

## Water Conservation, Direct Potable Reuse and Other Strategies - ChatGPT 2/19/23

"I" = Interviewer, "G" = ChatGPT AI

**I:** Good morning, G. Today, I'd like to discuss the future of the western United States' water. Where are the states that rely on the Colorado River going to get their water in the next 20 years?

**G:** Good morning! The future of water in the western United States is a critical issue that has been receiving increasing attention in recent years. The Colorado River basin is a primary source of water for several western states, including Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. These states rely on the river for agricultural, industrial, and municipal water use.

The Colorado River basin has been facing water shortages in recent years due to a combination of factors, including population growth, drought, and climate change. The river's water levels have been declining, and the demand for water is expected to exceed supply in the future.

To address this issue, water management agencies in the region have been working to develop plans to reduce water usage and increase water conservation. Additionally, there have been discussions about developing new sources of water, such as desalination, water reuse, and importing water from other regions.

One potential solution is to increase the use of groundwater resources in the region. However, overpumping of groundwater can lead to subsidence and other negative impacts on the environment.

Another possibility is to develop new water storage facilities, such as reservoirs, to capture water during wet years and release it during dry years. However, the construction of new dams and reservoirs can be costly and can have negative environmental impacts.

In conclusion, the future of water in the western United States is a complex issue that will require a multi-faceted approach. Developing new sources of water, reducing water usage, and increasing water conservation will all be necessary to ensure a sustainable water supply in the region.

**I:** You mentioned subsidence and other negative environmental consequences. Is one of those consequences the dewatering of some rivers, like the Verde River in central Arizona?

**G:** Yes, that is correct. Dewatering of rivers is one of the negative environmental consequences that can occur as a result of overpumping groundwater in a region. When large amounts of groundwater are pumped out of an aquifer, it can cause the water table to drop, and nearby rivers and streams may start to dry up.

The Verde River in central Arizona is an example of a river that has been impacted by groundwater pumping. The river is fed by groundwater from the Verde Valley aquifer, which has been overpumped in some areas. As a result, some portions of the river have been dewatered or reduced to a trickle, which can have significant ecological impacts, such as loss of habitat for fish and other

aquatic species, as well as impacts on riparian vegetation and wildlife that depend on the river for water.

To address this issue, water management agencies in Arizona have been working to develop groundwater management plans that aim to balance the use of groundwater with the needs of surface water resources like the Verde River. These plans typically involve setting limits on groundwater pumping, implementing conservation measures, and increasing the use of surface water resources to reduce the reliance on groundwater.

**I:** While groundwater pumping is certainly a factor in the dewatering of the Verde, other influences, like climate change and surface water diversions for crop irrigation, also play a major role, don't they?

**G:** Yes, you're right that groundwater pumping is just one of the factors that can contribute to the dewatering of rivers like the Verde River in central Arizona. Climate change and surface water diversions for crop irrigation are also major factors that can impact the flow of rivers and streams in the region.

Climate change can exacerbate the impacts of water withdrawals and diversions on rivers and streams by altering the timing and amount of precipitation, increasing evaporation rates, and changing the timing and extent of snowmelt. This can result in reduced streamflow, increased water temperatures, and altered hydrologic regimes, all of which can negatively impact aquatic ecosystems and the species that depend on them.

Surface water diversions for crop irrigation can also have a significant impact on the flow of rivers and streams in the region. The diversion of surface water from rivers and streams for irrigation can reduce the amount of water available downstream, which can lead to reduced flows, dewatered sections of the river, and other impacts on aquatic ecosystems.

To address the challenges of water management in the region, a holistic approach that considers multiple factors such as groundwater pumping, climate change, and surface water diversions, will be necessary. This will likely involve a combination of measures such as increasing water conservation, promoting sustainable land use practices, and developing new sources of water.

**I:** How might the people of the Verde's watershed increase their water conservation, and what sorts of changes to land use might be necessary?

**G:** There are a variety of strategies that people in the Verde River watershed could use to increase water conservation and promote sustainable land use practices. Here are a few examples:

1. **Water-efficient irrigation:** One of the main uses of water in the Verde River watershed is for crop irrigation. Using water-efficient irrigation techniques, such as drip irrigation or low-pressure sprinklers, can significantly reduce the amount of water needed to irrigate crops. Farmers and ranchers in the region could also use soil moisture sensors and other technologies to monitor soil moisture levels and adjust irrigation schedules accordingly.

2. Landscape water conservation: The use of water for landscaping, particularly in urban areas, is another significant source of water use in the region. Homeowners and businesses can promote water conservation by using drought-tolerant plants, reducing the amount of lawn area, and using mulch to retain moisture in the soil.
3. Water reuse: Another strategy for increasing water conservation is to promote the reuse of wastewater. Treated wastewater can be used for irrigation or other non-potable uses, which can reduce the demand for freshwater resources.
4. Sustainable land use practices: Land use practices, such as forest management and range management, can also have a significant impact on water resources in the region. Sustainable land use practices that promote healthy watersheds, such as reducing erosion and protecting riparian areas, can help to maintain and improve the quality and quantity of water resources in the region.
5. Water pricing and incentives: Water pricing policies that reflect the true cost of water use can encourage conservation by providing financial incentives for users to reduce their water use. Incentives such as rebates for water-efficient appliances and landscaping can also promote conservation.

Overall, a combination of these strategies and other measures will likely be necessary to achieve sustainable water management in the Verde River watershed and other regions of the western United States.

**I:** I'm struck by your use of the term "true cost of water." Can you help me understand what you mean by that?

**G:** When I refer to the "true cost of water," I am talking about the idea that the price that consumers pay for water often does not fully reflect the actual cost of providing that water. In many cases, the cost of water includes not only the cost of treating and delivering the water to consumers, but also the cost of maintaining the infrastructure that is used to provide the water, as well as the environmental and social costs associated with water use.

For example, in some regions of the western United States, the cost of treating and delivering water to consumers may be relatively low, but the cost of maintaining and replacing aging infrastructure may be quite high. Additionally, the environmental and social costs of water use, such as the impact of groundwater pumping on surface water resources or the impact of water withdrawals on endangered species, are not always reflected in the price that consumers pay for water.

By considering the true cost of water, policymakers and water managers can better understand the full range of costs associated with water use and make more informed decisions about how to allocate water resources. This may involve implementing water pricing policies that more accurately reflect the true cost of water, as well as promoting water conservation and other measures to reduce the overall demand for water.

**I:** I might include the cost of seeking, securing, and transporting new sources of water.

**G:** Yes, absolutely. The cost of seeking, securing, and transporting new sources of water is another important factor that can contribute to the true cost of water. In regions where water resources are scarce or over-allocated, it may be necessary to invest in new infrastructure, such as pipelines or treatment plants, to bring in water from other sources. These costs can be significant and should be taken into account when considering the true cost of water.

In addition to the financial costs of developing new sources of water, there may also be environmental and social costs associated with these efforts. For example, building new water infrastructure may require land acquisition or the displacement of communities. There may also be environmental impacts associated with the diversion of water from one area to another or the treatment of water from new sources.

By considering the full range of costs associated with seeking, securing, and transporting new sources of water, policymakers and water managers can make more informed decisions about how to meet water demand while also minimizing negative impacts on communities and the environment. This may involve exploring alternative approaches, such as water conservation or the use of non-traditional water sources, to reduce the need for new infrastructure and minimize the overall costs of water management.

**I:** Explain what you mean by "non-traditional water sources."

**G:** When I refer to "non-traditional water sources," I am talking about sources of water that are not typically used for human consumption or other traditional water uses. These sources may include:

1. **Wastewater:** Treated wastewater can be used for a variety of non-potable uses, such as irrigation or industrial processes. This can help to reduce the demand for freshwater resources and promote sustainable water management.
2. **Stormwater:** Stormwater runoff can be captured and used for irrigation or other non-potable uses. This can help to reduce the demand for groundwater or surface water resources and promote sustainable land use practices.
3. **Desalinated water:** Desalination is the process of removing salt and other minerals from seawater or brackish water to produce freshwater. While desalination can be expensive and energy-intensive, it may be a viable option in regions with limited freshwater resources.
4. **Reclaimed water:** Reclaimed water is treated wastewater that has been further purified to meet drinking water standards. While the use of reclaimed water for drinking water is still relatively uncommon, it is becoming more widely accepted as a way to augment traditional water supplies.
5. **Harvested rainwater:** Rainwater can be harvested and stored for later use, such as irrigation or non-potable indoor uses. This can help to reduce the demand for freshwater resources and promote sustainable water management.

By considering the use of non-traditional water sources, water managers and policymakers can help to reduce the overall demand for freshwater resources and promote more sustainable water management practices. However, it is important to carefully consider the potential environmental

and social impacts of these approaches and ensure that appropriate safeguards are in place to protect public health and the environment.

**I:** I'm interested in hearing more about reclaimed wastewater. How much water can a typical Arizona community save by instituting a reclaimed water project (also called "direct potable reuse", or DPR)?

**G:** Direct potable reuse (DPR) is the process of treating wastewater to drinking water standards and then injecting the treated water into a drinking water supply. While DPR is technically feasible, it is a relatively new and untested technology in the United States, and there are currently no large-scale DPR projects in Arizona.

However, Arizona has a well-established program for using reclaimed water for non-potable uses, such as irrigation and industrial processes. Reclaimed water is typically treated to a level that is safe for non-potable uses, but not for drinking water. The use of reclaimed water can help to reduce the demand for freshwater resources and is an important component of water management in the state.

According to the Arizona Department of Environmental Quality, the use of reclaimed water has helped to offset the demand for potable water by an average of 23% across the state. In some communities, the use of reclaimed water has offset as much as 70% of the demand for potable water.

While the use of reclaimed water for non-potable uses can be a cost-effective and sustainable approach to water management, the use of reclaimed water for DPR is still a relatively untested technology in the United States and there are significant technical, regulatory, and public perception barriers to overcome. Nonetheless, DPR is being explored as a potential option to increase water supplies in areas with limited water resources, and ongoing research and pilot projects are helping to further develop and refine the technology.

**I:** There seems to be a large difference in the amount of water that can be reclaimed. What does that depend on?

**G:** The amount of water that can be reclaimed from a wastewater treatment plant depends on a variety of factors, including the size of the plant, the quality of the wastewater, and the treatment processes used. Here are some key factors that can affect the amount of water that can be reclaimed:

1. Size of the plant: The size of the wastewater treatment plant can have a significant impact on the amount of water that can be reclaimed. Larger plants can typically produce more reclaimed water than smaller plants.
2. Quality of the wastewater: The quality of the wastewater can affect the amount of water that can be reclaimed. Wastewater that is heavily polluted with chemicals or other contaminants may require more treatment and produce less reclaimed water than wastewater that is relatively clean.
3. Treatment processes used: The treatment processes used at the plant can also affect the amount of water that can be reclaimed. Some treatment processes, such as reverse osmosis

or advanced oxidation, are more effective at removing contaminants from wastewater than others.

4. Climate and seasonality: Climate and seasonality can affect the amount of water that can be reclaimed from a wastewater treatment plant. In dry climates with limited rainfall, there may be less water available for reclamation, while in wetter climates, there may be more water available.
5. Demand for reclaimed water: The amount of water that can be reclaimed also depends on the demand for the reclaimed water. If there is a high demand for reclaimed water in the community, the plant may produce more reclaimed water.

In general, the amount of water that can be reclaimed from a wastewater treatment plant is highly variable and depends on a range of site-specific factors. However, by implementing water conservation measures and utilizing non-traditional water sources, communities can reduce their reliance on freshwater resources and promote sustainable water management practices.

**I:** How does the cost of DPR compare to the cost of new wells and traditional water treatment?

**G:** The cost of DPR (Direct Potable Reuse) can vary depending on the specific circumstances of the project, including the size of the treatment plant, the quality of the source water, and the level of treatment required to produce drinking water quality. However, in general, DPR is considered to be a more expensive water supply option compared to traditional water treatment or developing new wells.

One of the reasons why DPR is more expensive is because it requires more advanced treatment processes to ensure that the water meets drinking water quality standards. This can include additional steps such as advanced filtration, reverse osmosis, and UV disinfection, which can increase the cost of treatment.

In addition, DPR also requires significant investment in infrastructure to ensure that the treated water can be distributed to consumers. This can include the construction of pipelines, storage tanks, and other infrastructure, which can be expensive.

By comparison, traditional water treatment or developing new wells may be less expensive, especially if the source water is of good quality and requires less treatment. However, traditional water supply options may have their own environmental and financial costs, such as energy use and greenhouse gas emissions associated with pumping and treatment.

In any case, the cost of water supply projects can vary greatly depending on the specific circumstances, so it is important to carefully evaluate the costs and benefits of different options in the context of local conditions and priorities. In general, a mix of water supply options may be the most effective and sustainable approach to meeting water demand in a given region.

**I:** Would you consider DPR to be a more sustainable solution than drilling new wells?

**G:** In many cases, DPR (Direct Potable Reuse) can be a more sustainable solution than drilling new wells. Here are a few reasons why:

1. Conservation of groundwater resources: Groundwater resources can be depleted through over-pumping, leading to long-term declines in water levels and reduced water availability. By using reclaimed wastewater as a source of drinking water, communities can reduce their reliance on groundwater and promote the conservation of this important resource.
2. Protection of surface water resources: Surface water resources, such as rivers and lakes, can also be impacted by overuse and pollution. By utilizing reclaimed wastewater as a source of drinking water, communities can reduce their reliance on surface water resources and help protect these important ecosystems.
3. Reduced energy use and greenhouse gas emissions: The energy required to pump and treat groundwater can be significant, and can contribute to greenhouse gas emissions. By utilizing reclaimed wastewater, which has already been treated and is available at the treatment plant, communities can reduce the energy use and greenhouse gas emissions associated with water supply.
4. Improved water quality: Reclaimed wastewater can be treated to a high level of quality, which can result in a safer and more consistent source of drinking water than some groundwater sources.
5. Resilience to drought and climate change: As climate change leads to more frequent and severe droughts in some regions, communities that rely on traditional water sources may face increasing water scarcity. By utilizing reclaimed wastewater as a source of drinking water, communities can increase their resilience to these challenges and reduce their vulnerability to water scarcity.

Overall, while there are some challenges and costs associated with implementing DPR, it can be an effective and sustainable water supply option for many communities.

**I:** OK, what would you consider the cheapest and most effective way to reduce water consumption in a typical Arizona community?

**G:** There are a number of strategies that can be effective in reducing water consumption in a typical Arizona community, and the most cost-effective approach will depend on a variety of factors, including local water availability, the existing infrastructure, and community preferences. Here are a few potential strategies to consider:

1. Water-efficient landscaping: Many Arizona communities have high levels of outdoor water use, which can be addressed through water-efficient landscaping practices. This can include using drought-tolerant plants, reducing the amount of turf grass, and installing efficient irrigation systems that minimize water waste.
2. High-efficiency appliances and fixtures: Water-efficient appliances and fixtures, such as low-flow toilets and showerheads, can significantly reduce indoor water use. While there is a cost associated with upgrading to these technologies, the long-term water and cost savings can be substantial.

3. Education and outreach: Education and outreach campaigns can be an effective way to encourage behavior changes that reduce water consumption. This can include distributing information on water-saving tips and best practices, and offering workshops or training sessions on water-efficient practices.
4. Leak detection and repair: Leaks can be a significant source of water waste, and detecting and repairing leaks can be an effective way to reduce water consumption. Communities can implement leak detection programs, and provide information and support to residents to help them identify and repair leaks in their homes.
5. Water pricing and incentives: Water pricing structures that incentivize conservation can be an effective way to encourage reduced water consumption. This can include tiered pricing structures that charge higher rates for higher levels of consumption, or offering rebates or incentives for installing water-efficient appliances and fixtures.

Each of these strategies has its own costs and benefits, and the most effective and cost-efficient approach will depend on the specific circumstances of the community in question. In general, a combination of these strategies, tailored to local conditions and priorities, may be the most effective approach to reducing water consumption and promoting sustainability.

**I:** How much water might an average Arizona household expect to save by switching to low-flow showerheads?

**G:** An average Arizona household can expect to save around 2,900 gallons of water per year by switching to a low-flow showerhead. This assumes that the household is replacing an older, less efficient showerhead with a new, WaterSense-certified low-flow showerhead. WaterSense is a certification program run by the U.S. Environmental Protection Agency (EPA) that identifies water-efficient products, including showerheads, that meet specific performance criteria.

A typical showerhead without any special water-saving features uses about 2.5 gallons of water per minute (gpm), while a WaterSense-certified low-flow showerhead uses no more than 2.0 gpm. By reducing the flow rate of the showerhead, a household can save both water and energy. In addition to the water savings, using a low-flow showerhead can also reduce the amount of energy needed to heat the water for the shower, which can result in additional cost savings.

It's worth noting that the actual water savings will depend on a variety of factors, including how long the household members typically shower, the frequency of showers, and the type of showerhead being replaced. However, overall, switching to a low-flow showerhead is a relatively simple and cost-effective way to reduce water consumption in the home.

So, a savings of 2900 gallons per year doesn't seem like much when compared to the average water use of about 100,000 gallons per household per year, am I right?

You are correct that the water savings from switching to a low-flow showerhead may not seem significant compared to the total water use of a typical Arizona household. However, it's important to remember that reducing water consumption is a multifaceted effort, and every little bit helps. When combined with other water-saving measures, such as replacing old toilets and installing efficient

irrigation systems, the water savings from low-flow showerheads can add up to a significant reduction in overall water use.

Furthermore, the water savings from low-flow showerheads can have a positive impact beyond just the household level. By reducing water consumption, households can help to conserve limited water resources, support healthy river ecosystems, and promote water sustainability in the broader community. Additionally, reducing water use can help to lower energy costs associated with water treatment and delivery, which can have environmental and economic benefits.

In short, while the water savings from low-flow showerheads may not seem significant in isolation, when combined with other water-saving measures, they can contribute to a larger effort to reduce water consumption and promote sustainability.

**I:** OK, how about low flow toilets. What can an average Arizona household save by switching to these new toilets?

**G:** Switching to low-flow toilets can result in significant water savings for an average Arizona household. Older toilets can use as much as 3.5 to 7 gallons of water per flush, while WaterSense-certified low-flow toilets use no more than 1.28 gallons per flush. By replacing an older toilet with a low-flow model, an average household can save around 10,000 gallons of water per year, or even more if the older toilet used more than 1.28 gallons per flush.

It's worth noting that the actual water savings will depend on a variety of factors, including the number of people in the household and how often the toilet is used. However, overall, switching to low-flow toilets is a cost-effective way to reduce water consumption in the home. In addition to the water savings, using a low-flow toilet can also help to reduce the amount of energy needed for water treatment and delivery, which can result in additional cost savings.

Some households may also be eligible for rebates or incentives from their water utility for upgrading to low-flow toilets, which can help to offset the cost of the new fixtures. Additionally, some local and state codes now require the use of low-flow toilets in new construction and remodeling projects, which can help to promote their use and encourage further water conservation efforts.

**I:** But aren't most newer homes already equipped with low-flow toilets?

**G:** You are correct that most newer homes are equipped with low-flow toilets. Federal law requires that all new toilets sold in the United States use no more than 1.6 gallons per flush, and many newer toilets are designed to use even less water than that. However, older homes that have not been updated may still have older, less water-efficient toilets that use more than 1.6 gallons per flush.

Additionally, even if a home is equipped with a low-flow toilet, it may be an older model that uses more water than the most efficient WaterSense-certified models. Upgrading to a newer, more water-efficient toilet can still result in significant water savings and cost savings over time, particularly for households that use a lot of water.

It's also worth noting that low-flow toilets are not the only water-saving measure that households can take. There are many other water-saving fixtures and practices that can help to reduce water consumption, such as low-flow showerheads, faucet aerators, and efficient irrigation systems. By combining multiple water-saving measures, households can maximize their water savings and reduce their environmental impact.

**I:** In your response above, you placed changes to more water efficient landscaping first on the list, which is where I would put it, too. How much water might that save an average Arizona household per year?

**G:** Landscaping can be a significant source of water use in Arizona, particularly during the hot and dry summer months. By making changes to landscaping practices and using more water-efficient plants and irrigation systems, households can reduce their outdoor water use and achieve significant water savings.

The exact amount of water that can be saved through changes to landscaping will depend on a variety of factors, such as the size of the yard, the type of vegetation, and the climate in the area. However, studies have shown that households can reduce their outdoor water use by up to 50% or more by implementing water-efficient landscaping practices, such as:

- Planting native or drought-tolerant plants that require less water
- Using mulch to help retain moisture in the soil
- Installing a weather-based irrigation controller that adjusts watering schedules based on weather conditions
- Using drip irrigation or low-flow sprinklers that deliver water directly to plant roots and minimize evaporation
- Limiting or eliminating turf areas that require frequent watering and maintenance

By making these changes, an average Arizona household could potentially save several thousand gallons of water per year. However, the actual water savings will depend on the specific practices implemented and the water use patterns of the household.

**I:** And what percentage of an average Arizona home's water consumption is used for landscaping?

The percentage of an average Arizona home's water consumption used for landscaping can vary widely depending on a number of factors, such as the size of the yard, the type of vegetation, and the irrigation system used. However, it's estimated that outdoor water use can account for as much as 50% or more of a typical Arizona household's total water consumption during the hot and dry summer months.

**G:** In general, outdoor water use tends to be higher in areas with larger yards, more vegetation, and hotter and drier climates. However, by implementing water-efficient landscaping practices, households can reduce their outdoor water use and achieve significant water savings. By focusing on more water-efficient plants and irrigation systems, and minimizing the use of turf and other water-

intensive features, households can significantly reduce their outdoor water consumption and help to conserve this precious resource.

**I:** So, it seems like improvements in landscape plants and irrigation can yield the largest single benefit in terms of water consumption. Is there a way to have attractive landscaping that uses no water at all?

**G:** While it may be difficult to have a completely water-free landscape, there are several strategies that can be used to minimize water use and still achieve an attractive and functional outdoor space. One approach is to use xeriscaping, which is a type of landscaping that is designed to require minimal water use and maintenance.

Xeriscaping involves selecting plants that are native or adapted to the local climate, as these plants are often better suited to the available moisture and can require less irrigation. Other key principles of xeriscaping include:

- Using mulch and other ground covers to retain moisture in the soil
- Grouping plants based on their water needs to minimize overwatering
- Using drip irrigation or other low-water delivery systems to minimize evaporation
- Incorporating hardscaping elements such as rocks and gravel to reduce the amount of turf and other high-water-use features

By following these principles and selecting appropriate plants and materials, it's possible to create an attractive and functional outdoor space that requires little to no irrigation. While this approach may not work for every situation or aesthetic preference, it can be a highly effective strategy for reducing water use and promoting sustainability.

**I:** Just for the record, what is currently the average water consumption in Arizona per household, per year?

**G:** The average water consumption in Arizona can vary depending on a number of factors, such as the size of the household, the local climate, and the efficiency of the water fixtures and appliances used. However, according to the Arizona Department of Water Resources, the average single-family household in Arizona uses approximately 100,000 gallons of water per year. This includes both indoor and outdoor water use, such as drinking, cooking, bathing, laundry, irrigation, and other uses.

It's important to note that there is significant variation in water use across different households and communities, and that some households may use significantly more or less water than the state average. Additionally, the actual amount of water used can depend on a variety of factors, such as conservation efforts, changes in water availability, and changes in lifestyle or household size.

**I:** And how many people live in a typical Arizona household?

**G:** The average household size in Arizona is around 2.6 people, according to the United States Census Bureau's 2019 American Community Survey. However, household size can vary significantly depending on factors such as location, age demographics, and economic status. Additionally, the average household size can change over time, as people move in or out of a particular area or as demographic patterns shift.

**I:** OK, so what does that make the average residential "Gallons per capita, per day", or "GPCD" in Arizona?

**G:** Based on the average water consumption per household in Arizona (approximately 100,000 gallons per year) and the average household size in the state (around 2.6 people), the average residential Gallons per capita, per day (GPCD) in Arizona is approximately 236 gallons per day.

**Editor's note: This is a miscalculation on AI's part. We have seen miscalculations before, so we generally verify the AI's math. In this case, 100,000 gallons divided by 2.6 people, divided by 365 days per year comes out to 105.4 GPCD. The Arizona Department of Water Resources (ADWR) [figures the average to be 146 GPCD.](#)**

It's important to note that this is just an estimate, and actual GPCD can vary depending on a number of factors, such as the climate and availability of water in a particular region, the efficiency of water fixtures and appliances, and individual household behaviors and practices related to water use. Additionally, GPCD can change over time, as water use patterns and availability shift.

**I:** So, a community that can keep its residential GPCD below, say, 80, is substantially below the Arizona average, right?

**G:** Yes, that's correct. If a community can keep its residential GPCD below 80, it would be using significantly less water than the average residential GPCD in Arizona, which is around 236 gallons per capita per day. This would represent a significant reduction in water use and could contribute to more sustainable water management practices in the region. However, it's important to note that the appropriate level of water use for a particular community will depend on a range of factors, including local water availability and demand, as well as economic and social considerations.

**I:** Of course. Now, in that very water-conscious community, that may already have a sharply-tiered water rate structure, a high percentage of low-flow toilets, is charging close to the "true cost of water," and encourages conscientious landscaping, what more can be done to get their consumption down even more?

**G:** In a water-conscious community that has already taken steps to reduce water consumption, there are several additional measures that could be taken to further reduce water use:

1. Rainwater harvesting: Installing rainwater harvesting systems, such as rain barrels or cisterns, can help capture rainwater and reduce the need for municipal water for landscape irrigation.

2. Greywater reuse: Reusing greywater, which is wastewater from sinks, showers, and washing machines, for landscape irrigation can also help reduce the need for municipal water.
3. Water-efficient appliances: Encouraging the use of water-efficient appliances, such as dishwashers and washing machines, can help reduce indoor water use.
4. Leak detection and repair: Identifying and repairing leaks in homes and businesses can also help reduce water waste.
5. Education and outreach: Continuing to educate the community about the importance of water conservation and providing outreach and resources for households and businesses to adopt more water-efficient practices can also help reduce water use.

By combining these measures with those previously mentioned, a community can achieve even greater reductions in water consumption and move closer to achieving a sustainable water future.

**I:** I didn't see using reclaimed water on that list. Is there a reason, or was that an oversight?

**G:** Using reclaimed water can certainly be another way to reduce water consumption in a community, and it can be a very effective option, especially for non-potable uses such as irrigation. However, it requires a significant investment in infrastructure to treat and distribute the reclaimed water, and there may be some public perception and acceptance issues to overcome. So while it can be a valuable tool, it may not always be the most practical or cost-effective solution for every community.

**I:** I have heard that communities with very low water use might experience some problems with their wastewater systems, is that true?

**G:** It is possible for communities with very low water use to experience problems with their wastewater systems, as wastewater systems are designed to operate at certain flow rates and volumes. If the flow of wastewater is too low, it can cause issues such as clogging, odor, and corrosion. This is especially true for gravity sewer systems, where the flow of wastewater is dependent on the force of gravity to move the wastewater through the pipes.

In such cases, it may be necessary to take steps to increase the flow of wastewater in the system, such as by connecting more users to the system, increasing water use efficiency, or implementing water conservation measures that do not significantly reduce wastewater flows. Alternatively, it may be necessary to consider alternative wastewater treatment technologies that can handle lower volumes of wastewater.

**I:** Would the use of DPR reduce this problem?

**G:** Yes, the use of DPR can help address the problem of low wastewater flows in communities with very low water use. In traditional wastewater treatment systems, there needs to be a certain minimum amount of wastewater flow to keep the treatment process functioning properly. If flows are too low, the treatment process may not work effectively, which can lead to issues such as odor problems and the accumulation of solids in the system.

However, with DPR, the treated wastewater is directly returned to the drinking water supply, rather than being discharged to a river or other surface water body. This means that the low wastewater flows are not a problem, since the treated water is being immediately reused. In fact, the use of DPR can help reduce overall water demand and increase the efficiency of the water system, since the same water is being used multiple times before being discharged to the environment.

**I:** What are the typical losses in the DPR process?

**G:** The typical losses in the DPR (Direct Potable Reuse) process can vary depending on the specific treatment methods used, the quality of the source water, and the conditions of the distribution system. However, in general, some losses are expected during the various stages of the treatment process, such as the filtration and reverse osmosis steps. Additionally, some treated water may be lost during the distribution process, due to leaks in pipes or other infrastructure issues. The amount of loss can be minimized through careful design, maintenance, and monitoring of the treatment and distribution systems. Overall, DPR has been shown to be an effective and reliable way to increase water supply, while meeting high standards for water quality and public health.

**I:** If a community adopts DPR, and it collects and treats 500,000 gallons of wastewater per day, how much purified water could the DPR system produce?

**G:** The amount of purified water that a DPR system can produce depends on a number of factors, including the quality of the influent wastewater, the treatment processes used, and the intended use of the purified water.

However, as a rough estimate, a DPR system can typically produce 70-90% of the influent wastewater as purified water. So, if a community collects and treats 500,000 gallons of wastewater per day, a DPR system might be able to produce 350,000-450,000 gallons of purified water per day.

It's important to note that this is just a rough estimate, and the actual amount of purified water that a DPR system can produce will depend on a variety of factors specific to each system.

**I:** So, if the community delivers 800,000 gallons of potable water to its customers and gets 70% of it back as wastewater, you might expect the DPR system to produce about 450,000 gallons of water, thereby increasing its water supply by about 55%?

**G:** Yes, that is correct. By recycling and reusing treated wastewater through DPR, a community can potentially increase its water supply and reduce the amount of water that it needs to obtain from traditional sources. The actual amount of water that can be produced through DPR will depend on various factors, including the efficiency of the treatment process, the quality of the source water, and the specific needs of the community.

**I:** How much water does a modern DPR system lose as brine?

**G:** The amount of brine generated by a modern DPR system can vary depending on several factors, including the specific treatment processes used and the quality of the influent wastewater. However, in general, brine can represent a loss of up to 20% of the treated water in a DPR system. This brine typically contains high levels of salts and other dissolved solids, and must be managed carefully to prevent impacts to the environment and public health.

**I:** If the influent wastewater is class A+ treated effluent, how much brine would be typical?

**G:** The amount of brine produced by a DPR system can vary depending on factors such as the quality of the influent wastewater and the specific treatment processes used in the system. However, in general, modern DPR systems can be designed to produce a relatively low volume of brine, often less than 10% of the volume of treated water. In the case of influent wastewater that has already undergone Class A+ treatment, the brine volume may be even lower. It's worth noting that brine from DPR systems is typically disposed of using methods that minimize impacts to the environment, such as deep well injection.

**I:** So, using a+ effluent for the influent to the DPR system might allow the DPR system to produce an even higher percentage of community's water needs?

**G:** Yes, using A+ treated effluent as influent to the DPR system can improve the quality of the treated water and reduce the amount of brine produced. This could potentially increase the percentage of the community's water needs that can be met by the DPR system. However, the specific amount of water that can be produced by the DPR system would depend on a number of factors, including the capacity of the system, the quality of the influent wastewater, and the efficiency of the treatment process.

**I:** Ok, I think that's good for now. Thanks for the help!

**G:** You're welcome! It was my pleasure to help. Don't hesitate to ask if you have any more questions in the future.