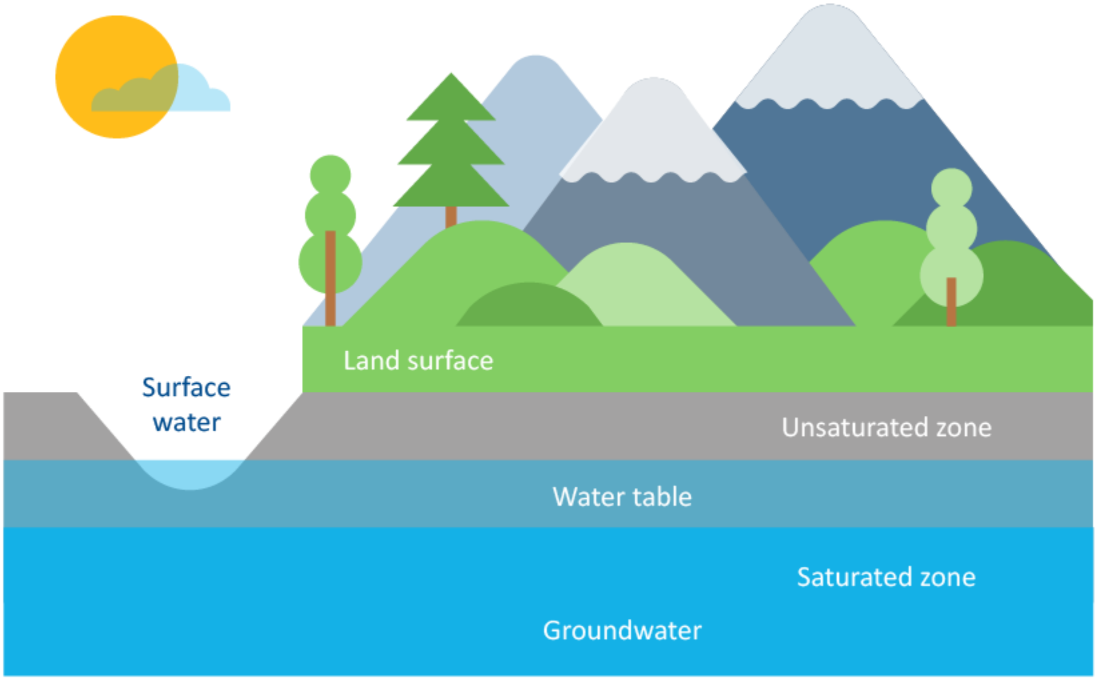
Americans drink more than 1 billion (https://www.epa.gov/sites/production/files/2014-09/documents/one-billion-glasses-of-water.pdf) glasses of drinking water per day. We take the colorless, odorless liquid for granted, but it's a remarkable substance. It composes 60 percent (https://www.usgs.gov/special-topic/water-science-school/science/water-you-water-and-human-body?qt-science_center_objects=0#qt-science_center_objects) of our bodies and it makes the basic molecules of life, including DNA, cell membranes, and proteins, work.

More than 780 million people (https://www.cdc.gov/healthywater/global/wash_statistics.html) around the world lack access to clean drinking water. And clean water is a relatively recent (http://exhibits.hsl.virginia.edu/hands/victorian/) luxury in North America. In 1908, Jersey City, NJ was the first city to disinfect their drinking water (https://www.cdc.gov/healthywater/drinking/history.html). Thousands of cities followed Jersey City's lead during the next decade, and the occurrence of waterborne diseases such as cholera and typhoid fever decreased dramatically in the U.S.

Today, the majority of Americans have disinfected drinking water delivered to their homes and businesses. But do you know how that water makes its way to your faucet so you can make your morning coffee? Keep reading to find out how water travels from source to tap.



Surface water

- Supplies 64% of public water systems
- Comes from rain and snow
- Accumulates in rivers, streams, and lakes
- Piped and pumped to water treatment centers

Groundwater

- Supplies 36% of public water systems
- Comes from rain and snow
- Seeps into the ground and is then stored in natural aquifers
- Must be accessed at a natural spring or pumped out of the ground with a well

sources: chargerwater.com dep.pa.gov epa.gov

From Source to Tap

The majority (https://www.usgs.gov/special-topic/water-science-school/science/surface-water-use-united-states?qt-science_center_objects=0#qt-science_center_objects) of our freshwater supply comes from surface water (https://www.americanrivers.org/rivers/discover-your-river/drinking-water/), which comes from rain and snow that runs off into rivers, streams, and lakes. Those water sources aren't always nearby. Roughly 90 percent (https://www.nytimes.com/interactive/2016/03/24/nyregion/how-nyc-gets-its-water-new-york-101.html) of New York city's water comes from the Catskill/Delaware watershed, which extends 125 miles northwest of the city. Chicago's water travels more than 100 miles from Lake Michigan. Atlanta's water travels a couple hundred miles upstream from the Chattahoochee and Flint Rivers. And people in seven states stretching from Denver to Los Angeles rely on drinking water from the Colorado River.

The rest of our fresh water comes from groundwater (https://www.usgs.gov/special-topic/water-science-school/science/surface-water-use-united-states?qt-science_center_objects=0#qt-science_center_objects), which originates from rain and snow that seeps into the soil. It's stored in aquifers, natural formations of soil, rocks, and sand beneath the ground. Groundwater is accessed from natural springs or pumped out of the ground by way of a well and is mainly used as drinking and irrigation water. Where the majority of states are mainly supplied with fresh water from surface water sources, Miami (https://www.miamidade.gov/water/biscayne-aquifer.asp), Memphis (https://cooperyoung.org/4-things-to-know-about-the-memphis-aquifer/), and San Antonio (https://www.saws.org/Your_Water/aquifer/) draw most of their water from groundwater because these locations have aquifers.

Want to know where your municipal drinking water comes from? Check out the EPA's interactive drinking water map (https://www.epa.gov/sourcewaterprotection/drinking-water-mapping-application-protect-source-waters-dwmaps).

Water Treatment

Between 13 (https://www.epa.gov/privatewells) million and 15 million (https://www.cdc.gov/healthywater/drinking/private/wells/index.html) American households (10 to 12 percent) rely on private groundwater wells for drinking water—either by choice or because the town they live in does not have a municipal water source (which is often the case in rural settings). Because EPA regulations that safeguard public drinking water do not apply to wells, homeowners with private wells are responsible for testing their water (https://www.epa.gov/privatewells/protect-your-homes-water)for bacteria, nitrates, total dissolved solids, and pH levels. It's important to use certified laboratories (you can find a certified lab in your state here (https://www.epa.gov/dwlabcert/contact-information-certification-programs-and-certified-laboratories-drinking-water)); local health departments often provide private well testing free of charge. If a well water sample shows high levels of contaminants, well owners can contact their public health department for instructions to retest and confirm the concentration of said contaminants. Some treatments are fairly quick and easy—for instance, adding new or better filtration systems.

Everyone else gets their water from the nation's 150,000 public water systems (https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-your-drinking-water). Public water suppliers draw their water from both surface water and groundwater sources. This drinking water must undergo regular tests to verify it meets the U.S. Environmental Protection Agency's Safe Drinking Water Standards. The most common water treatment steps are as follows.

- Catchment

A series of pumps and pipes connect a water source to a treatment plant. Most treatment plants use gravity as much as possible to move the water.

- Screening

When the water reaches the treatment area, a large metal screen traps large debris, such as plants, trees, trash, and fish, to keep them out.

- Coagulation and Flocculation

Chemicals with a positive charge (called coagulants) are added to the water. Common coagulants (http://www.cosatx.us/home/showdocument?id=1010) include aluminum sulfate, ferrous sulfate, activated silica, and other chemicals. The coagulants bind with negatively charged dirt particles, and together they form larger gelatinous particles called floc.

- Sedimentation and Clarification

Floc is separated from the water and pumped to a sedimentation pond. Meanwhile, the water is sent on for further treatment.

- Ozonation

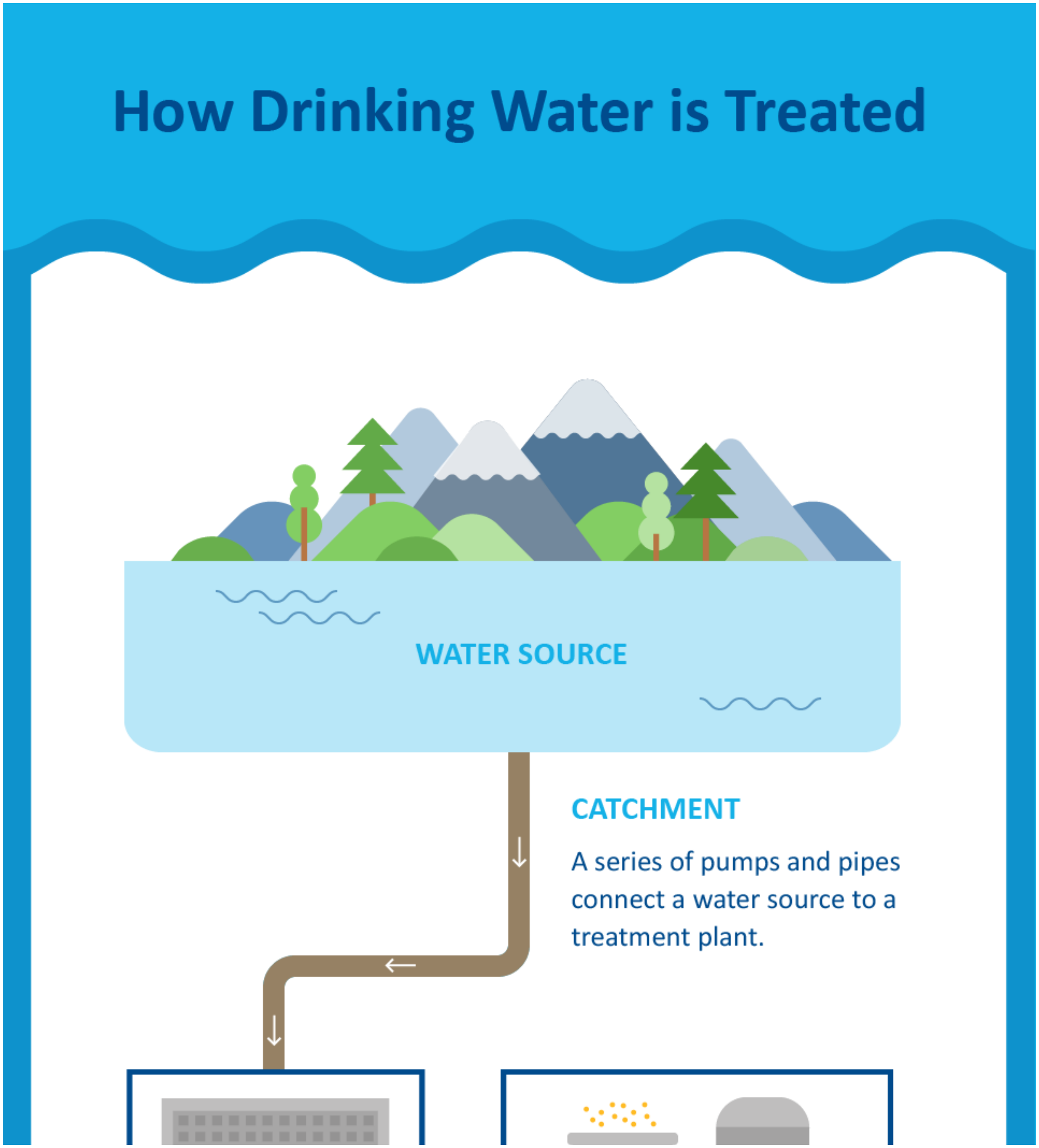
In some systems, ozone (https://www.water-research.net/index.php/ozonation) (a highly reactive colorless gas) is added to the water. Ozone consists of three molecules of oxygen bound together and is made by applying electricity to liquid oxygen. When it's pumped through water, it kills bacteria, viruses, and protozoans and reduces the concentration of iron, manganese, and sulfur. It also degrades pesticides (https://www.lenntech.com/library/ozone/drinking/ozone-applications-drinking-water.htm) and helps correct bad odors and tastes.

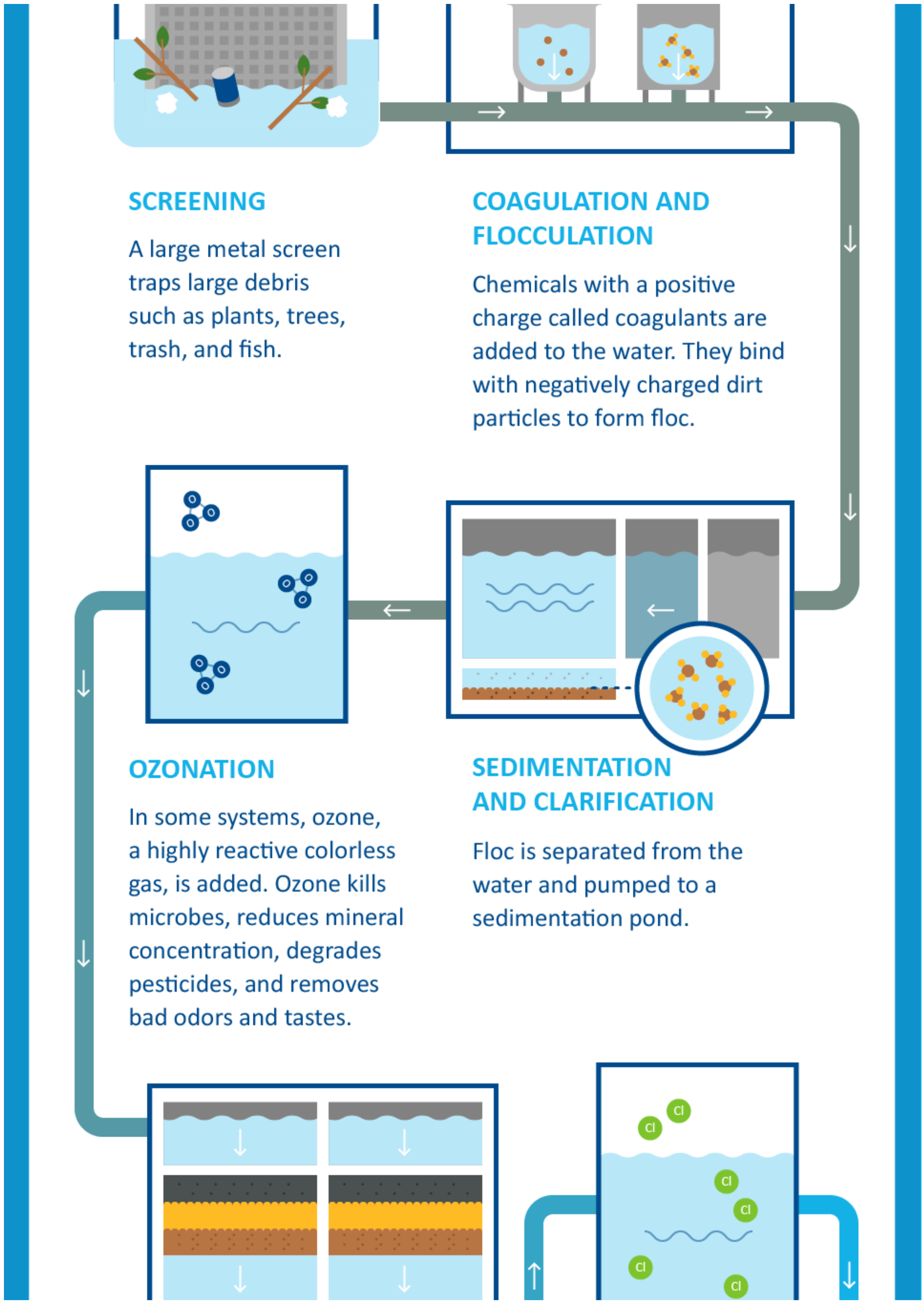
- Filtration

Next, gravity pulls water through filters, which are usually made from sand, gravel, granular activated charcoal, or another medium. The filters remove particles from the water.

- Disinfection

Chlorine gas, liquid bleach, or a chlorine compound (https://www.safewater.org/fact-sheets-1/2017/1/23/what-is-chlorination) is added to the water to kill or inactivate microorganisms. In more than 20 percent (https://www.wqa.org/Portals/0/Technical/Technical%20Fact%20Sheets/2014_Chloramine.pdf) of water treatment systems, ammonia is also added to form chloramine. Sometimes, fluoride is also added to the water for dental health.




SCREENING
A large metal screen traps large debris such as plants, trees, trash, and fish.
COAGULATION AND FLOCCULATION
Chemicals with a positive charge called coagulants are added to the water. They bind with negatively charged dirt particles to form floc.
OZONATION
In some systems, ozone, a highly reactive colorless gas, is added. Ozone kills microbes, reduces mineral concentration, degrades pesticides, and removes bad odors and tastes.
SEDIMENTATION AND CLARIFICATION
Floc is separated from the water and pumped to a sedimentation pond.
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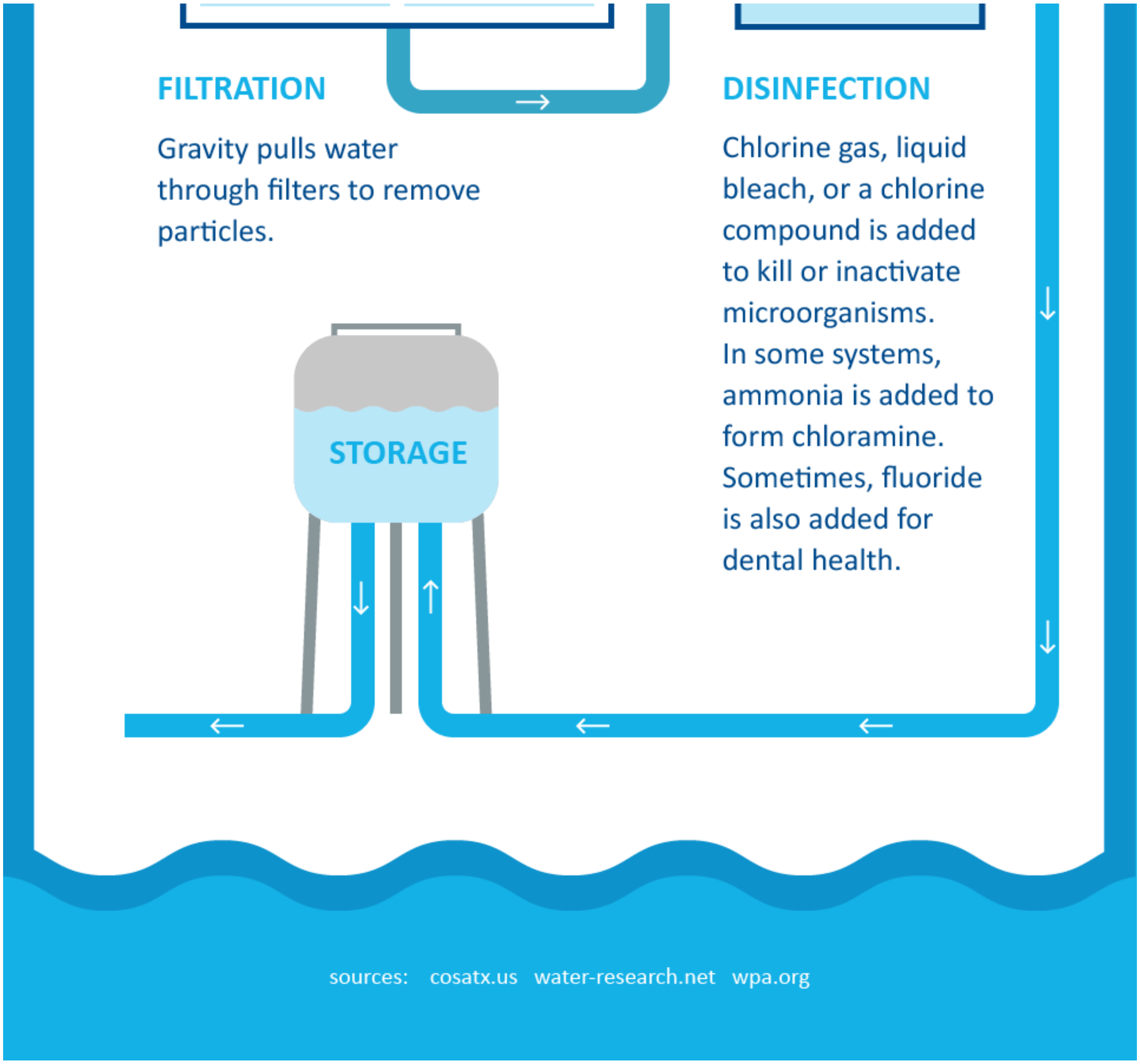


Water Distribution

After drinking water is treated and meets the U.S. Environmental Protection Agency's Safe Drinking Water Standards, it's transported to storage facilities where homes and businesses can access safe, clean drinking water straight from their taps. American water distribution systems span nearly 1 million miles (https://www.epa.gov/dwsixyearreview/drinking-water-distribution-systems) and deliver water to approximately 300 million people (https://www.infrastructurereportcard.org/cat-item/drinking_water/). Distribution systems are mostly underground and include pipes, control valves, pumps, meters, storage tanks, and hydrants.

Distribution systems must provide an adequate amount of water, and they must also provide it with sufficient pressure. Without pressure, water stands still.

Water pressure (https://www.plumbingsupply.com/residential-water-pressure-explained.html) is created by pumping water to the top of a water tower or to a water tank in a high location. When the water descends, it creates force, which in turn moves the water through the mains and pipes. Residential water pressure is usually kept between 45 and 80 pounds per square inch (psi).

The pipes that transport water can be made of several different materials. Some of the most common materials include:

- Steel

An alloy of iron and carbon, steel is the strongest and most durable material used for water supply pipes.

- Galvanized steel or iron

These pipes have a protective zinc coating to prevent rusting. Once popular, the use of these materials is declining (https://sswm.info/sswm-university-course/module-2-centralised-and-decentralised-systems-water-and-sanitation-1/water-distribution-pipes) because pipes corrode over time, giving water an unpleasant taste and smell.

- Cast iron

This iron alloy has been used for water distribution pipes for hundreds of years. It's still used today because it's incredibly durable.

- Concrete cement and asbestos cement

Concrete cement pipes are still used and tend to be resistant to erosion. Asbestos cement pipes were used in the early- to mid-1900s, especially in the western states. They make up 12 to 15 percent (https://blog.ansi.org/2018/06/keeping-asbestos-out-of-drinking-water/#gref) of drinking water systems in the country. Asbestos has been banned in many countries because of concerns about workers breathing it in. Some health experts have also raised concerns (https://blog.ansi.org/2018/06/keeping-asbestos-out-of-drinking-water/#gref) about potential health effects when asbestos fibers from old pipes leach into water.

- Copper

A red-brown elemental metal, copper is lightweight, durable, and naturally corrosion resistant. Copper pipes can leach small amounts of copper (https://www.dartmouth.edu/~toxmetal/toxic-metals/more-metals/copper-faq.html) into the water. While leached copper is not a health threat for most people, it's harmful to individuals with certain medical conditions, including Wilson's Disease.

- Polyvinyl Chloride (PVC)

A rigid plastic, PVC is usually only used for cold water pipes because it breaks down when exposed to heat.

- Chlorinated Polyvinyl Chloride (CPVC)

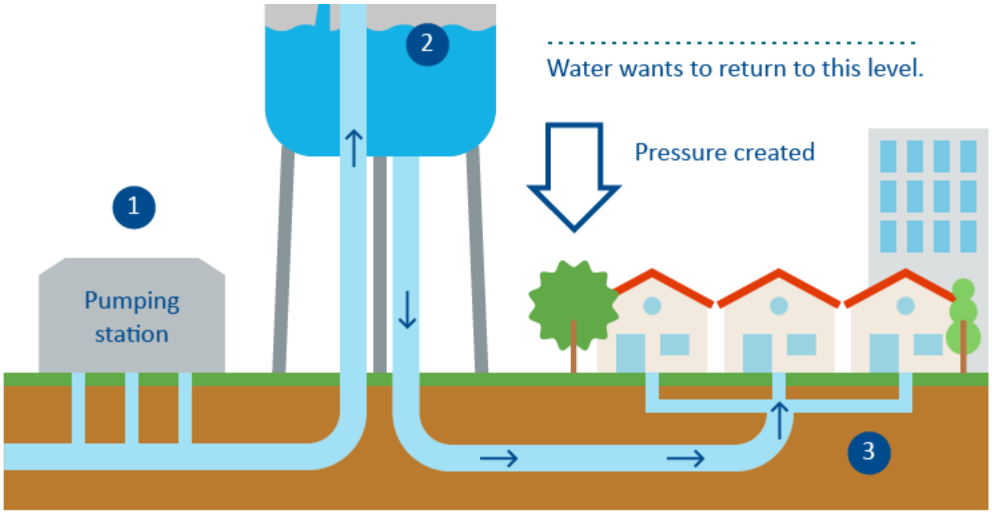
This type of plastic can withstand temperatures up to about 180 degrees Fahrenheit and is used for both hot and cold water pipes.

- Cross-linked Polyethylene (PEX)

A lightweight, flexible, and inexpensive plastic, PEX is replacing copper and galvanized steel. It's used in 60 percent of new construction residential water supply systems. Some (https://www.sciencedirect.com/science/article/abs/pii/S0043135414006289) studies (https://www.ewg.org/enviroblog/2017/11/amid-pipe-wars-researchers-wary-plastic-pipes-leaching-chemicals) suggest PEX pipes can leach odors as well as potentially harmful chemicals into drinking water.

- Lead

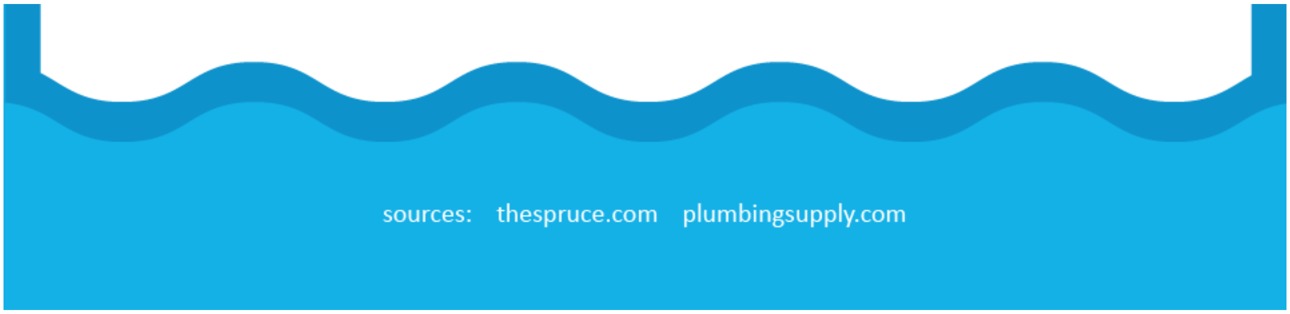
This malleable elemental metal was used to make and solder pipes until Congress banned it in 1986 (https://nepis.epa.gov/Exe/ZyNET.exe/10003GWO.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1986+Thru+1990&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QF
&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=
to prevent childhood lead poisoning. More than 10 million homes (https://www.edf.org/health/lead-pipes-threat-kids-across-america) still get their water from older lead water service lines (the pipes that connect main service lines to a house's plumbing system).



1. Water is transported from the treatment plant to a storage tank or tower.
2. Water is pumped to the top. When it descends, it creates water pressure, which moves it through the distribution system.
3. Water flows through mains and service pipes to people's homes and businesses.

Drinking water pipes in the U.S. are made of various materials.

- Steel
- Galvanized steel or iron
- Cast iron
- Concrete cement
- Asbestos cement
- Copper
- Polyvinyl chloride (PVC)
- Chlorinated polyvinyl chloride (CPVC)
- Cross-linked polyethylene (PEX)
- Lead (banned in 1986 but old pipes still remain)



Conclusion

Waterborne illnesses such as giardia, hepatitis A, typhoid, and cholera are real risks for residents and travelers who drink tap water in many parts of the world. In general, the tap water in the U.S. is safe—but American treatment and distribution systems aren't perfect. (This is evidenced by examples like the Flint, Michigan water crisis.) About one quarter of U.S. residents (https://www.nytimes.com/2017/05/04/us/tapwater-drinking-water-study.html?action=click&module=RelatedCoverage&pgtype=Article&region=Footer) get their drinking water from sources that violate the EPA's Safe Drinking Water Standards. Most are in low-income, rural areas. And even if water is deemed safe to drink when it leaves a treatment center, it can be contaminated by pipes in aging distribution systems. Lead can also leach into water inside homes and businesses from old lead pipes or from brass plumbing fixtures (http://www.mwra.state.ma.us/04water/html/Lead_Faucets.htm) made before 2014. Filtering water before you drink it is the best way to ensure your water is clean, safe, and tastes great.

By Abby Quillen in partnership with Waterlogic and Ghergich & Co

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