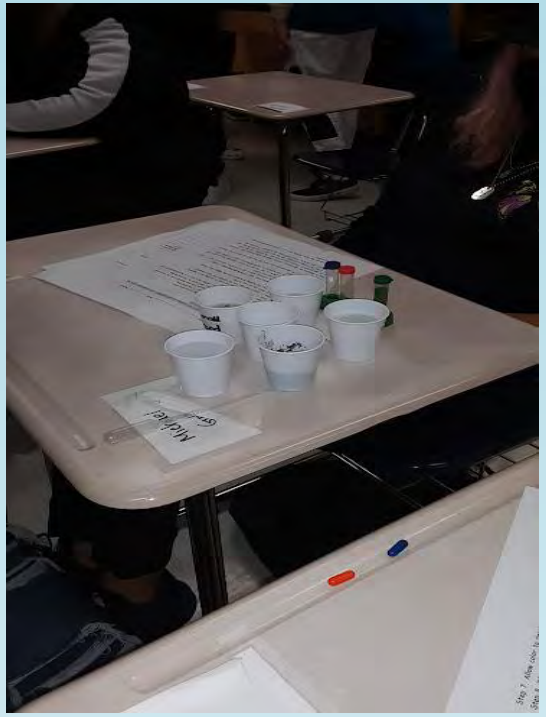
- By extracting water faster than nature can replace it and by wasting, polluting, and underpricing this natural resource, we are using available fresh water unsustainably.
- Fresh water is not evenly distributed over Earth's surface—estimates show that one in nine people do not have access to clean, fresh water.

Let's Accelerate

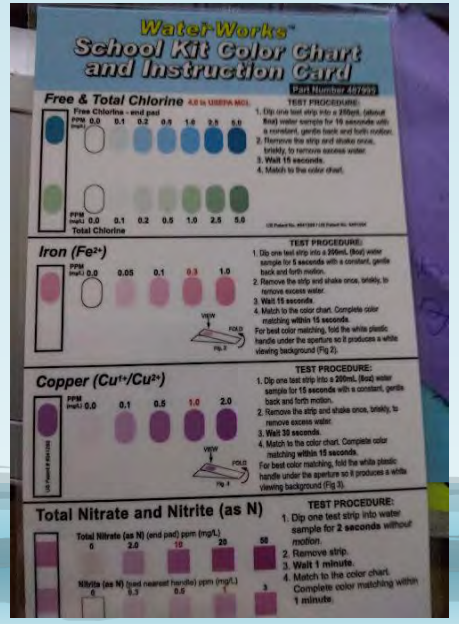
- Water Quality Lab (Field and Science Lab-Classroom) - Google Docs
- Water and Soil Quality Testing Lab - Google Docs

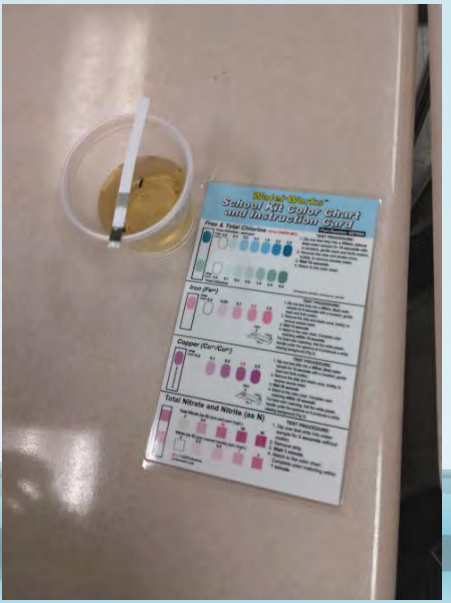
- These labs test water quality such as pH, nitrates, phosphates, potash, dissolved oxygen, turbidity, etc.
- These labs are inquiry-based labs in which students are able to work individually or in small groups.



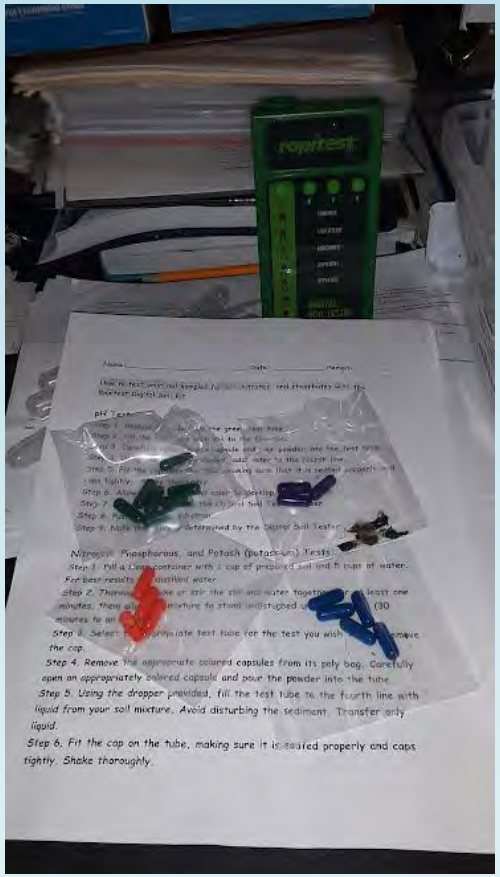


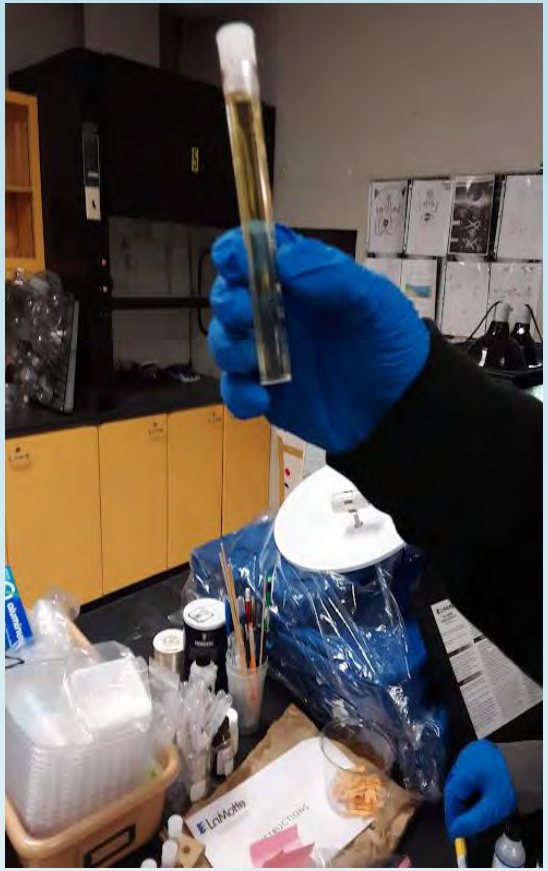

Student
Hydroponics Kit
INSTRUCTION MANUAL

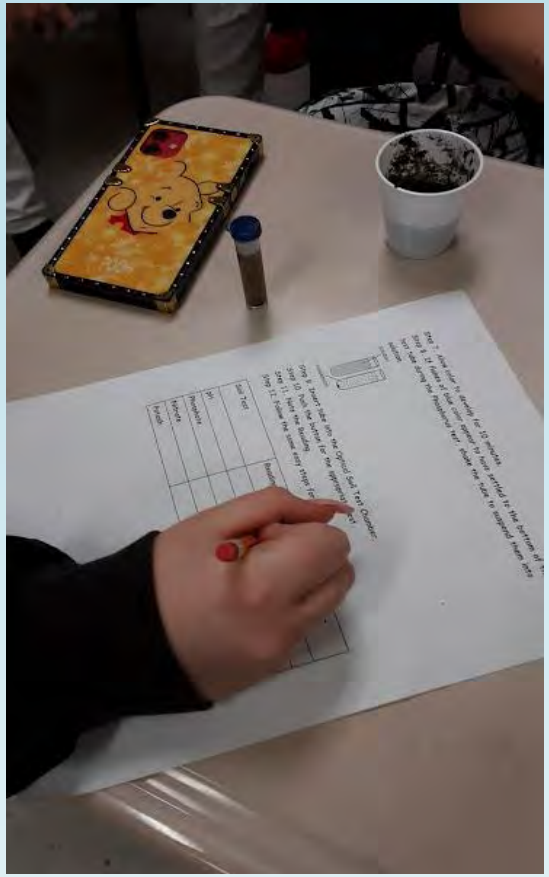

Water-Works
School Kit Color Chart
and Instruction Card
Free & Total Chlorine
Iron (Fe²⁺)
Copper (Cu¹⁺/Cu²⁺)
Total Nitrate and Nitrite (as N)

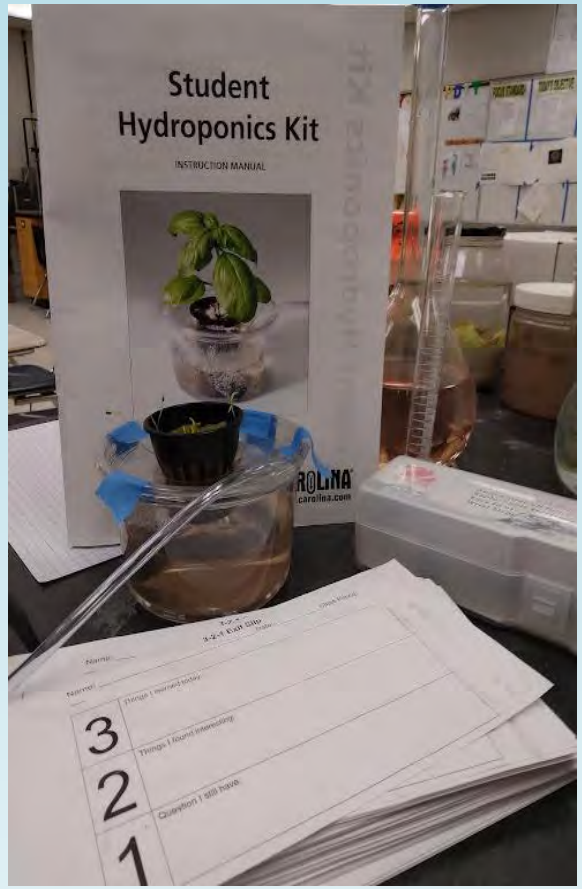


Data Collection and Analysis

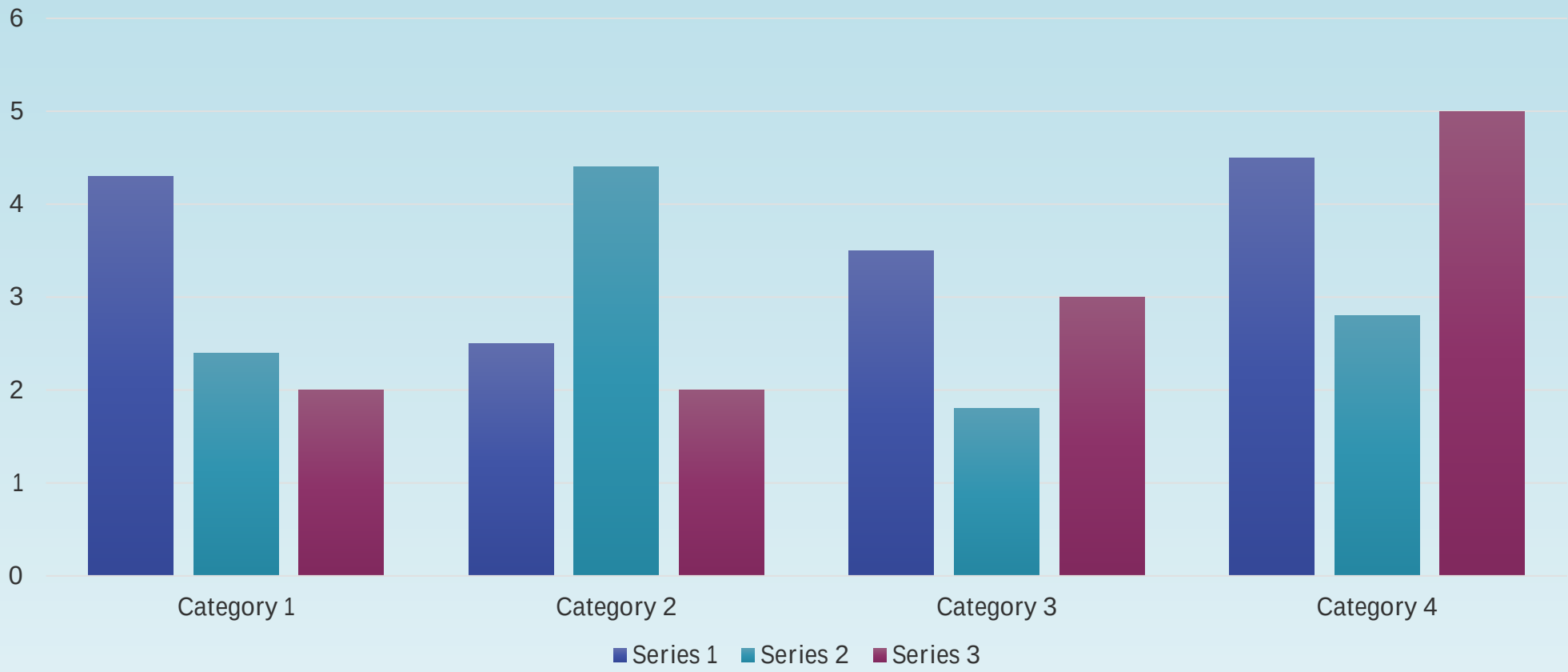








Group Data Chats



Water Footprint Calculator Activity

Name: _____ **Per:** ____

Water Footprint Calculator:

WATER USE: (added to final total)

1. How many people are in your household? = _____
2. In which state do you live? _____ (18 for KY, LA, ND, WY, WV; 6 for all others) = _____
3. How much water is used to generate electricity? (multiply #1 x #2) = _____

Domestic ("household") Water Use:

Use:	How Many:	Multiply by:	Subtotal:
Baths	(per week)	X 5	a.
Showers	(minutes)	X 3 (gallons/minute) X number of people: #1	b.
Toilets	(people - see #1)	X 12 (gallons/day/person)	c.
Sinks	(minutes)	X 3 (gallons/minute) X number of people: #1	d.
Laundry	(loads/week)	X 4	e.
Dishes	(loads/day)	X 10 (gallons/load)	f.

4. **Total for Domestic Water Use (add a through f) =** _____
5. How many times each week do you water your lawn and garden? _____ x171 gal/day =_____
6. Do you have a pool? If yes, add 52 points. Do you cover it? If no, add 16 points = _____

Automobile:

Use:	How Many:	Multiply by:	Subtotal:
Gas	(cars)	X 5	a.
Car Washing	(cars)	X 21	b.

7. **Total for Automobile (add a and b) =** _____

Daily Water Use at Home

Complete this survey to estimate how much water is used in your home daily.

Average Use: Write the number of times you and your family members do each activity in one day. Then multiply the number for **Water Used** by the **Number of Times** the activity is done. This will give you the number for the **Gallons Used** column.

Calculated Use: Record the number of total minutes used for each activity. Then multiply the number for **Water Used** by the number of **Total Minutes** to find the number for the **Gallons Used** column. For an activity you didn't do, place a 0 under **Gallons Used**. Add all the numbers under **Gallons Used** to find the **Total Gallons Used**.

AVERAGE USE			
Activity	**Water Used**	**Number of Times**	**Gallons Used**
Dishwasher	12 gallons per load		
Toilet Flushing	4 gallons per flush		
Bathing	45 gallons (full tub)		
Laundry	43 gallons per load		
CALCULATED USE			

Daily Water Use at Home Survey

daily_water_use_2012 (state.fl.us)

Extension Activity with Southwest Florida Water Management District

- Take the Classroom Challenge | WaterMatters.org (state.fl.us)
  - Calculate how much water they are using at home and share with the rest of the class your data.
  - The objective is to conserve water by using water-saving appliances, using a broom instead of the hose outside on our porches and driveways, shutting off the water while we brush our teeth, running a full load of laundry, using rain barrels in our gardens, taking shorter showers, and doing more research on water conservation throughout this month and reporting back to Mrs. Kingdom on how you conserved water in your home and outside your home (This may consist of our surrounding community.)

"The Case of the Mysterious Renters"

- Students read a case about renters and decide whether or not there are more than 4 people staying in Apartment 319. They must draw conclusions based on calculations and other data they collect from reading the article (either alone or with a partner).
- They must record facts, form a hypothesis, fill out a water survey, and draw a valid conclusion.
- Then, students can compare with others in the class during a think-pair-share.

The Case of the Mysterious Renters: Magnificient Ground Water Connection (epa.gov)

Water Footprint Calculator Activity

Diet:

Use:	How Many:	Multiply by:	Subtotal:
Meat Eating	(vegans)	X 446	a.
	(vegetarians)	X 516	b.
	(meat eaters)	X 1032	c.
Bottled Water	(people - see #1)	X 1.5	d.

8. **Total for Diet (add a through d) = _____**

WATER SAVINGS: subtracted from final total

9. Recycling

a. Paper: multiply #1 x 5 (gallons/day/person) = _____

b. Plastic: multiply #1 x 3 (gallons/day/person) = _____

c. Clothing: multiply #1 x 5 (gallons/day/person) = _____

10. Graywater and Rainwater

a. Does your household reuse greywater? If yes, multiply #1 x 40 = _____

b. Does your household collect rainwater? If yes, add 9. If no, add zero = _____

TOTAL HOUSEHOLD WATER FOOTPRINT: (Add 3 – 8, Subtract 9 and10) =

TOTAL INDIVIDUAL WATER FOOTPRINT: (Divide above result by #1) =

WHAT DOES YOUR SCORE MEAN? The score for the average American is 1,190.

✔ **900 & below: Water Warrior**: Congratulations, you are doing better than most Americans! Give yourself a pat on the back for being water conscious. You have a thing or two to teach your neighbors, but there may still be ways to cut back on your water use.

✔ **901-1,300: Water Activist**: Not too shabby! Your water consumption is typical of most Americans. But as we know, Americans are among the highest water users worldwide. The good news is, there are many ways to use less water and decrease your footprint.

✔ **1,301 & above: Water Enthusiast:** Time for a water-use makeover! Your household is a thirsty one, even by American standards. Now is a great time to think of ways to reduce your water usage.

Once you have completed the water footprint calculator for your family, answer these questions:

1. What category has the largest number of points in your water footprint and why?

_____

_____

_____

_____

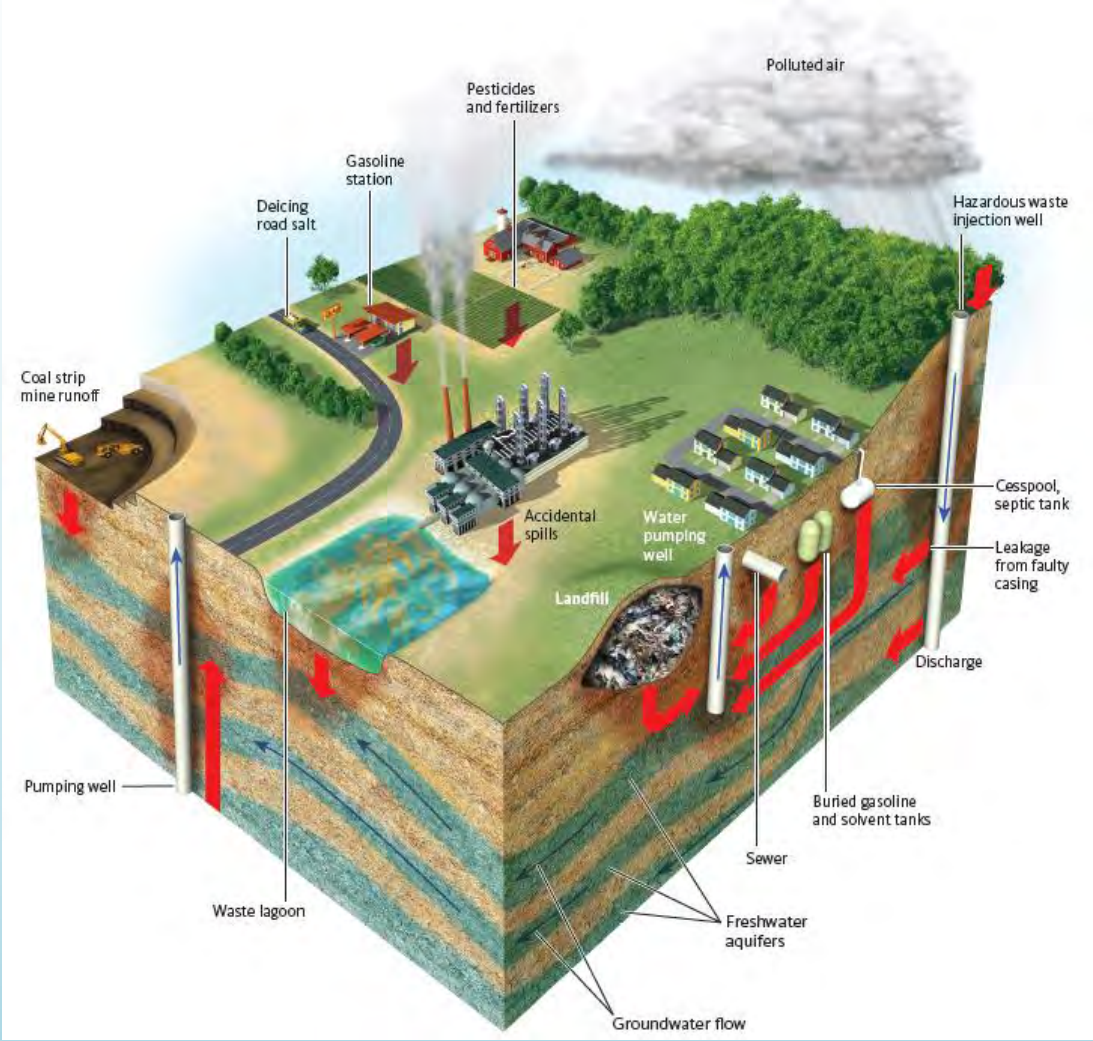
2. Change the numbers in three different categories. How does the water footprint change? Which category can make the biggest difference?

_____

_____

3. What can you do in your everyday life to reduce your water footprint?

Sources of Water→ Pollution



Microorganisms in Water

- There are bacterial diseases that are transmitted through water—cholera, typhoid fever and bacillary dysentery.
- “Microbial waterborne diseases also affect developed countries. In the USA, it has been estimated that each year 560,000 people suffer from severe waterborne diseases, and 7.1 million suffer from a mild to moderate infections, resulting in estimated 12,000 deaths a year.” (Water Microbiology. Bacterial Pathogens and Water - PMC (nih.gov))

Water Microbiology. Bacterial Pathogens and Water - PMC (nih.gov)

Table 1.

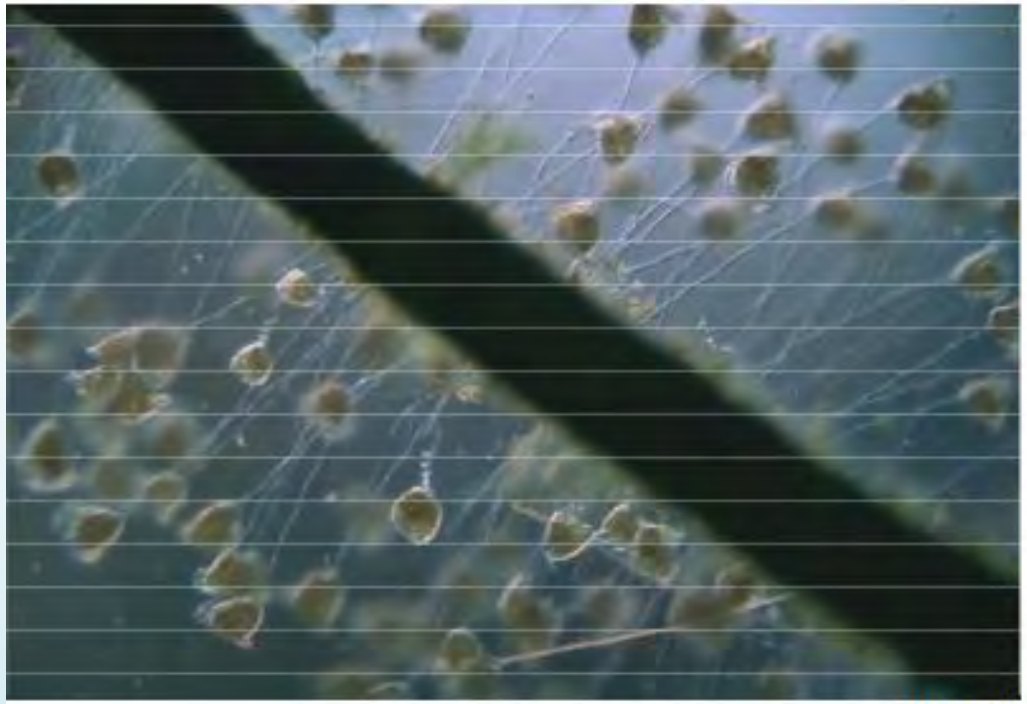
The main bacterial diseases transmitted through drinking water.

Disease	Causal bacterial agent
Cholera	*Vibrio cholerae*, serovarieties O1 and O139
Gastroenteritis caused by vibrios	Mainly *Vibrio parahaemolyticus*
Typhoid fever and other serious salmonellosis	*Salmonella enterica* subsp. *enterica* serovar Paratyphi
	Salmonella enterica subsp. *enterica* serovar Typhi
	Salmonella enterica subsp. *enterica* serovar Typhimurium
Bacillary dysentery or shigellosis	*Shigella dysenteriae*
	Shigella flexneri
	Shigella boydii
	Shigella sonnei
Acute diarrheas and gastroenteritis	*Escherichia coli*, particularly serotypes such as O148, O157 and O124

Water Microbiology. Bacterial Pathogens and Water - PMC (nih.gov)

Let’s Accelerate (Part 1)

- Using a microscope to understand what is in a "Pond Mystery Mix" that is provided by Carolina Biological. This activity allows students to see microorganisms that live in freshwater pools that face several challenges (pollution, runoff, not enough oxygen, etc.)
- "Pools (vernal pools) are often seasonal, filling with spring showers and dry in the summer. Winter temperatures may drop too low to support the metabolism of the organisms that live in some of the pools." (Carolina Biological Supply, 2010)
- Bacteria live in vernal pools. The first is Vorticella, a cell on a spring, then Paramecium. Both are bacteria feeders, which start the vernal pool food chain by breaking down last year's detritus. The increase in bacteria allows more protozoans to feed and multiply. Bacterial decomposition (bacterial biodegradation) depletes dissolved oxygen; eliminates populations of high-oxygen using organisms
- Students will be given higher-order questioning pertaining to behavior of organisms, interdependence of organisms, and cellular response to the environment.



Vorticella

TID6414.pdf (dcmp.org)

Paramecia

TID6414.pdf (dcmp.org)

Biotic Indicators of Water Quality

- There are three types of biotic indicators
  - Very sensitive to pollution and turbidity
  - Somewhat sensitive to pollution and turbidity
  - Tolerant of pollution and turbidity
- Organisms very sensitive to turbidity (sometimes known as E.P.T.)
  - Ephemeroptera (mayfly Nymphs)
  - Plecoptera (Stonefly Nymphs)
  - Trichoptera (Caddisfly Larvae)

Rotifers

“Vernal pools are a rotifer stronghold. Dozens of different rotifer species live in most vernal pools. Some rotifers attach to objects in the water and bring in food by creating powerful currents using their ciliated wheel organs. Others swim through the open water taking in microalgae, bacteria and protozoans. Some are asexual, producing eggs that hatch into another generation of female rotifers. Others mate and produce resistant eggs that can withstand long periods of drying, an essential adaptation for living in vernal pools. Many rotifers survive short periods of drying by going into a state of abiosis. They lose their water and lay dormant until a rain brings life back to the desiccated rotifer.” (TID6414.pdf (dcmp.org))

Algae

- The name Algae covers a diverse assortment of single-celled organisms that photosynthesize.
- In the evolution of algae, golden yellow diatoms and green algae are as far apart on the evolutionary tree as plants are from animals.
- “Vernal pool microalgae are an important early food source for emerging crustaceans and others. As the pool fills, algae hatch from cysts produced when the pool dried in the previous season. Later, algae feed insect larvae and other organisms as the pool dries.” (TID6414.pdf (dcmp.org))

BIOTIC INDICATORS OF WATER QUALITY

VERY SENSITIVE
to pollution and turbidity.

The abundance and diversity of these three taxonomic orders are used as a primary indicator of good water quality.

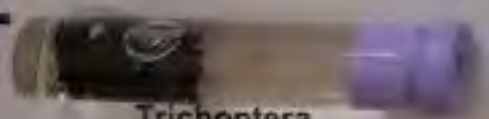
It is often referred to as the **"E.P.T. Index"**.

E

Ephemeroptera
Mayfly Nymphs

P

Plecoptera
Stonefly Nymphs



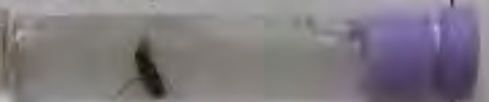
T

Trichoptera
Caddisfly Larvae

SOMEWHAT SENSITIVE
to pollution and turbidity.

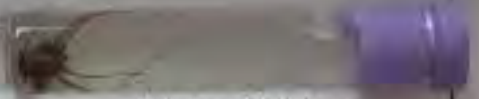
These organisms are found in most healthy water systems and are tolerant of moderate levels of pollution and turbidity.

Dragonfly Nymphs



Backswimmers

Water Scavenger Beetles



Water Striders

Clams & Mussels

Grass Shrimp

Crayfish

TOLERANT
of pollution and turbidity.

These organisms can be found in most water systems including stagnant water. They are the most tolerant of higher levels of pollution and turbidity.

Lunged Snails

Glassworms (Phantom Gnat Larvae)

Mosquito Larvae & Pupae

Leeches

1. *"California's Vernal Pools". wildlife.ca.gov. Retrieved 2020-06-08.*

Lake and Reservoir Pollution

- Lakes and reservoirs have lower flow rates and are less effective at self-cleansing, as they typically have stratified layers.
- Near urban and agricultural areas, chemical runoff causes nutrient enrichment of lakes and the mouths of rivers (cultural eutrophication).
- Nutrient overload produces algal/bacteria overgrowth, which depletes dissolved oxygen and kills off fish and marine organisms in bottom waters (dead zones).

Let’s Accelerate (Part 2)

Explore the "Lake Carson Crisis Interdisciplinary Kit" from Carolina Biological.

This kit allows "students to jump into the role of environmental forensic investigators as they attempt to solve the issues plaguing Lake Carson. An algal bloom has taken over the lake and threatens to shut down the town unless someone can find the contaminant's source. Students become hands-on—investigating topics such as conductivity, water flow modeling, water testing, algae identification, and macro-invertebrates. Students get to help build a compelling case and save this town before it's too late!"

Nutrient Pollution and Harmful Algal Blooms

- “Harmful algal blooms, or HABs, occur when colonies of algae — simple plants that live in the sea and freshwater — grow out of control and produce toxic or harmful effects on people, fish, shellfish, marine mammals and birds. The human illnesses caused by HABs, though rare, can be debilitating or even fatal.” (What is a harmful algal bloom? | National Oceanic and Atmospheric Administration (noaa.gov))
- What is Nutrient Pollution? Nutrient pollution is the process where too many nutrients, mainly nitrogen and phosphorus, are added to bodies of water and can act like fertilizer, causing excessive growth of algae.

Sustainable Ways to Reduce and Prevent Water Pollution

- Find substitutes for toxic pollutants.
- Remove hazardous waste before it reaches sewage treatment facilities.
- Use natural sewage treatment methods.
- Reduce nonpoint sources of runoff.
- Slow population growth and reduce poverty.
- Eliminate air pollution.
- Encourage recycling and reuse of resources

Many people treat the oceans as a dumping site.

- 80% of marine pollution originates on land.
- 80–90% of municipal sewage from the coastal areas of less-developed countries is dumped into the oceans without any treatment.
- It *may* be safer to dump wastes and degradable pollutants into the deep ocean, where it can be diluted, dispersed, and degraded.

Contaminants in the Ocean

- Viruses in raw sewage and from sewage treatment plants
- Toxic chemicals, garbage, sewage, and waste oil from cruise ships
- Nitrates/phosphates and sewage from agricultural waste
- Crude and refined petroleum
  - Biomagnified into sea birds
- Urban and industrial runoff

The Great Ocean Cleanup

- The Ocean Cleanup begins cleaning the Great Pacific Garbage Patch – YouTube
- Transition to System 03: Our Blueprint for Scale-Up | Cleaning Oceans | The Ocean Cleanup – YouTube
- Boyan Slat unveils the Interceptor River Cleanup system | Cleaning Rivers | The Ocean Cleanup - YouTube
- How The Ocean Cleanup Mapped the World's Rivers | Research | The Ocean Cleanup – YouTube
- Interceptor 007 Faces the First Rain Event in LA (& stops 35,000 lbs of waste) | The Ocean Cleanup - YouTube

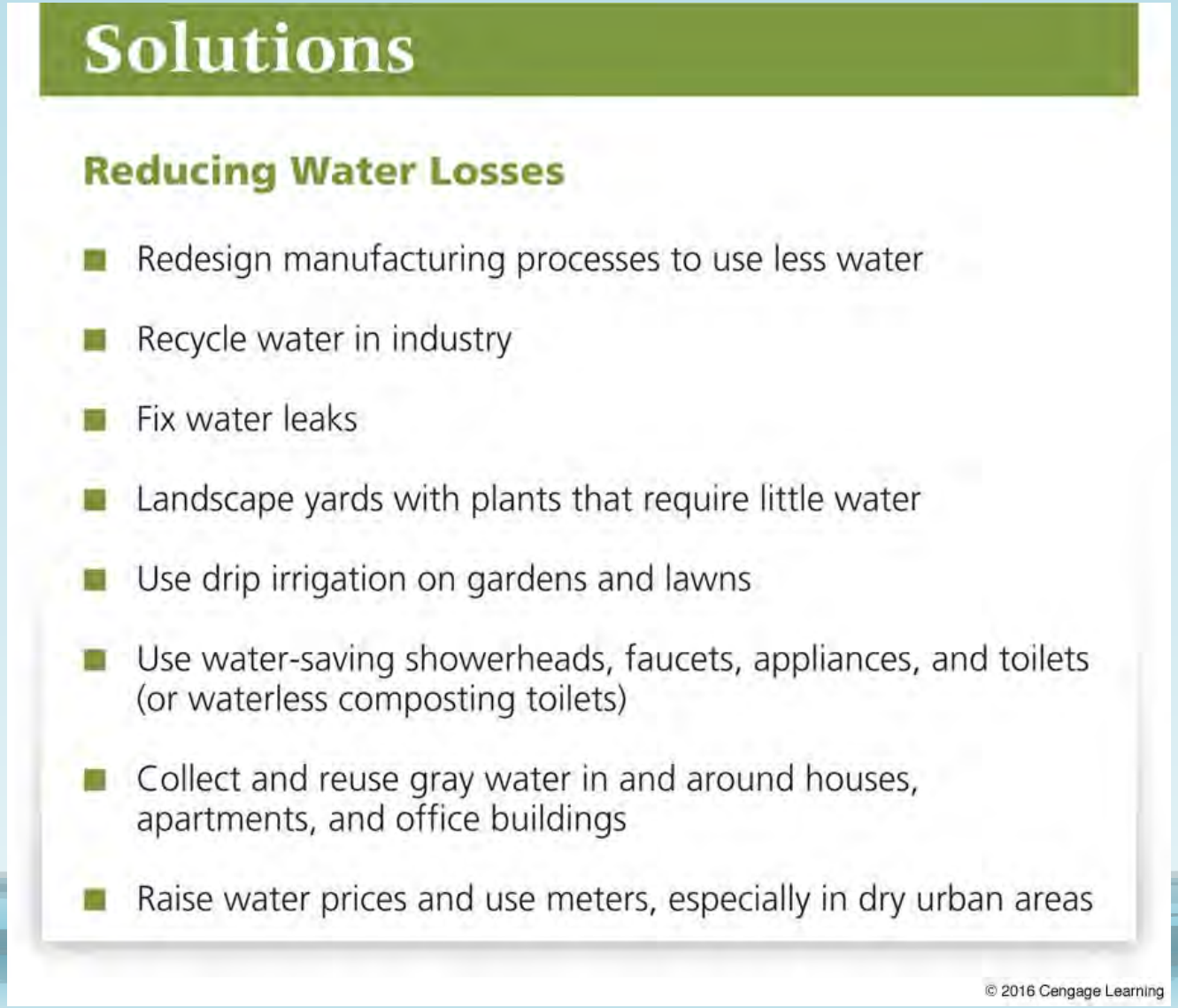
Boyan Slat • Founder and CEO of The Ocean Cleanup

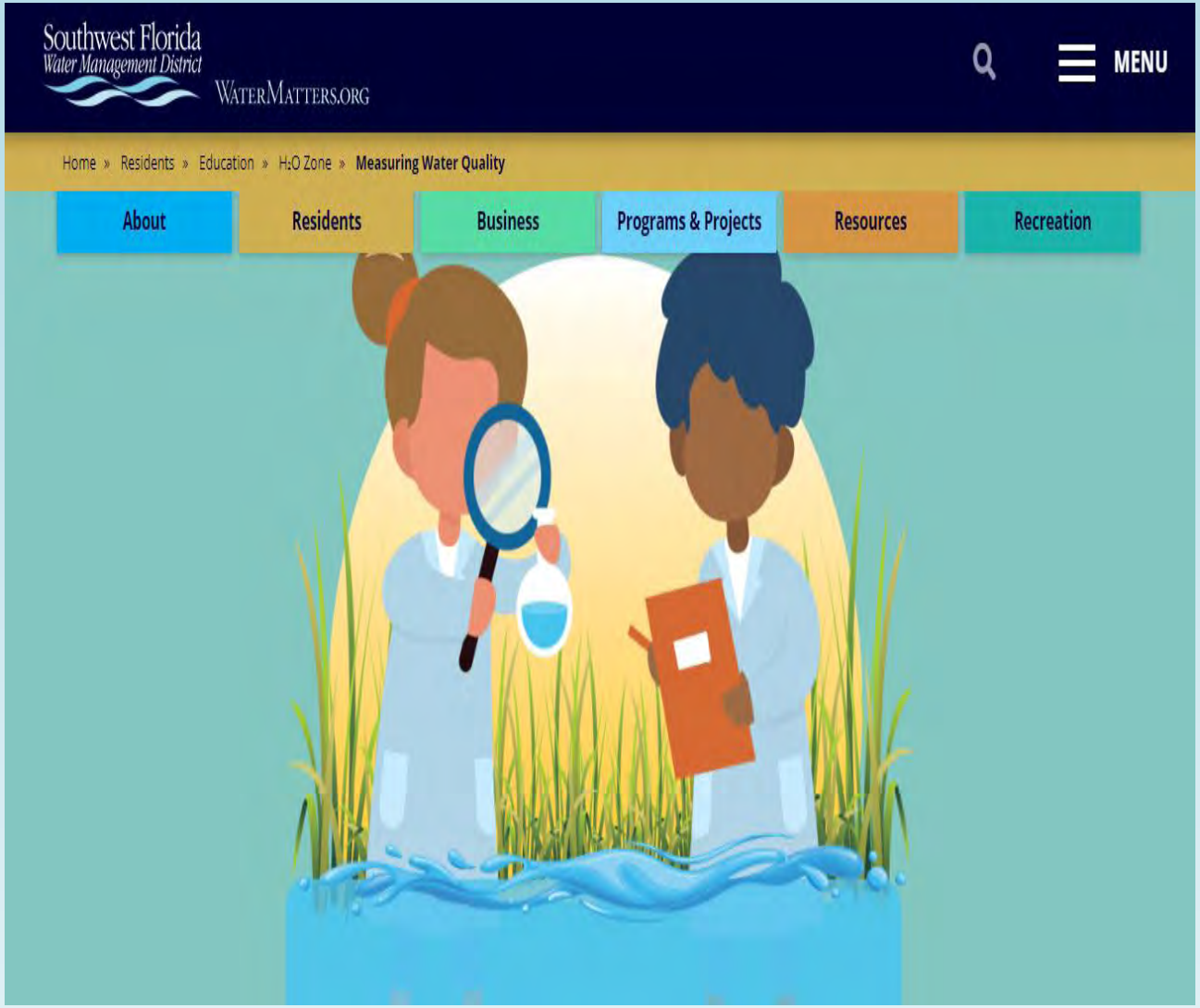
Clean Water Act of 1972

- The principle law governing pollution control and water quality of the Nation's waterways
- In 1969 Ohio's Cuyahoga River was so fouled by industrial pollution that the river caught on fire. Public outcry over dirty rivers spurred Congress to pass the landmark Clean Water Act in 1972.

How the Clean Water Act Protects Your Rivers – American Rivers

Ways to Reduce Freshwater Losses in Industries





Solutions

Groundwater Pollution

Prevention

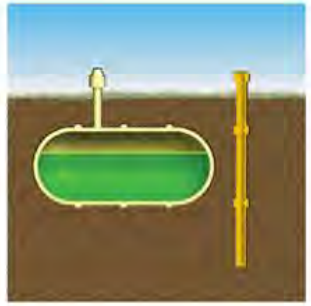
Find substitutes for toxic chemicals

Keep toxic chemicals out of the environment

Require leak detectors on underground tanks

Ban hazardous waste disposal in landfills and injection wells

Store harmful liquids in aboveground tanks with leak detection and collection systems



Cleanup

Pump to surface, clean, and return to aquifer (very expensive)

Inject microorganisms to clean up contamination (less expensive but still costly)

Pump nanoparticles of inorganic compounds to remove pollutants (still being developed)

Reduce, Reuse, Recycle

What Can We Do on Our End?

By reducing waste, raising prices, slowing population growth, and protecting ecosystems that store water naturally, we can use available fresh water more sustainably.

What Can You Do?

Water Use and Waste

- Use water-saving toilets, showerheads, and faucets
- Take short showers instead of baths
- Turn off sink faucets while brushing teeth, shaving, or washing
- Wash only full loads of clothes or use the lowest possible water-level setting for smaller loads
- Repair water leaks
- Wash your car from a bucket of soapy water, use gray water, and use the hose for rinsing only
- If you use a commercial car wash, try to find one that recycles its water
- Replace your lawn with native plants that need little if any watering
- Water lawns and gardens only in the early morning or evening and use gray water
- Use drip irrigation and mulch for gardens and flowerbeds

How to Conserve Water At Home

- “Take shorter showers = 4 gallons per minute.,
- Remind an adult about a leaky faucet or toilet = 5 to 200 gallons per day.,
- Use a broom instead of a water hose to clean the driveway and sidewalks = 9 gallons per minute.,
- Remind an adult to adjust sprinklers so they water only lawn and plant areas — not driveways, sidewalks and streets.,
- Remind an adult to install water-saving sprinklers and a rain sensor to override the sprinkler system when it rains.,
- Encourage family, friends and neighbors to conserve water., Run the dishwasher only when it is full = 12 gallons per load.,
- When taking a bath, close the drain before turning on the water and fill the tub only half way = 22.5 gallons vs. 45 gallons (full tub).,
- Throw tissues, bugs and other trash in the wastebasket, not the toilet = 4 gallons per flush.,
- Turn off the faucet while washing hands or face = 4 gallons per minute.,
- Turn off the faucet while brushing teeth = 4 gallons per minute.,
- Wait until there is a full basket of laundry before running the washing machine = 43 gallons per load.”

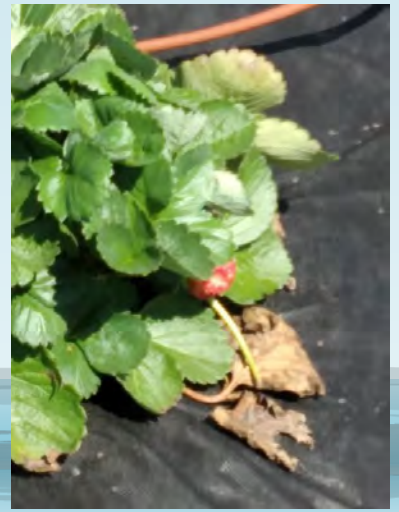
-Water Matters (S.W.F.W.M.D.)

Take the Classroom Challenge | WaterMatters.org (state.fl.us)

Our Greenhouse and Garden Restoration Project

- Drip Irrigation
- Rain Barrels
- Aquaponics (inside/outside the classroom)
- Hydroponics (inside/outside the classroom)




Credits

https://www.americanrivers.org/

Carolina Biological Company

(Educational Online Resources)

Southwest Florida Water

Management District

Tampa Bay Times