

IS DALLAS' WATER SAFE? IS IT SUSTAINABLE?

INDEPENDENT RESEARCH BY

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INTRODUCTION & SUMMARY OF FINDINGS

BACKGROUND

I started doing independent research about the water in Dallas June 2022. I decided to split my research into three categories: demand, supply, and risks/threats. After spending the month of June doing independent research to answer my questions within these three categories, I thought that I would reach out to people who would be very knowledgeable in this field. I reached out to reporters and journalists who had previously written about the water in Dallas to see if I could have a discussion with them. I also reached out to the City of Dallas, and two people working for Dallas Water Utilities responded to my request, and I had a great discussion with them. They helped me answer a lot of my critical outstanding questions. I spent the month of July continuing my research and preparing a summary of my findings along with my detailed notes.

I also started a blog. You can check it out here: <https://www.isyourwatersafe.com/>. The two months I spent doing research led me to here, finally finishing my research report. Below is a summary and some of the most important findings/conclusions from my research.

SUMMARY OF FINDINGS

Safety

- Dallas' water is very safe. In fact, Dallas' water is rated a "Superior Water System," which is the highest rating given by the State of Texas for water quality. Dallas also recently won the Environmental Protection Agency's Region 6 Environmental Excellence Award for Public Water Supply, which means that Dallas has

some of the best drinking water within five states, including Texas, Arkansas, Oklahoma, Louisiana, and New Mexico.¹ Dallas' water is tested between 40 and 50 thousand times per month, so the water quality is constantly being monitored.²

Sustainability

- Although Dallas' current connected water supply will not last for more than 15 years, Dallas has a comprehensive plan to increase the water supply to make sure that the city has enough water for decades to come. Dallas' plans to increase the water supply are outlined in the 500-page 2014 Long Range Water Supply Plan. Dallas' projects to increase the water supply are already funded, and the first one is currently under construction.³

Additional risks

- No matter the quality of a water system, there are always going to be risks, both to the quality and quantity of the water. DWU currently does a great job of mitigating risks. However, there are still unknowns about whether or not Dallas will face similar issues as other places in the United States.

SUMMARY OF CONCLUSIONS⁴

Demand Conclusions: Dallas's water needs will continue to grow with the population increase, despite conservation efforts.

- Demand: driven by population growth, water demand expected to go up by 70% in the next 50 years.
- Dallas uses 470 million gallons a day (MGD) among 3.2 million people for an average usage of 145 gallons per person per day.
- Dallas' water is used by both residents and customer cities.
- Dallas' demand will go up to 700 MGD by 2070, but it will be split among 6.4 million people for an average usage of 110 gallons per person per day.
- Dallas' population growth will be around 1.45% per year, a slight decrease from the 1.6% growth per annum that Dallas saw the past few years.
- Dallas' current conservation efforts will help save over 100 million gallons per year, and future conservation efforts will help save even more water.

Supply Conclusions: new infrastructure to increase Dallas' water supply to meet demand through 2070.

- Dallas' current water supply can sustainably produce over 500 MGD of clean water.
- Dallas gets its water from seven sources, including six lakes, also called reservoirs (Lake Grapevine, Lake Lewisville, Lake Ray Hubbard, Lake Ray Roberts, Lake Fork, Lake Tawakoni) and one river system (Elm Fork of Trinity River).

- Dallas' 38.3 inches of yearly rainfall fill up Dallas' reservoirs, and all of Dallas reservoirs, with the exception of Lake Fork are above 85% capacity.
- By 2070, Dallas will complete four projects to increase the sustainable supply capacity from 500 MGD to 850 MGD, and these projects will cost over \$1.8 billion.
- Dallas has 3 different water treatment plants, 2 wastewater treatment plants, 22 pump stations, 15 wastewater pump stations, and 21 storage tanks. Dallas has over 5,000 miles of water main pipelines 4,000 miles of wastewater main pipelines, and 3,000 miles of storm drain pipelines.
- Dallas is currently upgrading its old/existing infrastructure to make sure that it is effective for years to come.
- Dallas uses chloramine (ozone), which is combination of chlorine and ammonia, to treat its water. Chloramine is safer than just chlorine because chlorine causes a reaction in the water that produces trihalomethanes, which are not good for humans.⁵

Risks/Threats Conclusions: no imminent risks, but concerns to stay on top of.

- Dallas' water is incredibly safe, but threats like in Flint, Michigan, where underfunded maintenance budgets and aged infrastructure allowed lead to seep into its water supply; threats like in Austin, Texas, where population increases outpaced existing wastewater treatment capacity, causing it to overflow into its clean water system; and threats like in Hinkley, California, where chemicals used to treat the water

- were actually toxic to humans can cast doubt on whether or not Dallas will face similar or other issues.
- Questions / concerns below bring up issues that Dallas has a risk of facing.
 - Even though the FDA regulates safe levels for certain chemicals, are there certain unknown harmful effects of these chemicals? What is being done to ensure we continue to regulate the safety of the water above and beyond testing for known harmful chemicals?
 - Is DWU's current operating budget sufficient to upgrade the existing infrastructure?
 - Is DWU's future operating budget enough to maintain future infrastructure?
 - As climate change continues, what are the effects on the water supply?
 - Although the City of Dallas is being planful about its next steps, will there be any other unforeseen events that could put the water supply in jeopardy?

DETAILED WORK PLAN

The following is the detailed work plan I created to conduct my independent research:

Category	Questions	Online research	How research relates to question/findings
Supply	How does the water get to our tap?	https://www.punctualplumberdallas.com/blog/where-does-our-water-come-from/	
	How is it treated and reclaimed?	http://greendallas.net/water/city-water/dallas-drinking-water/-:~:text=DWU uses settling, filtering, chemicals,and for corrosion control%3B and	DWU uses settling, filtering, chemicals, and ozone disinfection to purify its drinking water: Chloramine (a combination of chlorine and ammonia, which is less hazardous than chlorine alone) and ozone for are used for disinfection; lime and iron sulfate are used to remove suspended solids and for corrosion control; and activated carbon is used to control taste and odor. Fluoride is also added to the water to prevent tooth decay.
	What is being done to capture fresh water?		Dallas' water supply comes from six reservoirs and the Elm Fork of the Trinity River: Grapevine, Lewisville, Ray Roberts, Ray Hubbard, Fork, and Tawakoni. Ray Hubbard is the only reservoir completely owned and operated by the City of Dallas. Dallas' lakes are filled by rainwater. Dallas also has plans to use Lake Fork and Lake Palestine in the future when water demands increase. All of Dallas' water supply comes from surface water (water from reservoirs or rivers). Dallas does not use any ground water (water from wells or aquifers), although Dallas does sit atop an aquifer.
	How many treatment plants are there?	https://dallascityhall.com/departments/waterutilities/DC/H%20Documents/pdf/Water%20Conservation%20Plan.pdf	There are 3 water treatment plants in Dallas: Bachman, Eastside, and Elm Fork. Each of these plants treats the water from the twelve lakes and then sends the water to the pump stations to be pumped to our houses and other places.

			<p>There are 15 pump stations in Dallas. Each of them gets the treated water from the treatment plants and then sends the water through the clean water pipes to get to our houses and other places.</p> <p>There are 2 wastewater treatment plants in Dallas: TRA's Central Regional, and Central wastewater treatment plants. There are over 4000 miles of wastewater pipes throughout Dallas</p>
	How old are the treatment plants?	https://dallascityhall.com/departments/waterutilities/DC/H%20Documents/pdf/Water%20Conservation%20Plan.pdf	
	What is the maintenance of the plants? (process, budget, gaps)	TBA	
	How much annual rainfall does Dallas get?	37.1 inches per year	
	Is this rainfall being used as a water source? If not, how much of an impact could it make?	https://savedallaswater.com/conservation/	In short, rainfall refills Dallas reservoirs and basically provided the water needed after 2006. Rainfall continues to fill these reservoirs and is the only source of water that these reservoirs get.
	Where do we get our water? (source)	https://dallascityhall.com/departments/waterutilities/DC/H%20Documents/pdf/Water%20Conservation%20Plan.pdf https://www.dallas-citynews.net/bachman-water-treatment-plant-	We get our water from twelve lakes and rivers in the Dallas Forth Worth area. Dallas currently obtains water from area reservoirs: Lake Ray Hubbard, Lake Lewisville, Lake Grapevine, Lake Ray Roberts and Lake Tawakoni. We also have plans to use Lake Fork and Lake Palestine in the future when water demands increase. Dallas owns and operates Lake Ray Hubbard only. The rest are not owned by the city of Dallas.

		<p>saving-millions-of-gallons-per-year https://maps.waterdata.usgs.gov/mapper/index.html https://savedallaswater.com/conservation/</p>	
	<p>How can Dallas increase their water supply even after water runs out?</p>		<p>Dallas has a larger problem than it seems. In coastal cities like Los Angeles, they can desalinate water, however, they have not done it yet due to cost. However, since Dallas is not a coastal city, how will it get adequate water? One of the ways can be through conservation. Because most lawns in the state of Texas are not native grasses, they need extra water. Over 50% of consumed water goes to watering lawns. If Dallas can cut that number way down, then Dallas can conserve water and extend its water supply until we can find a more long-term solution. However, a longer-term solution can be through reuse. After wastewater goes through a wastewater treatment plant, it is clean enough to go back into our waterways (lakes, rivers, creeks, etc.). However, water can be placed at the beginning of a waterway (like a river or creek or lake) so that it can resupply the city. It will be captured into water treatment plants that treat the water to be consumed. This creates a cycle, where water is reused so that Dallas does not run out. The cycle goes like this:</p> <div style="text-align: center;"> <p>Urban Water Cycle</p> <pre> graph TD Waterway --> WaterTreatmentPlant[Water treatment plant] WaterTreatmentPlant --> Consumer[consumer] Consumer --> WastewaterSewerSystem[wastewater/sewer system] WastewaterSewerSystem --> Waterway </pre> </div>

Demand	How much water is currently being used?	https://www.texasmonthly.com/articles/the-last-drop/ https://savedallaswater.com/conservation/	110 gallons per person per day. This adds up to around 600,000,000-700,000,000 million gallons of water per day on average. This leads to 219,000,000,000-255,500,000,000 gallons per year usage currently. However, with the growing population, demand will increase. By 2060, demand will increase 86%, or by 188,340,000,000-219,730,000,000 gallons per year.
	For what purposes? (Consumption, bathing, landscaping, manufacturing etc.,) Does this differ by demographic or age group?		Over half of Dallas' consumed water goes to watering lawns. Because the grasses are not native to Texas and the Texas environment, they require more water to survive.
	Estimated population growth? By 2050		Demographers project that DFW will reach 10 million people sometime in the 2030s, surpassing Chicago to become America's third-largest metro area. Dallas–Fort Worth is emerging as a megacity but a distinctly polycentric one—more like Los Angeles than New York or Chicago. Current populations is around 6.5 million people
	How many households can it support?		not quite sure yet, but the supply of water is completely inadequate to meet future needs. Dallas will need to supply more water using conservation and reuse methods.
Risks/ Threats	What issues have other municipalities faced? (Austin, Flint, California etc)	https://www.nadallas.com/2021/09/30/369829/water-scarcity-in-north-texas https://www.kxan.com/news/local/austin/austin-water-answers-questions-about-what-	In Austin, there have been two boil water notices in the first two months of 2022. There was also a boil water notice in February 2021, due to the snowstorm, however, the boil water notices in 2022 were because of a different reason. It is not uncommon for officials in towns or cities to issue boil-water notices in response to storms or flooding. Less frequent, and often more long-lasting, are water supply problems that stem from the city's own infrastructure, as has been the case in Flint,

		<p>caused-recent-boil-water-notice/</p> <p>https://www.britannica.com/event/Flint-water-crisis</p> <p>https://www.ioes.ucla.edu/news/beyond-perfect-drought-californias-real-water-crisis/#:~:text=The%20record%2Dbreaking%20drought%20in,water%20shortages%20and%20must%20adapt</p>	<p>Mich., and Jackson, Miss as well as Austin, Tx. Since flooding in 2018, there have been issues with the Austin Tx water treatment plants. The most recent boil water notice in Austin (February 2022) was caused by employee error. “the operators... don’t really know the science behind adding lime to the water,” he said. “We don’t want the operators to be just following [Standard Operating Procedure] again. It’s their ability to understand the science behind water and ability to come up with a solution when something does happen.” The Employees were just following instructions, and did not have a true understanding of what their job truly was. The issues in Flint Michigan were caused by lead contaminating the water supply. After the city of Flint switched their water supply from the Detroit Water and Sewerage Department to their own river to reduce costs, there was an outbreak of Legionnaire’s Disease. The outbreak as well as a corrosion problem led to the investigation of Flint’s water supply. It turns out that the water was contaminated by lead. The record-breaking drought in California is not chiefly the result of low precipitation. Three factors – rising temperatures, groundwater depletion, and a shrinking Colorado River – mean the most populous U.S. state will face decades of water shortages and must adapt. However, depletion of the groundwater in California has caused structural problems. The land has started to sink. Increasing population and demand certainly does not help.</p>
	<p>How long will the drought in California last?</p>	<p>https://www.nytimes.com/2022/02/17/climate/noaa-weather-western-drought.html#:~:text=Scientists who study past climate,this year and likely longer.</p>	<p>All 58 counties in California are now under a drought emergency proclamation. Most rain and snow falls in California from November through April. It fills the reservoirs and aquifers that we use to supply homes, businesses, and farms. The National Aeronautics and Space Administration (NASA) is now predicting</p>

			<p>that California only has enough water supply to last one year.</p> <p>Although Dallas is in a terrible situation, with only enough water to last a decade, California is in dire need of water and water conservation/reuse methods, as they can only supply one more year of water to their inhabitants. However, another problem is that they are also already using their underground aquifers and the land is sinking, so they do not have a backup plan like Dallas does. Short term water solutions are vital to the water supply, as rains will not fill up California's lakes because the rainy season came to a close in April.</p>
	How are restrictions put in place to conserve water?	https://savedallaswater.com/resource-center/twice-weekly-watering-schedule/	This link shows and answers FAQ about restrictions in dallas.
	What are the biggest issues facing Dallas' water supply?		Of all these, though, the cities of Dallas and Fort Worth face the worst dilemma, a sort of perfect storm of failing supply and skyrocketing demand, made palpably real by the recent drought. This area is going to need a colossal amount of water in the future. By 2035 it will have exhausted all its existing supplies.
	What have been issues in the past? Future?		<p>Past: there was a drought in 2005-6, basically, the lakes that supply pretty much all of Dallas' water all had droughts to where each lake was below 40% of full capacity. Heavy rains in 2006 filled these lakes back up and helped supply water for years to come.</p> <p>The water contained in the twelve reservoirs that serve Dallas and Fort Worth is completely inadequate to meet future need. The state's official projections for the water shortfall over the next fifty years are nothing less than astonishing.</p>
	Why doesn't Dallas use groundwater	https://www.hdrinc.com/sites/default/files/2017-05/hdr-	This link is Dallas Long Range Water Supply Plan. Dallas is currently getting all of its water from the surface (lakes, rivers, streams, etc.) and it is not getting any water

	and the aquifer it sits upon?	long-range-water-supply-plan.pdf	from underground, however Dallas sits upon an aquifer. In their plan, there is no mention of groundwater or aquifers at all, so this arises the question: Why doesn't Dallas use groundwater and the aquifer it sits upon? Through talk with Mr. Northcut, Dallas' aquifer is too small to be a viable option for consumption.
	Current and future threats? (eg., aging facilities)		current: Dallas' water supply is inadequate. The 12 reservoirs that serve Dallas/Ft. Worth's residents with water do not have the kind of supply to last for years to come. (see image at end of table)
	How do residents get notified of issues?		Through the news and other announcement mechanisms (addresses by politicians, etc.)
	How do microplastics and forever chemicals affect our water supply and the health of the people who drink it?		
Other	Are Dallas' water plants powered by electricity? What happens if there is a long-term power outage?		(to answer part 1) The City of Dallas supplies the facility with approximately 1.3 million ft ³ of biogas per day, which is converted by engines into electricity and heated water. The electricity is sold back to the plant, and the hot water is returned to the plant's hot water system, and it is used for heating purposes.

DETAILED REPORT & KEY EXHIBITS

DEMAND

Who uses the water?

Dallas' water is used almost equally between two groups of people: Dallas residents (this category includes residents and businesses in the Dallas Water Utilities service area) and customer cities.⁶

How much water is being used? What is the water used for?

Dallas Water Utilities supplies around 470 million gallons per day to its customers. The average Dallas resident uses around 145 gallons of water per day for drinking, bathing, cooking, landscaping, etc. Half of Dallas' residential water is used for residential landscaping. Dallas' customer cities need both treated water (for human consumption) and untreated water (for irrigation).⁷

What has Dallas done to conserve more water?

Since Dallas uses half of its water for landscaping, the City has enacted two different watering restrictions in an effort to conserve water. These restrictions include watering no more than twice a week and no watering during the hours of 10 am – 6 pm. These restrictions reduced water consumption by over 20%, or 130 million gallons per day (from almost 600 MGD to just under 470 MGD).⁸

The City of Dallas is also taking other measures to increase water conservation. One key initiative is focused on businesses. The City of Dallas will grant these businesses cash subsidies to meet water saving targets. In total, these 14 projects have saved between 90 million and 168 million gallons per year, or between 247 and 460 thousand gallons per day.⁹

The City of Dallas also already saves almost 20 million gallons a year through a project called “New Throne for your Home.” This project will replace residents' old toilets for free. Dallas Water Utilities says it plans to use water usage data to target customers who will potentially qualify for free, minor plumbing repairs, which already saves the city 3 million gallons per year, or over 8,000 gallons per day.¹⁰

Even though it seems like each of these conservation projects do not save a considerable amount of water, water savings will add up and these projects will help Dallas save lots of water in the long run.¹¹

What is the projected growth in demand?

The current water demand is 470 million gallons per day, and by 2070, the water demand is projected to be 700 million gallons per day (a 70% increase). However, there are two factors that determine the demand: population and per person consumption.¹²

Population

The current population that Dallas Water Utilities serves is 3.2 million. By 2070, this number will double to 6.4 million people. This represents an estimated 1.45% population growth per annum, which is slightly lower than the 1.6% per annum growth Dallas saw over the past few years. Despite the slightly lower per annum growth, the absolute population is still expected to double, thereby, doubling the water demand.¹³

Per person consumption

Even though the population will double by 2070, Dallas' water demand only goes up by 70%. The average Dallas resident currently uses almost 145 gallons per day. By 2070, the average resident is

projected to use only 110 gallons, which is a 25% decrease from 50 years prior. This estimate is driven by continued conservation strategies to be implemented by both Dallas residents and Dallas Water Utilities' customer cities.¹⁴

SUPPLY

Where does Dallas get its water? How much water can Dallas supply?

Dallas gets its water from seven sources, included are six lakes, also called reservoirs (Lake Grapevine, Lake Lewisville, Lake Ray Hubbard, Lake Ray Roberts, Lake Fork, Lake Tawakoni) and one river system (Elm Fork of Trinity River). Of all of these, Lake Ray Hubbard is the only reservoir that the City of Dallas owns and operates. Dallas and other municipalities share the rights to extract water from the other six places.¹⁵

What is Dallas' rainfall like and what is its importance?

Dallas' yearly 38.3 inches of rainfall is essential to Dallas' water supply. Rainfall fills the reservoirs, and after a wet 2021, the reservoirs are all above 85% capacity, with the exception of Lake Fork, which is only at 72% due to repair work occurring at its dam. All of these reservoirs are at a lower level, consistent with yearly water level fluctuations. Dallas is very lucky to have a predictable amount of yearly rainfall. As climate change continued over the past few decades, the western part of the United States has become dryer, while the eastern part of the United States has become wetter. Dallas is right in the middle of United States, and the city has maintained a seemingly predictable amount of yearly rainfall for the past 150 years. The seven lakes/streams and annual rainfall allow Dallas to have a sustainable water supply capacity of 502 million gallons per day (MGD).¹⁶

What is Dallas doing to increase the water supply?

Because of rising water demand driven by population growth, Dallas' current lakes and reservoirs will not be able to sustainably supply the city with water past 2030, and Dallas is estimated to run out of water in

2035.¹⁷ As a result, the City of Dallas has approved, funded, and is currently working on connecting three more water sources and building a reservoir to extend its water supply through 2070. Dallas will do this through four main projects: The Integrated Pipeline Project (IPL), connecting Dallas to Lake Palestine; Indirect Reuse through a Balancing Reservoir; a connection to the Neches River; and a connection to Lake Columbia. These projects will be completed by 2027, 2050, 2060, and 2070 respectively, and are projected to increase the water supply to 850 MGD (a 350 MGD increase) and keep Dallas' water sustainable even as the population doubles by 2070.¹⁸

Dallas' first of four projects is the Integrated Pipeline Project (IPL). The IPL is the construction of over 150 miles of pipelines, three new intake pump stations (one for Lake Palestine, one for the future Neches River project, and one for the future Lake Columbia project), and three new booster pump stations (to help move the water towards Dallas at a faster rate). The 9-foot pipe will connect Lake Palestine to Joe Pool Lake where another pipeline will take the water to Bachman Water Plant to be cleaned and treated. The IPL is currently slated for a 2027 completion, and this project will provide Dallas with an additional 102 MGD, and it will help Dallas meet demand through 2050.¹⁹

The second project is called Indirect Reuse through a Balancing Reservoir where Dallas will construct a reservoir to store discharged non-potable water from the wastewater treatment plants so that Dallas can treat the water and then use the water as needed. This project will be completed by 2050, and it will increase Dallas' water supply by 102 MGD, bringing the total supply to over 750 MGD.²⁰

The third project is the connection to the Neches River. The Neches River runs south out of Lake Palestine, and the intake pump station, created in the IPL, will pump water through a pipeline to Lake Palestine. This water will then get pumped through the 90-mile pipeline, created in the IPL, back to Dallas where it will be sent to Bachman Water Plant to be cleaned and treated. This project will supply an additional 42 MGD, bringing the water supply capacity to almost 800 MGD.²¹

The final project slated to be complete before 2070 is the connection to Lake Columbia. Lake Columbia is located 20 miles east of Lake Palestine. Similar to the Neches River connection project, an intake pump station will pump the water from Lake Columbia to Lake Palestine, via a pipeline, where it will go inside the same 90-mile pipeline to Joe Pool Lake. The project will supply an additional 42 MGD, bringing Dallas' water supply capacity up to almost 850 MGD.²²

What is the total cost of these projects?

Dallas will spend a total of \$3.914 billion on DWU's water projects between 2020 and 2070. The four main water supply projects mentioned above will cost a total of \$1.851 billion (\$1.097 billion for the IPL, \$675 million for the Balancing Reservoir, \$227 million for the Neches River Connection, and \$160 million for the Lake Columbia connection). Not only is DWU executing the above four projects, but DWU is executing sixteen other projects, between 2015 and 2070, to improve existing infrastructure. These projects will cost \$2.063 billion, and plan to execute expansions to existing water plants, expansions to an existing balancing reservoir, and improvements to the filters at the water plants.²³

What are the other lakes in the Dallas area used for?

There are eight other smaller lakes in the Dallas area that are not connected to the Dallas Water Supply, including Bachman Lake, Joe Pool Lake, Mountain Creek Lake, Lemmon Lake, North Lake, Fish Trap Lake, Lake Cliff, White Rock Lake, and Parkdale Lake. Water in half of these lakes (Joe Pool Lake, Mountain Creek Lake, White Rock Lake, and North Lake) is used as a coolant for Dallas Power and Electric Plants. Bachman Lake is used for municipal water storage. Lemmon Lake used to be a one-of-a-kind wildlife area but has since dried up due to a breach in the earthen dam.²⁴

What is the nature of the infrastructure in the Dallas water system?

Dallas has 3 different water treatment plants, 2 wastewater treatment plants, 22 pump stations, 15 wastewater pump stations, and 21 storage tanks. Dallas has over 5,000 miles of water main pipelines 4,000 miles of wastewater main pipelines, and 3,000 miles of storm drain pipelines.²⁵

Dallas' water treatment plants treat water from DWU's reservoirs daily. Together, these three water treatment plants have a water treatment capacity of 900 MGD. These water treatment plants supply Dallas with clean drinking water every day. The Eastside Water Treatment Plant produces almost 63% of Dallas' clean water, or 314 MGD to around 2.2 million people. The Elm Fork and Bachman Water Treatment Plants, together, produce the remaining 37% of Dallas' daily drinking water, or about 188 MGD to around 1 million people per day.²⁶

Dallas' two wastewater treatment plants clean wastewater so that the water can go back into the environment: places like local creeks, lakes, and the Trinity River. However, this water is not potable, and it

still needs to be treated before it can be used for human consumption. The two wastewater treatment plants, Southside and Central Wastewater Treatment Plants, can clean up to 260 MGD. However, the plants only treat around 160 MGD combined as that is how much wastewater DWU's customers produce per day.²⁷

Dallas' 22 pump stations pump clean water to DWU's customers. These pump stations pumping capacity is anywhere between 50,000 and 900,000 gallons per minute, or between 72 MGD and 1,200 MGD. The large gap is due to the age of the pump stations. Some of Dallas' pump stations are from the 1930s and can pump 50,000 gallons per minute. The newest pump stations can pump upwards of 900,000 gallons per minute. The water from these pump stations goes into the water pipelines and to DWU's customers to be used.²⁸

15 wastewater pump stations are dotted around DWU's 700 square mile service area. These pump stations pump wastewater from DWU customers to the wastewater treatment plants. Together, these pump stations can pump over 4.7 BGD, but currently, they only pump 160 MGD.²⁹

Dallas' 21 storage tanks help store water for their service area. There are 9 above ground tanks and 12 underground tanks. Although these storage tanks do not have a minimum storage capacity requirement, they must meet the storage and fire demands of its service area.³⁰

Dallas' thousands of miles of piping carry water miles to its various destinations. Dallas has three different types of water pipelines: water mains, wastewater mains, and storm pipes. Dallas has 5,000 miles of water mains, 4,000 miles of wastewater mains, and 3,000 miles of storm pipes. Most

of these pipes range between 4" and 120" in diameter, and carry water to different parts of the city.³¹

What are some upgrades that Dallas is doing maintain its current and future infrastructure?

While Dallas' infrastructure is effective, almost two thirds of it is over 30 years old. Dallas is trying to solve its number one problem, aging infrastructure, by constantly replacing old parts of the water system. Dallas is also renovating and replacing various essential infrastructure, including the water/wastewater treatment plants, the pump stations, the storage tanks, and piping. Here are some examples:

The Eastside Water Treatment Plant recently had some renovations done to increase its capacity to store clean, treated water. Four 16-million-gallon concrete tanks were added, increasing the capacity of treated water to 64 million gallons. This water can be sent to customers at a moment's notice. All four tanks were completed on time and within budget. By 2024, the Eastside Water Treatment Plant will provide water to over 3 million people.

The Elm Fork Water Treatment Plant will have its filter complex replaced. This replacement was part of DWU's long term planning. According to Mark S. Swain, City of Dallas Auditor, "The Elm Fork Water Treatment Plant Filter Complex has reached the end of its useful life and the project plans to improve water quality and filtration efficiency. The project was estimated to cost between \$130 million and \$145 million."

The Walcrest Pump Station had a complete rebuild. After being demolished, construction started in 2014 and finished eight years later in the spring of 2022. The

Walcrest Pump Station was over 50 years old, so replacement parts were hard to find, and the equipment did not meet the current standards. The new Walcrest Pump Station now serves over 850,000 residents with clean water daily.³²

Dallas' pipes are also in need of being replaced. Around 1% of the piping is replaced per year, but Dallas has plans to increase annual pipe replacement so that the DWU water system can continue to run smoothly and serve its customers daily.

To maintain its future infrastructure, DWU must increase its operating budget. DWU is increasing its water rates so that the organization can increase its \$500 million operating budget to cover the additional maintenance costs that come with the new infrastructure.³³

How is the water treated to make sure that it is safe and clean?

According to the City of Dallas, "DWU uses chemical treatment, settling, filtering and disinfection to purify drinking water. The chemicals we use include chlorine and ammonia (which combines to make chloramine) or ozone to disinfect the water; lime and iron sulfate to remove suspended

solids in the water and for corrosion control; activated carbon to control offensive tastes and odors; and fluoride to help prevent tooth decay.

"We use chloramine instead of chlorine to protect the health and safety of our citizens. Studies have shown that using chlorine by itself can cause a reaction in the water that leaves by-products called trihalomethanes. Some studies indicate that trihalomethanes could be harmful if consumed in large quantities over long periods of time. Dallas water is considered non-corrosive, which means that it is less likely to leach lead from pipes than water that is corrosive.

"The combination of our treatment processes and the non-corrosive nature of Dallas water results in exceptionally high quality, safe drinking water. In fact, in 1991, DWU won the Environmental Protection Agency's Region 6 Environmental Excellence Award for Public Water Supply. Recently, Dallas was notified that it will again receive this prestigious award. That means that Dallasites are drinking some of the best water in five states: Texas, Arkansas, Oklahoma, Louisiana, and New Mexico."³⁴

RISKS / THREATS

Dallas' water system is of the highest quality, and there have not been large issues in the past. However, with recent issues experienced by other water municipalities, it leads one to wonder whether Dallas, even with its superior water quality and rigorous testing, would face threats to its water quality at some point. Threats like in Flint, Michigan, where underfunded maintenance budgets and aged infrastructure allowed lead to seep into its water supply. Threats like in Austin, Texas, where population increases outpaced existing wastewater treatment capacity, causing it to overflow into its clean water system, and threats like in Hinkley, California, where chemicals used to treat the water were actually toxic to humans.³⁵ Below are some other risks that could be an issue for Dallas' water.

Is Dallas Water Utilities' operating budget sufficient to upgrade the existing infrastructure?

Most of Dallas' infrastructure is over 30 years old, and despite continuous efforts to maintain, repair, and replace various facilities, it is unclear whether there is sufficient budget or whether the pace of repairs and upgrades is sufficient to stave off future issues.

Is Dallas Water Utilities' future operating budget enough to maintain future infrastructure?

As Dallas continues to construct more infrastructure, especially as projects like the IPL are being completed, the operating

budget must increase to cover new maintenance costs. It is unclear how much the budget is slated to increase.

As climate change continues, what are the effects on the water supply?

As the climate continues to get warmer, evaporation increases, taking water from Dallas' supply, and as rainfall could potentially decrease, other threats of our current climate to the supply of water remain unclear.

Even though the FDA regulates safe levels for certain chemicals, are there certain unknown harmful effects of these chemicals that are used to treat Dallas' water? What is being done to ensure we continue to regulate the safety of the water above and beyond testing for known harmful chemicals?

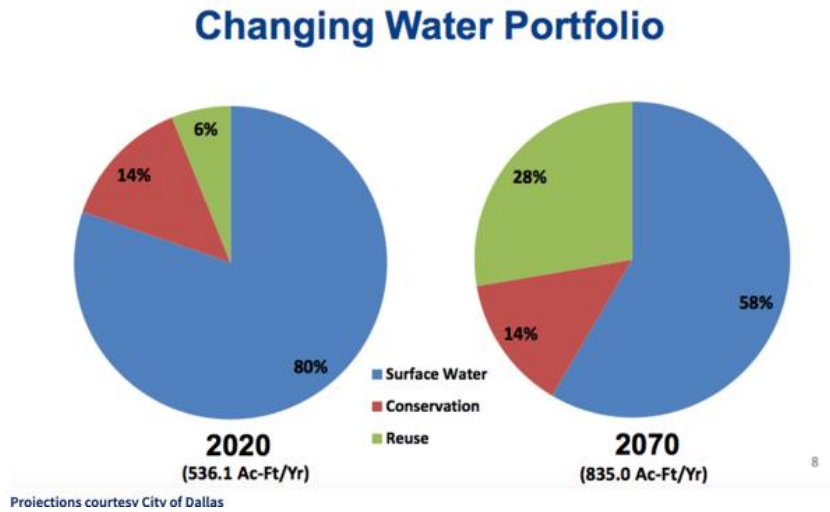
Just like more harmful effects are being discovered about forever chemicals, there could be unknown harmful effects of certain chemicals that are used in the Dallas water.

Although the City of Dallas is being planful about its next steps, will there be any other unforeseen events that could put the water supply in jeopardy?

Events like natural disasters, pandemics, and other large events could harm the water supply. Infrastructure could get destroyed in a natural disaster, and people might not be able to work due to a pandemic, putting at risk the ability to source Dallas with a sufficient amount of safe water.

KEY EXHIBITS

Dallas' Changing Water Portfolio



Dallas' Water Supply and Demand

https://www.dallascityhall.com/departments/waterutilities/DCH%20Documents/2014_LR_WSP_Final_Report_all_11302015.pdf

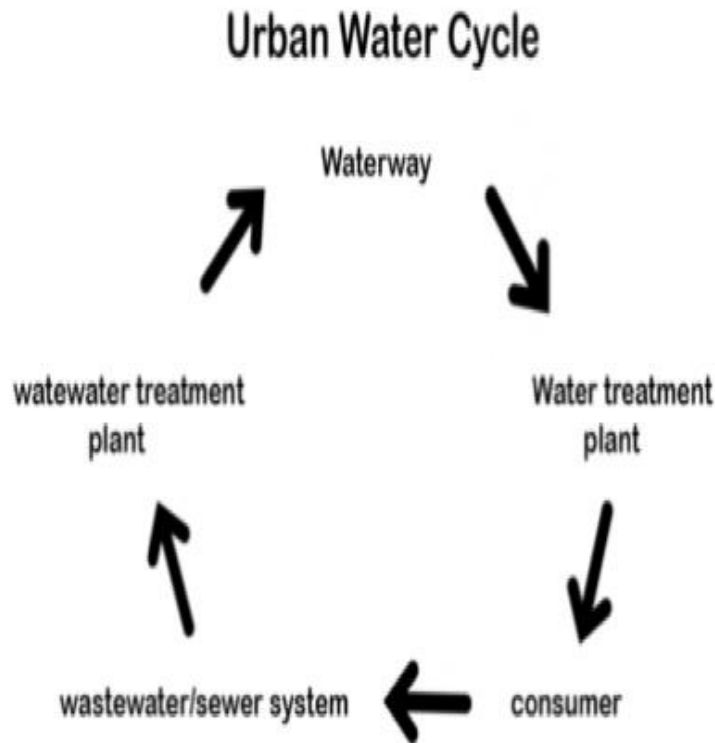
Table ES-8 page 16

Table units: MGD

Supplies and Demands	2020	2030	2040	2050	2060	2070
Western Subsystem						
Lake Grapevine Supply	12.8	12.3	11.8	11.2	10.7	10.2
Elm Fork System Supply	162	155	149	143	136	130
Elm Fork Return Flows ^a	13.3	16.4	20.8	29.2	41.8	50.3
Western Subsystem Supply Total	188.1	183.7	181.6	183.4	188.5	190.5
50% Demand	234.4	251.8	278.9	307.3	339.1	358.9
Buffer / Deficit	(46.3)	(68.1)	(97.3)	(123.9)	(150.6)	(168.4)
Eastern Subsystem						
Lake Ray Hubbard Supply	50.0	49.1	48.1	47.3	46.3	45.4
Lake Tawakoni Supply	157	152	148	144	139	135
Lake Fork Supply	107	104	101	97.3	93.8	90.4
Eastern Subsystem Supply Total ^b	314	305.1	297.1	288.6	279.1	270.8
50% Demand	234.4	251.7	278.8	307.2	339.1	358.9
Buffer / Deficit	79.6	53.4	18.3	(18.6)	(60.0)	(88.1)
Total System						
Total Supply	502.1	488.8	478.7	472	467.6	461.3
Total Demand	468.8	503.5	557.7	614.5	678.2	717.8
Buffer / Deficit	33.3	(14.7)	(79)	(142.5)	(210.6)	(256.5)

^a Includes increases in return flows available to Dallas in the Elm Fork System above the amount of return flows included in

Urban Water Cycle (created based on multiple sources)



Selected US Cities, Population and Daily Consumption (various Google searches)

City	Population 2022	Daily Water Consumption 2022
NYC	8.38 million	1 billion gallons (~120 gallons per person per day)
LA	4 million	440 million gallons per day (~110 per person per day)
Chicago	2.699 million	290 million gallons per day (~105 gallons per person per day)
Houston	2.313 million	449 million gallons per day (~194 gallons per person per day)
Philly	1.582 million	250 million gallons per day (~158 gallons per person per day)
Dallas	1.3 million	143 million gallons per day (~110 per person per day)
Phoenix	1.445 million	166 million (~115 gallons per person per day)
San Diego	1.415 million	120 million (~85 gallons per person per day)
Austin	965 thousand	115 million (~120 gallons per person per day)
San Antonio	1.529 million	129 million (~85 gallons per person per day)
Miami	461 thousand	55 million (~120 gallons per person per day)
San Jose	1.029 million	82 million (~80 gallons per person per day)
Atlanta	497 thousand	60 million (~121 gallons per person per day)

BLOG: IS YOUR WATER SAFE **isyourwatersafe.com**

I decided to create a blog of my research findings, as well as use this as a vehicle to discuss other water-related topics that I research and would like to share. Below are my articles up through December 2022. Please see my blog for the more recent blog entries:

7/7/2022 Intro: Is Your Water Safe?



My name is John Householder, and I am a rising sophomore at St. Mark's School of Texas located in Dallas. I am 15 years old, and I am very interested in the global water crisis. My interest in water came from a few experiences including:

- Having to find and purify water during my scout campouts.
- Facing a “boil water notice” while at a volleyball tournament in a big city like Austin.
- Noticing how Dallas’ tap water tastes different during different times of the year making me wonder “is this water safe to drink?”
- Going without water during a winter freeze that broke some pipes in our house and not knowing when our water would be available again causing me to wonder how people go without a reliable source of water elsewhere in the world.

This summer, I am researching the water in my home city of Dallas. I got together with a few of my teachers and a couple people who work for my city to enhance my online research about the water in Dallas, more specifically, the supply, demand, and threats to our water supply. I am learning a lot of interesting information and I am very excited to record my experiences and findings while doing this research. For now, I plan on posting here twice monthly.

I hope you enjoy my journey into learning if the water in Dallas is safe, and if there is enough supply to sustain our city over the next decades to come. I hope it also helps you ponder if the water in your city is safe, and if there is enough to sustain your community for decades to come. And lastly, I hope it raises our collective interests in understanding how to ensure the water is safe in all communities across the globe, and what we can do to help stem the global water crisis by first starting in our local communities.

7/21/2022 Urban Watershed

Urban Watershed Exhibit: Beautifying Cities While Providing Safe and Sustainable Water



I visited a great exhibit called the Urban Watershed, which just opened up in Fort Worth. It is run by Dr. Adrian Parr, former University of Texas at Arlington (UTA) professor, who put together the exhibit with some of the students who attend UTA. This exhibit was previously on display in Europe, and is currently on display here until August 2022 at the Fort Worth Museum of Science and History before it will be on display in other North Texas cities. I visited this exhibit a couple weeks ago, and it presented lots of interesting ideas, including the idea benefiting residents by creating practical green space. It also presented current and future projects that create a perfect mix of practical water supply and human enjoyment.

The exhibit showed a project that had turned a run-down reservoir into a clean park, so it could supply water and be a peaceful place for its residents to enjoy. Another panel showed the deliberate planning of the City of Lewisville, Texas. It showed an area that was set aside to be a park 70 years ago (shown in the blue outline below), and how even through development and urbanism, the park area was preserved and then developed into a green space for residents to enjoy.



Image: City of Lewisville developing around an area set aside to be a public park

FRAMEWORK PLAN

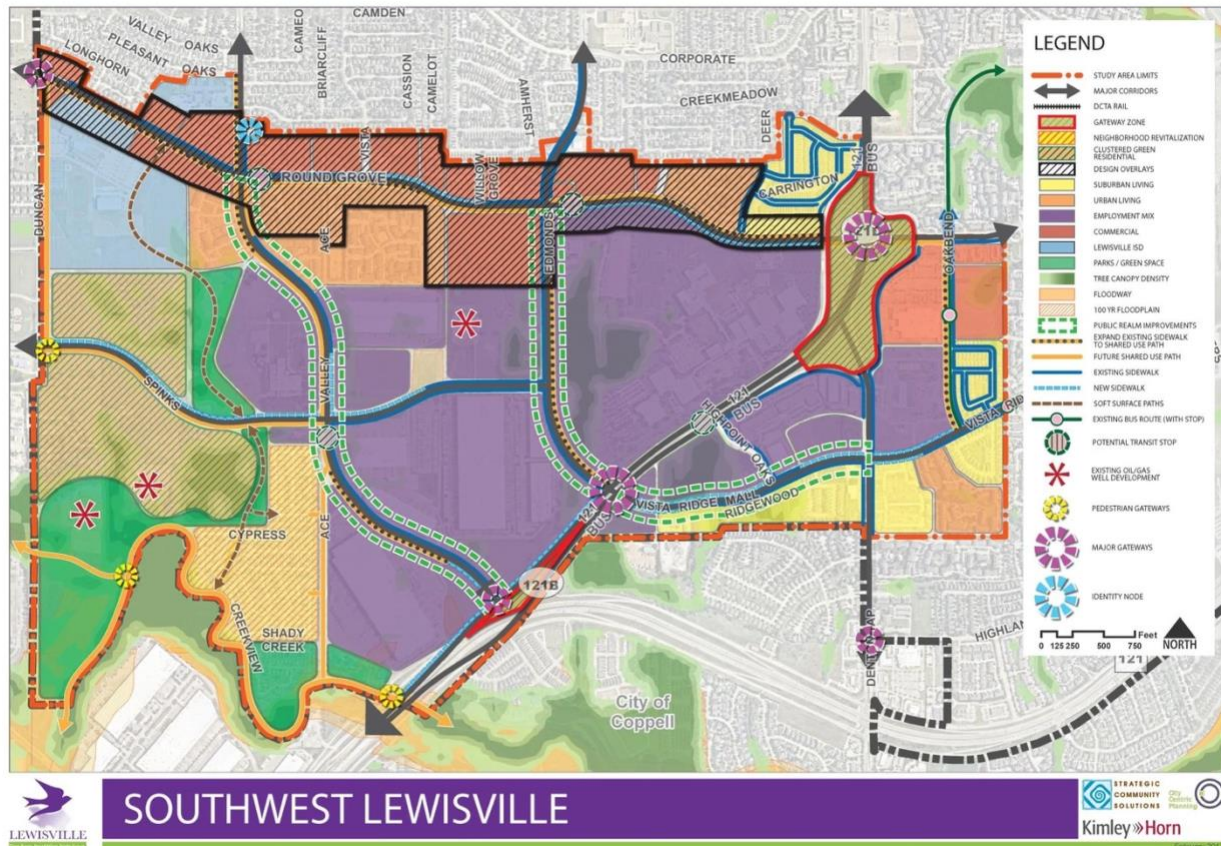


Image: zoning map of Southwest area of Lewisville. The green shading represents developed green space areas/parks.

The Urban Watershed exhibit presented an idea about a hybrid rain panel, which is a type of roof that combines pervious and impervious surfaces to reduce roof runoff and capture water into a rainwater tank. This invention makes it possible for residents to capture rainwater themselves using a low maintenance system. The panels can be installed on existing roofs. These panels are still a new idea, so they are pretty expensive. Scientists will continue to improve the panels with one of their goals being to make them more affordable. These panels could help residents capture lots of water, which could possibly give some residents their own independent water supply. They would lower water bills and lower biogas emissions (biogas is highly toxic, flammable, and potentially explosive).

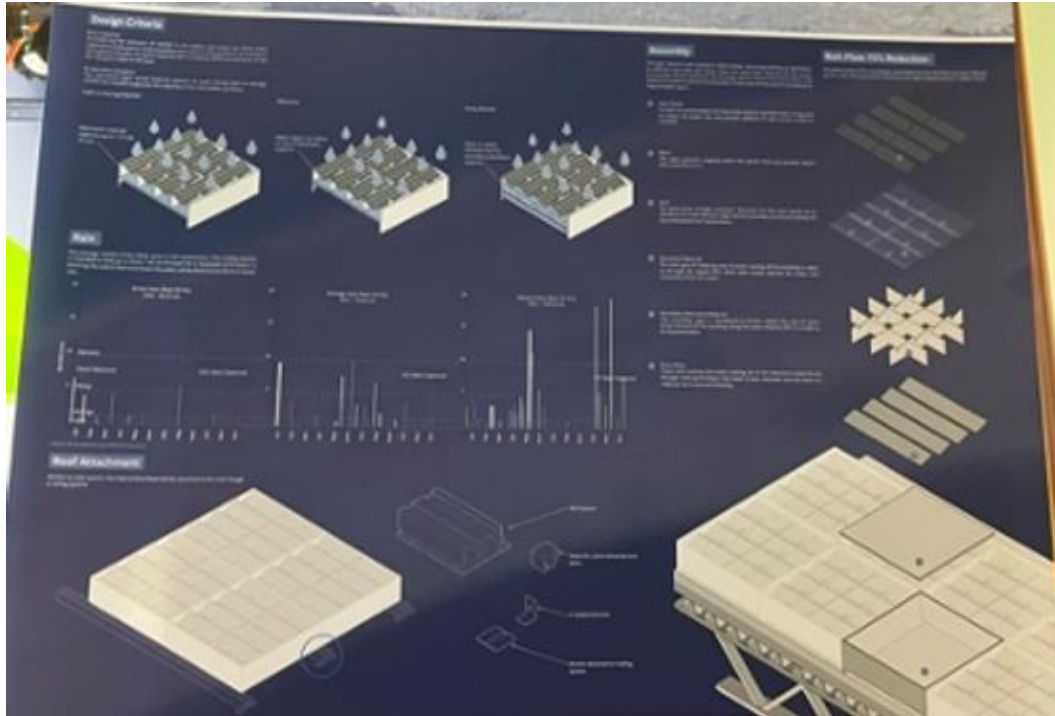


Image: the several layers that go into the hybrid rain panel.

Urban Watershed also presented an idea about creating a new park called Harold Simmons Park. After the Trinity River's course river level changed due to storms and natural disasters previous to development of Harold Simmons Park, the water levels have been relatively inconsistent. The park will replenish the Trinity River as needed by helping to control flooding into the river. This flooding would help create a more consistent water level of the Trinity, which would improve wildlife health and create a more consistent water supply. This would help Dallas because Dallas gets some of its water from the river. Runoff of the Trinity River also helps supply Houston, so the park would help Houston maintain a consistent water supply as well.

These new and innovative ideas would be good for other cities to implement because there are so many benefits to the city and its residents, including helping the city continue to be planful about managing its water supply while beautifying the city for its residents.³⁶

8/12/2022 Discussion with the City of Dallas Water

Dallas Water Utilities: Preserving the Water We Have For Now and Future Decades



Sourced from: <https://dallascityhall.com/departments/waterutilities/pages/default.aspx>

As part of my research, I reached out to many journalists and reporters who had previously written about the state of the water in Dallas to learn more about their findings. I also reached out to the City of Dallas to see if I could talk with someone who would be very knowledgeable about what Dallas is doing to prepare for projected water demand. I reached out to Alicia Lee, the Water Conservation Manager of Dallas, and she responded to my request to have a discussion. In addition, Denis Qualls, who is entering his 20th year as superintendent of the Planning Division of Dallas Water agreed to meet with me as well. Denis Qualls helps lead the planning for water related projects in Dallas and Alicia Lee works with her team to strategize ways to conserve water. After spending the majority of my summer conducting independent research about the City of Dallas Water, I still had some other critical questions that I still needed to find answers to. I thought that there would be no better way to find the answers and learn more about Dallas water than to talk to people who are experts about it.

Below are the highlights of my questions and of our discussion.

How safe is the water in Dallas?

Through my previous research, I learned that Dallas' water is rated as a superior water system, which is the highest rating given by the state of Texas for water quality.

After my discussion with Denis Qualls and Alicia Lee, I learned that Dallas tests its water about 45,000 times per month, or almost 63 tests per minute. These tests meet all of the testing requirements set by the FDA, and the city also exceeds these requirements by doing extra testing for other toxins/contaminants that are not on the FDA's list. Dallas' water is some of the highest quality water accessible within the region. It appears that Dallas' water is very safe.³⁷

What is Dallas doing about the new risk of forever chemicals?

PFAS is a microscopic and toxic forever chemical. As more research about this toxin is being published, more and more negative effects of this chemical are being revealed. These effects include increased cholesterol, increased likelihood of cancer, decreased vaccination response in children, changes in liver enzymes, increased blood pressure in pregnant women, and decreased newborn weight. Once this chemical gets into the water supply or in your blood, it is extremely

hard to eliminate, and it will stay for a very long time and does not degrade easily, hence the name ‘forever chemical’.³⁸

According to Denis Qualls, “we are testing for PFAS regularly, and there is less than 1 part per trillion [of PFAS] in our water.” The EPA health advisory for PFAS is 70 parts per trillion, and Dallas has 3 parts per trillion, or less than one drop of PFAS in 21 million gallons of water.³⁹



Sourced from: <https://aurigaresearch.com/water-testing/types-of-water-testing/>
Image: water testing done by the City of Dallas.

Will Dallas run out of water?

Dallas currently gets its water from seven lakes, rivers, and reservoirs, and based on Dallas Water Utilities’ forecasts, Dallas' current water supply will sustain water demand through 2030, and these water supplies will be exhausted in 2035.

The seven lakes/reservoirs and rivers that supply Dallas with water are highlighted in blue below.



Sourced from: <https://www.punctualplumberdallas.com/blog/where-does-our-water-come-from/>

Through my original independent research, it was unclear whether or not the City of Dallas has a plan to increase our water supply because I had read in an article titled *The Last Drop* (posted on the Texas Monthly), that Dallas will run out of water in 2035.

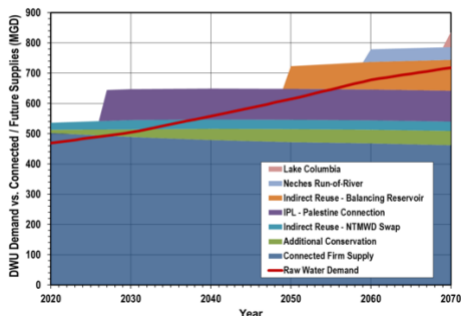
However, the City of Dallas plans to connect two more lakes, connect one more river, and reuse a considerably higher amount of water by constructing a reservoir. These projects are already funded and are under construction. Dallas’ current project is called the Integrated Pipeline Project. Slated for a 2027 completion, the 9-foot-wide pipeline will connect Lake Palestine

(located Southeast of Tyler, Texas) to the Dallas water supply. This project will provide over 100 million gallons per day to the Dallas water supply, and it will help Dallas meet the rising water demand through 2050. ⁴⁰

The next project is called Indirect Reuse through a Balancing Reservoir. This reservoir will store discharged non-potable water from the wastewater treatment plants and allow Dallas to treat the water and then use the water as needed. This project will be completed by 2050. ⁴¹

The next two projects will connect the Neches River, which runs south out of lake Palestine, and Lake Columbia, which is located 30 miles east of Lake Palestine. Since there is already a pipeline from Lake Palestine to Dallas, the water from the Neches River and Lake Columbia will go into that same pipeline, and then head back to Dallas. These two projects will be completed by 2060 and 2070 respectively. Together, these four projects will increase the water supply by 70% (from 500 million gallons per day to 850). ⁴²

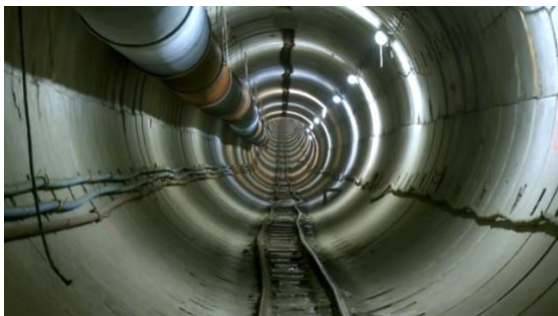
Figure ES-12. Recommended Strategy Implementation Timeline for Total DWU System (comparing Demands and Supplies)
Source: Section 6.4, Figure 6-9



Sourced from:

https://www.dallascityhall.com/departments/waterutilities/DCH%20Documents/2014_LRWSF_Final_Report_all_11302015.pdf

Image: projected water supply until 2070. The red line represents raw water demand, and the colored sections represent the daily quantity of water supplied by different projects.



Sourced from: <https://www.trwd.com/20249-2/>

Image: inside a section of the 100-mile pipeline created in the IPL.

What are we doing to conserve water?

Dallas uses half of its water for landscaping, and the City has enacted two different watering restrictions in an effort to conserve water. These restrictions include watering no more than twice a week and no watering during the hours of 10 am – 6 pm. These restrictions reduced water

consumption by over 20%, or 130 million gallons per day (from almost 600 MGD to just under 470 MGD).⁴³

The City of Dallas is also taking other measures to increase water conservation. One key initiative is focused on businesses. The City of Dallas will grant these businesses cash subsidies to meet water saving targets. In total, these 14 projects have saved between 90 million and 168 million gallons per year, or between 247 and 460 thousand gallons per day. The City of Dallas also already saves almost 20 million gallons a year through a project called “New Throne for your Home.” This project will replace residents’ old toilets for free. Dallas Water Utilities says it plans to use water usage data to target customers who will potentially qualify for free, minor plumbing repairs, which already saves the city 3 million gallons per year, or over 8,000 gallons per day. Even though it seems like each of these conservation projects do not save a considerable amount of water, water savings will add up and these projects will help Dallas save lots of water in the long run.⁴⁴

Other Highlights/Conclusion

Coming out of this discussion, I felt more secure about Dallas’ water supply. Denis Qualls and Alicia Lee told me that Dallas Water Utilities always prepares for the worse-case scenario. After asking so many questions and receiving quick and succinct answers, I realized that Denis Qualls and Alicia Lee, among many others in the City and at Dallas Water Utilities, have already discussed the issues I raised, and they have created plans to resolve them. In fact, they readily shared their 500-page water supply plan with me, which is titled *2014 Long Range Water Supply Plan*. The City is working updating their water supply plan, and it will be released in 2023/2024. The City of Dallas seems to be very planful about how it can preserve the quantity and quality of Dallas’ water for now and for future decades. It is great to know that our leaders have our daily necessities as their priority.

8/28/2022 Dallas Water Storage Tanks

An Essential Eyesore: Dallas Water Storage Tanks



Sourced from: <https://www.mentalfloss.com/article/64577/how-do-water-towers-work>

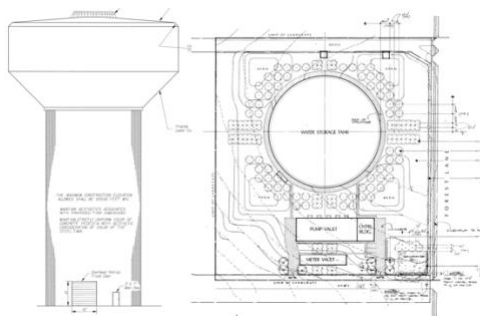
Image: Water tower

Introduction

Driving around town, I keep noticing these large cylinder-shaped water towers dotted around the Dallas area. These towers are elevated water storage tanks. Through my research about the water in Dallas, I learned that there are 21 storage tanks serving Dallas residents: 9 elevated, and 12 underground. These storage tanks are used to maintain water pressure, to store emergency water supply, and to provide additional water to meet peak demands.⁴⁵

Why are they cylindrical?

I've often wondered why all of these storage tanks are cylindrically shaped. Come to find out, there are a number of reasons for this. The cylindrical shape is better to hold liquid because it is extremely stable. The shape allows the storage tank to withstand the outward pressure that the liquid puts on the walls. It provides both a low center of gravity and strength to withstand harsher weather, especially high-speed winds as the cylinder allows wind to pass quickly around the tank versus pushing into it. The cylindrical shape, in the long run, also reduces corrosion and leakages that would occur in shapes with sharp edges and corners.



Sourced from:

https://dallascityhall.com/departments/waterutilities/DCH%20Documents/pdf/ElevatedStorageTank_standards_Oct2012.pdf

Image: Side and top views of an elevated water storage tank.

What are some requirements of these storage tanks?

There are many requirements for how these storage tanks must be built. In fact, Dallas has a 30-page document outlining exactly what requirements these storage tanks must meet. For both

elevated and underground tanks, there are, vehicular access, security access and surveillance, drainage, tank design, SCADA (control system), disinfection, quality assurance, warranty, acceptance, and administrative requirements. One of the most important requirements is the storage capacity and water pressure requirements: both elevated and underground tanks must meet the storage and firefighting demands (including hydrants and sprinkler systems) of the service area. One of the requirements is that the tank must be able to supply 500 gallons of water per minute to its fire hydrants.



Sourced from: <https://chiefunderground.com/underground-fireline-services/fire-hydrant-installation/>

Image: Fire hydrant in Dallas.

Conclusion

These storage tanks are the backup to the main water supply. Thanks to these storage tanks, Dallas was able to have running water through many storms that knocked out power in the Dallas area including: the winter storm of 2011, the winter storm of February 2021, the many tornados that occurred in the past few decades, and all of the smaller yet harsh storms.

I originally thought that these water storage tanks were merely eyesores—which probably explains why over half of Dallas’ water storage tanks are underground—but after learning more about them, I realize they are extremely valuable and clearly much needed



Sourced from: <https://www.wfaa.com/article/news/local/texas/dallas-texas-electrical-power-outage-ercot-failures/287-50797307-0afe-43eb-8175-b78e7e4fc13a>

Image: Dallas in the midst of the February 2021 winter storm that knocked out power for almost 10 days.

9/18/2022 Is Dallas' Water Safe and Sustainable Part 1 of 4: Summary of Findings



Background

I started doing independent research, with the guidance of some of my teachers, about the water in Dallas June 2022. I decided to split my research into three categories: demand, supply, and risks/threats. After spending the month of June doing independent research to answer my questions within these three categories, I thought that I would reach out to people who would be very knowledgeable in this field. I reached out to reporters and journalists who had previously written about the water in Dallas to see if I could have a discussion with them. I also reached out to the City of Dallas, and two people working for Dallas Water Utilities responded to my request, and I had a great discussion with them. They helped me answer a lot of my critical outstanding questions. I spent the month of July continuing my research and preparing a summary of my findings along with my detailed notes. I also started a blog, which you are reading now. The two months I spent doing research led me to here, finally finishing my research report. Below is a summary and some of the most important findings/conclusions from my research.

Summary

Safety

Dallas' water is very safe. In fact, Dallas' water is rated a "Superior Water System," which is the highest rating given by the State of Texas for water quality. Dallas also recently won the

Environmental Protection Agency's Region 6 Environmental Excellence Award for Public Water Supply, which means that Dallas has some of the best drinking water within five states, including Texas, Arkansas, Oklahoma, Louisiana, and New Mexico. Dallas' water is tested between 40 and 50 thousand times per month, so the water quality is constantly being monitored.

Sustainability

Although Dallas' current connected water supply will not last for more than 15 years, Dallas has a comprehensive plan to increase the water supply to make sure that the city has enough water for decades to come. Dallas' plans to increase the water supply are outlined in the 500-page *2014 Long Range Water Supply Plan*. Dallas' projects to increase the water supply are already funded, and the first one is currently under construction.

Additional risks

No matter the quality of a water system, there are always going to be risks, both to the quality and quantity of the water. DWU currently does a great job of mitigating risks. However, there are still unknowns about whether or not Dallas will face similar issues as other places in the United States.



Sourced from: <https://www.niehs.nih.gov/health/topics/agents/water-poll/index.cfm>

Findings/Conclusions

Demand: driven by population growth, water demand expected to go up by 70% in the next 50 years.

- Dallas uses 470 million gallons a day (MGD) among 3.2 million people for an average usage of 145 gallons per person per day.
- Dallas' water is used by both residents and customer cities.
- Dallas' demand will go up to 700 MGD by 2070, but it will be split among 6.4 million people for an average usage of 110 gallons per person per day.
- Dallas' population growth will be around 1.45% per year, a slight decrease from the 1.6% growth per annum that Dallas saw the past few years.
- Dallas' current conservation efforts will help save over 100 million gallons per year, and future conservation efforts will help save even more water.

Supply: new infrastructure to increase Dallas' water supply to meet demand through 2070.

- Dallas' current water supply can sustainably produce over 500 MGD of clean water.
- Dallas gets its water from seven sources, including six lakes, also called reservoirs (Lake Grapevine, Lake Lewisville, Lake Ray Hubbard, Lake Ray Roberts, Lake Fork, Lake Tawakoni) and one river system (Elm Fork of Trinity River).

- Dallas' 38.3 inches of yearly rainfall fill up Dallas' reservoirs, and all of Dallas reservoirs, with the exception of Lake Fork are above 85% capacity.
- By 2070, Dallas will complete four projects to increase the sustainable supply capacity from 500 MGD to 850 MGD, and these projects will cost over \$1.8 billion.
- Dallas has 3 different water treatment plants, 2 wastewater treatment plants, 22 pump stations, 15 wastewater pump stations, and 21 storage tanks. Dallas has over 5,000 miles of water main pipelines 4,000 miles of wastewater main pipelines, and 3,000 miles of storm drain pipelines.
- Dallas is currently upgrading its old/existing infrastructure to make sure that it is effective for years to come.
- Dallas uses chloramine (ozone), which is combination of chlorine and ammonia, to treat its water. Chloramine is safer than just chlorine because chlorine causes a reaction in the water that produces trihalomethanes, which are not good for humans.

Risks/threats: no imminent risks, but concerns to stay on top of.

- Dallas' water is incredibly safe, but threats like in Flint, Michigan, where underfunded maintenance budgets and aged infrastructure allowed lead to seep into its water supply; threats like in Austin, Texas, where population increases outpaced existing wastewater treatment capacity, causing it to overflow into its clean water system; and threats like in Hinkley, California, where chemicals used to treat the water were actually toxic to humans can cast doubt on whether or not Dallas will face similar or other issues.
- Questions below bring up issues that Dallas has a risk of facing.
 - Even though the FDA regulates safe levels for certain chemicals, are there certain unknown harmful effects of these chemicals? What is being done to ensure we continue to regulate the safety of the water above and beyond testing for known harmful chemicals?
 - Is DWU's current operating budget sufficient to upgrade the existing infrastructure?
 - Is DWU's future operating budget enough to maintain future infrastructure?
 - As climate change continues, what are the effects on the water supply?
 - Although the City of Dallas is being planful about its next steps, will there be any other unforeseen events that could put the water supply in jeopardy?⁴⁶

10/2/2022 Is Dallas' Water Safe and Sustainable Part 2 of 4: Dallas Water Demand



Who uses the water?

Dallas' water is used almost equally between two groups of people: Dallas residents (this category includes residents and businesses in the Dallas Water Utilities service area) and customer cities.

How much water is being used? What is the water used for?

Dallas Water Utilities supplies around 470 million gallons per day to its customers. The average Dallas resident uses around 145 gallons of water per day for drinking, bathing, cooking, landscaping, etc. Half of Dallas' residential water is used for residential landscaping. Dallas' customer cities need both treated water (for human consumption) and untreated water (for irrigation).

What has Dallas done to conserve more water?

Since Dallas uses half of its water for landscaping, the City has enacted two different watering restrictions in an effort to conserve water. These restrictions include watering no more than twice a week and no watering during the hours of 10 am – 6 pm. These restrictions reduced water consumption by over 20%, or 130 million gallons per day (from almost 600 MGD to just under 470 MGD).

The City of Dallas is also taking other measures to increase water conservation. One key initiative is focused on businesses. The City of Dallas will grant these businesses cash subsidies to meet water saving targets. In total, these 14 projects have saved between 90 million and 168 million gallons per year, or between 247 and 460 thousand gallons per day.

The City of Dallas also already saves almost 20 million gallons a year through a project called "New Throne for your Home." This project will replace residents' old toilets for free. Dallas Water Utilities says it plans to use water usage data to target customers who will potentially qualify for free, minor plumbing repairs, which already saves the city 3 million gallons per year, or over 8,000 gallons per day.

Even though it seems like each of these conservation projects do not save a considerable amount of water, water savings will add up and these projects will help Dallas save lots of water in the long run.

What is the projected growth in demand?

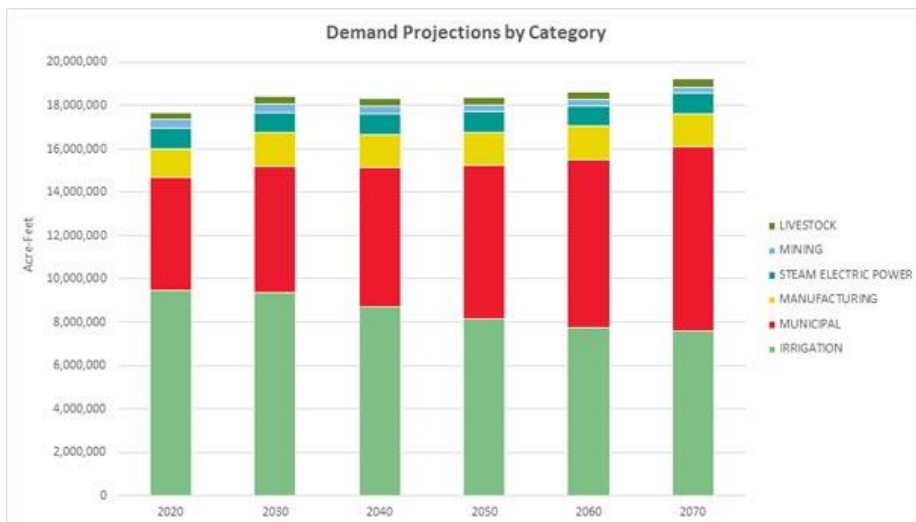
The current water demand is 470 million gallons per day, and by 2070, the water demand is projected to be 700 million gallons per day (a 70% increase). However, there are two factors that determine the demand: population and per person consumption.

Population

The current population that Dallas Water Utilities serves is 3.2 million. By 2070, this number will double to 6.4 million people. This represents an estimated 1.45% population growth per annum, which is slightly lower than the 1.6% per annum growth Dallas saw over the past few years. Despite the slightly lower per annum growth, the absolute population is still expected to double.

Per person consumption

Even though the population will double by 2070, Dallas’ water demand only goes up by 70%. The average Dallas resident currently uses almost 145 gallons per day. By 2070, the average resident is projected to use only 110 gallons, which is a 25% decrease from 50 years prior. This estimate is driven by continued conservation strategies to be implemented by both Dallas residents and Dallas Water Utilities’ customer cities.⁴⁷



10/23/2022 Is Dallas' Water Safe and Sustainable Part 3 of 4: Dallas Water Supply



Where does Dallas get its water? How much water can Dallas supply?

Dallas gets its water from seven sources, included are six lakes, also called reservoirs (Lake Grapevine, Lake Lewisville, Lake Ray Hubbard, Lake Ray Roberts, Lake Fork, Lake Tawakoni) and one river system (Elm Fork of Trinity River). Of all of these, Lake Ray Hubbard is the only reservoir that the City of Dallas owns and operates. Dallas and other municipalities share the rights to extract water from the other six places.

What is Dallas' rainfall like and what is its importance?

Dallas' yearly 38.3 inches of rainfall is essential to Dallas' water supply. Rainfall fills the reservoirs, and after a wet 2021, the reservoirs are all above 85% capacity, with the exception of Lake Fork, which is only at 72% due to repair work occurring at its dam. All of these reservoirs are at a lower level, consistent with yearly water level fluctuations. Dallas is very lucky to have a predictable amount of yearly rainfall. As climate change continued over the past few decades, the western part of the United States has become dryer, while the eastern part of the United States has become wetter. Dallas is right in the middle of United States, and the city has maintained a seemingly predictable amount of yearly rainfall for the past 150 years. The seven lakes/river and annual rainfall allow Dallas to have a sustainable water supply capacity of 502 million gallons per day (MGD).

What is Dallas doing to increase the water supply?

Because of rising water demand driven by population growth, Dallas' current lakes and reservoirs will not be able to sustainably supply the city with water past 2030, and Dallas is estimated to run out of water in 2035. As a result, the City of Dallas has approved, funded, and is currently working on connecting three more water sources and building a reservoir to extend its water supply through 2070. Dallas will do this through four main projects: The Integrated Pipeline Project (IPL), connecting Dallas to Lake Palestine; Indirect Reuse through a Balancing Reservoir; a connection to the Neches River; and a connection to Lake Columbia. These projects will be completed by 2027, 2050, 2060, and 2070 respectively, and are projected to increase the water supply to 850 MGD (a 350 MGD increase) and keep Dallas' water sustainable even as the population doubles by 2070.

Dallas' first of four projects is the Integrated Pipeline Project (IPL). The IPL is the construction of over 150 miles of pipelines, three new intake pump stations (one for Lake Palestine, one for the future Neches River project, and one for the future Lake Columbia project), and three new booster pump stations (to help move the water towards Dallas at a faster rate). The

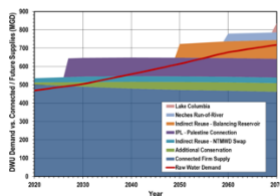
9-foot pipe will connect Lake Palestine to Joe Pool Lake where another pipeline will take the water to Bachman Water Plant to be cleaned and treated. The IPL is currently slated for a 2027 completion, and this project will provide Dallas with an additional 102 MGD, and it will help Dallas meet demand through 2050.

The second project is called Indirect Reuse through a Balancing Reservoir where Dallas will construct a reservoir to store discharged non-potable water from the wastewater treatment plants so that Dallas can treat the water and then use the water as needed. This project will be completed by 2050, and it will increase Dallas' water supply by 102 MGD, bringing the total supply to over 750 MGD.

The third project is the connection to the Neches River. The Neches River runs south out of Lake Palestine, and the intake pump station, created in the IPL, will pump water through a pipeline to Lake Palestine. This water will then get pumped through the 90-mile pipeline, created in the IPL, back to Dallas where it will be sent to Bachman Water Plant to be cleaned and treated. This project will supply an additional 42 MGD, bringing the water supply capacity to almost 800 MGD.

The final project slated to be complete before 2070 is the connection to Lake Columbia. Lake Columbia is located 20 miles east of Lake Palestine. Similar to the Neches River connection project, an intake pump station will pump the water from Lake Columbia to Lake Palestine, via a pipeline, where it will go inside the same 90-mile pipeline to Joe Pool Lake. The project will supply an additional 42 MGD, bringing Dallas' water supply capacity up to almost 850 MGD.

Figure ES-12. Recommended Strategy Implementation Timeline for Total DWU System (comparing Demands and Supplies)
Source: Section 6.4, Figure 6-9



Sourced from:

https://www.dallascityhall.com/departments/waterutilities/DCH%20Documents/2014_LRWSF_Final_Report_all_11302015.pdf

Image: projected water supply until 2070. The red line represents raw water demand, and the colored sections represent the daily quantity of water supplied by different projects.

What is the total cost of these projects?

Dallas will spend a total of \$3.914 billion on DWU's water projects between 2020 and 2070. The four main water supply projects mentioned above will cost a total of \$1.851 billion (\$1.097 billion for the IPL, \$675 million for the Balancing Reservoir, \$227 million for the Neches River Connection, and \$160 million for the Lake Columbia connection). Not only is DWU executing the above four projects, but DWU is executing sixteen other projects, between 2015 and 2070, to improve existing infrastructure. These projects will cost \$2.063 billion, and plan to execute expansions to existing water plants, expansions to an existing balancing reservoir, and improvements to the filters at the water plants.

What are the other lakes in the Dallas area used for?

There are eight other smaller lakes in the Dallas area that are not connected to the Dallas Water Supply, including Bachman Lake, Joe Pool Lake, Mountain Creek Lake, Lemmon Lake, North Lake, Fish Trap Lake, Lake Cliff, White Rock Lake, and Parkdale Lake. Water in half of these lakes (Joe Pool Lake, Mountain Creek Lake, White Rock Lake, and North Lake) is used as a coolant for Dallas Power and Electric Plants. Bachman Lake is used for municipal water storage. Lemmon Lake used to be a one-of-a-kind wildlife area but has since dried up due to a breach in the earthen dam.



Sourced from: <https://www.pinterest.com/pin/54254370480747272/>

Image: White Rock Lake in Dallas

What is the nature of the infrastructure in the Dallas water system?

Dallas has 3 different water treatment plants, 2 wastewater treatment plants, 22 pump stations, 15 wastewater pump stations, and 21 storage tanks. Dallas has over 5,000 miles of water main pipelines, 4,000 miles of wastewater main pipelines, and 3,000 miles of storm drain pipelines.

Dallas' water treatment plants treat water from DWU's reservoirs daily. Together, these three water treatment plants have a water treatment capacity of 900 MGD. These water treatment plants supply Dallas with clean drinking water every day. The Eastside Water Treatment Plant produces almost 63% of Dallas' clean water, or 314 MGD to around 2.2 million people. The Elm Fork and Bachman Water Treatment Plants, together, produce the remaining 37% of Dallas' daily drinking water, or about 188 MGD to around 1 million people per day.

Dallas' two wastewater treatment plants clean wastewater so that the water can go back into the environment: places like local creeks, lakes, and the Trinity River. However, this water is not potable, and it still needs to be treated before it can be used for human consumption. The two wastewater treatment plants, Southside and Central Wastewater Treatment Plants, can clean up to 260 MGD. However, the plants only treat around 160 MGD combined as that is how much wastewater DWU's customers produce per day.

Dallas' 22 pump stations pump clean water to DWU's customers. These pump stations pumping capacity is anywhere between 50,000 and 900,000 gallons per minute, or between 72 MGD and 1,200 MGD. The large gap is due to the age of the pump stations. Some of Dallas' pump stations are from the 1930s and can pump 50,000 gallons per minute. The newest pump stations can pump upwards of 900,000 gallons per minute. The water from these pump stations goes into the water pipelines and to DWU's customers to be used.

15 wastewater pump stations are dotted around DWU's 700 square mile service area. These pump stations pump wastewater from DWU customers to the wastewater treatment plants. Together, these pump stations can pump over 4.7 BGD, but currently, they only pump 160 MGD.

Dallas' 21 storage tanks help store water for their service area. There are 9 above ground tanks and 12 underground tanks. Although these storage tanks do not have a minimum storage capacity requirement, they must meet the storage and fire demands of its service area.

Dallas' thousands of miles of piping carry water miles to its various destinations. Dallas has three different types of water pipelines: water mains, wastewater mains, and storm pipes. Dallas has 5,000 miles of water mains, 4,000 miles of wastewater mains, and 3,000 miles of storm pipes. Most of these pipes range between 4" and 120" in diameter, and carry water to different parts of the city.



Sourced from: <http://dal-tech.com/wp-content/uploads/2015/11/pro-11-3.png>

Image: Ariel view of Dallas' Southside Water Treatment Plant

What are some upgrades that Dallas is doing maintain its current and future infrastructure?

While Dallas' infrastructure is effective, almost two thirds of it is over 30 years old. Dallas is trying to solve its number one problem, aging infrastructure, by constantly replacing old parts of the water system. Dallas is also renovating and replacing various essential infrastructure, including the water/wastewater treatment plants, the pump stations, the storage tanks, and piping. Here are some examples:

The Eastside Water Treatment Plant recently had some renovations done to increase its capacity to store clean, treated water. Four 16-million-gallon concrete tanks were added, increasing the capacity of treated water to 64 million gallons. This water can be sent to customers at a moment's notice. All four tanks were completed on time and within budget. By 2024, the Eastside Water Treatment Plant will provide water to over 3 million people.

The Elm Fork Water Treatment Plant will have its filter complex replaced. This replacement was part of DWU's long term planning. According to Mark S. Swain, City of Dallas Auditor, "The Elm Fork Water Treatment Plant Filter Complex has reached the end of its useful life and the project plans to improve water quality and filtration efficiency. The project was estimated to cost between \$130 million and \$145 million."

The Walcrest Pump Station had a complete rebuild. After being demolished, construction started in 2014 and finished eight years later in the spring of 2022. The Walcrest Pump Station was over 50 years old, so replacement parts were hard to find, and the equipment did not meet the current standards. The new Walcrest Pump Station now serves over 850,000 residents with clean water daily.

Dallas' pipes are also in need of being replaced. Around 1% of the piping is replaced per year, but Dallas has plans to increase annual pipe replacement so that the DWU water system can continue to run smoothly and serve its customers daily.

To maintain its future infrastructure, DWU must increase its operating budget. DWU is increasing its water rates so that the organization can increase its \$500 million operating budget to cover the additional maintenance costs that come with the new infrastructure.

How is the water treated to make sure that it is safe and clean?

According to the City of Dallas, "DWU uses chemical treatment, settling, filtering and disinfection to purify drinking water. The chemicals we use include chlorine and ammonia (which combines to make chloramine) or ozone to disinfect the water; lime and iron sulfate to

remove suspended solids in the water and for corrosion control; activated carbon to control offensive tastes and odors; and fluoride to help prevent tooth decay.

“We use chloramine instead of chlorine to protect the health and safety of our citizens. Studies have shown that using chlorine by itself can cause a reaction in the water that leaves by-products called trihalomethanes. Some studies indicate that trihalomethanes could be harmful if consumed in large quantities over long periods of time. Dallas water is considered non-corrosive, which means that it is less likely to leach lead from pipes than water that is corrosive.

“The combination of our treatment processes and the non-corrosive nature of Dallas water results in exceptionally high quality, safe drinking water. In fact, in 1991, DWU won the Environmental Protection Agency's Region 6 Environmental Excellence Award for Public Water Supply. Recently, Dallas was notified that it will again receive this prestigious award. That means that Dallasites are drinking some of the best water in five states: Texas, Arkansas, Oklahoma, Louisiana, and New Mexico.”⁴⁸

12/11/2022 Is Dallas’ Water Safe and Sustainable Part 4 of 4: Risks and Threats



Dallas’ water system is of the highest quality, and there have not been large issues in the past. However, with recent issues experienced by other water municipalities, it leads one to wonder whether Dallas, even with its superior water quality and rigorous testing, would face threats to its water quality at some point. Threats like in Flint, Michigan, where underfunded maintenance budgets and aged infrastructure allowed lead to seep into its water supply. Threats like in Austin, Texas, where population increases outpaced existing wastewater treatment capacity, causing it to overflow into its clean water system. Threats like in Hinkley, California, where chemicals used to treat the water were actually toxic to humans. Below are some other risks that could be an issue for Dallas’ water.

Table ES-10. Recommended Strategies for Dallas
Source: Section 6.3.2, Table 6-3

Recommended Strategy	Proposed Supply (MGD)	Total Project Cost (Million Dollars)	Unit Cost (\$/MGD-yr)
Additional Conservation	48.4	\$81.7*	\$3.38
Indirect Reuse Implementation - Main Stem Pump Station - NEMWD Lease Agreement	31.1	\$25.6*	\$3.25
Indirect Reuse Implementation - Main Stem Balancing Reservoir	102	\$670	\$1.74
Connect Lake Palestine	102*	-	-
IPL Part 1 - Connection to Lake Palestine*	-	\$939	\$2.31
IPL Part 2 - Connection to Bachman WTP**	-	\$244	\$3.69
Stretch Part of River	42.2	\$227	\$1.88
Lake Columbia	60.0	\$289	\$1.78
Totals	373.7	\$2,491.6	\$1.24*

Sourced from:

https://www.dallascityhall.com/departments/waterutilities/DCH%20Documents/2014_LRWSF_Final_Report_all_11302015.pdf

Image: Dallas’ future budget allotted to projects which will increase the water supply.

Is Dallas Water Utilities’ operating budget sufficient to upgrade the existing infrastructure?

Most of Dallas’ infrastructure is over 30 years old, and despite continuous efforts to maintain, repair, and replace various facilities, it is unclear whether there is sufficient budget or whether the pace of repairs and upgrades is sufficient to stave off future issues.

Is Dallas Water Utilities’ future operating budget enough to maintain future infrastructure?

As Dallas continues to construct more infrastructure, especially as projects like the IPL are being completed, the operating budget must increase to cover new maintenance costs. It is unclear how much the budget is slated to increase.

As climate change continues, what are the effects on the water supply?

As the climate continues to get warmer, evaporation increases, taking water from Dallas’ supply, and as rainfall could potentially decrease, other threats of our current climate to the supply of water remain unclear.



Sourced from: <https://www.punctualplumberdallas.com/blog/where-does-our-water-come-from/>
 Image: Reservoirs in the greater Dallas area.

Even though the FDA regulates safe levels for certain chemicals, are there certain unknown harmful effects of these chemicals that are used to treat Dallas’ water? What is being done to ensure we continue to regulate the safety of the water above and beyond testing for known harmful chemicals?

Just like more harmful effects are being discovered about forever chemicals, there could be unknown harmful effects of certain chemicals that are used in the Dallas water.

Although the City of Dallas is being planful about its next steps, will there be any other unforeseen events that could put the water supply in jeopardy?

Events like natural disasters, pandemics, and other large events could harm the water supply. Infrastructure could get destroyed in a natural disaster, and people might not be able to work due to a pandemic, putting at risk the ability to source Dallas with a sufficient amount of safe water.⁴⁹

12/31/2022 Inside Bill's Brain: Reinventing the Toilet

Background

Over the past few months, I have been watching various documentaries and movies relating to the global water crisis. A documentary that I found interesting was *Inside Bill's Brain*, which is a three-part series about Bill Gates' life. Included in this three-part series is how Bill Gates helps develop technology to help solve global issues. Watching this documentary led me to do some more research about Bill Gates' work in helping solve the global sanitation crisis.

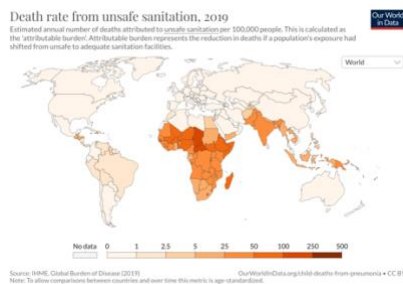


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Image: Bill Gates' *Inside Bill's Brain*

Scope of the global sanitation crises:

- 2.3 billion people, around 29% of the world, worldwide still do not have access to basic sanitation facilities. Basic sanitation facilities include places for safe disposal of human waste and maintenance of hygienic conditions (including garbage, industrial, and hazardous waste collection as well as wastewater treatment/disposal).
- 4.5 billion people, around 60% of the world, do not have access to safely managed sanitation
- 1.1 billion people, around 15% of the world, still practice open defecation
- Poor sanitation is the 18th most common cause of death, killing 775,000 people each year.



Sourced from:

<https://ourworldindata.org/sanitation#:~:text=Unsafe%20sanitation%20is%20responsible%20for%20775%2C000%20deaths%20each,15%25%20of%20the%20world%20still%20practice%20open%20defecation.>

Image: Death rates due to poor sanitation

What has been done to date:

In 2011, the Bill Gates Foundation challenged the world to reinvent the toilet. The goal of the “Reinvent the Toilet” program was to create a toilet that would process waste locally, without the need to connect to a sewer system. These toilets would help places without modern sewage systems and proper waste processing/disposal.

The world responded to Gates’ challenge, and within the decade, many toilets were created. Lots of these toilets turned human waste into valuable resources, including water, fertilizer, and electricity.

The documentary

In his documentary, *Inside Bill’s Brain*, Bill Gates highlights the \$50,000 toilet. Though it is called a toilet, it is more like a waste processor and will serve as a central sewage processing station. When waste is put into the machine, it converts it into clean, drinkable water. Because this toilet is expensive, it would not be inputted into every home. Instead, it would serve as a communal sewage plant and be placed in the middle of a town, slum, or city, so people can safely get rid of their waste and get clean water at the same time.



Sourced from: https://us.search.yahoo.com/yhs/search?hspart=ima&hsimp=yhs-remarklist&p=4.5%2F6&type=q3020_D3L4M_ext_bcrq

Image: the \$50,000 toilet

Learnings

Something that I learned from his documentary and my research of the sanitation crisis is that the sanitation crisis is directly related to the water crisis. When human waste is not properly processed and cleaned, it finds its way into nature. In one jar of untreated human feces, there could be up to 200 trillion rotavirus cells, 20 billion Shigella bacteria, and 100,000 parasitic worm eggs. Latrines, or outhouses, and open defecation, or excreting outdoors, directly contribute to the sanitation and water crises. Latrines contain lots of untreated waste and open defecation puts untreated waste directly into nature. Within this waste are deadly diseases that seep into nature. Because of the lack of proper sanitation, these diseases have found their way into water sources around the world, contaminating the world's clean water.⁵⁰

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