larly alarming in California, where the effects of climate change are already apparent, and the effects on the state's water supply are predicted to be devastating.

High Cost of Importing Water

Monetary cost is another major concern. It is amazingly expensive to move water against gravity. Every day, millions of gallons of water are moved hundreds of miles from the Delta to Orange County, and, as with other counties that rely on imported water, Orange must pay the cost of transporting its water.

Orange County also imports its water from another source: the Colorado River. Moving water from there has many of the same drawbacks as importing water from Northern California. To complicate matters, the water of the Colorado is divided among seven states and Mexico. This formerly reliable source, however, has been drying up due to drought and agricultural diversions: a river that once flowed into the Gulf of California, also known as the Sea of Cortez, is now barely a trickle by the time it reaches the sea.

Dilemma: Meeting Orange County's Future Water Demand

Regardless of logistics and costs, when Orange County's 2.3 million residents turned on the tap, they expected a quick and clean flow of

water. The management of the county's water utility had to ensure such a flow. However, as the county's water officials assessed their current usage and looked at projections for the next twenty to thirty years, they became concerned about their heavy reliance on Northern California and the Colorado River. Increasing the amount of water imported would subject them to high economic, political, and environmental costs. And they couldn't guarantee that an increase would satisfy the water demands of Orange County and leave enough water for the rest of the state's people, industries, and ecosystems.

In the mid-1990s, Phil Anthony, one of the elected officials charged with managing Orange County's water procurement, saw the situation this way: "The risk (for meeting the county's water needs) was just too big to depend on more water imported from the Delta or the Colorado." He and the eight other directors of the Orange County Water District began to look for ways to improve their access to local sources of water. Orange County's local source of water is its groundwater basin, a large underground reservoir fed by water from both surface and underground waters. Over the years, as the population grew and demand increased, the groundwater basin was being emptied faster than it was being replenished. A five-year drought had taken its toll and, to make matters worse, saltwater had begun seeping into the groundwater basin from the coastline. (As the waters in the groundwater basin are depleted and fall below the level of the adjacent ocean, the seawater enters the basin through

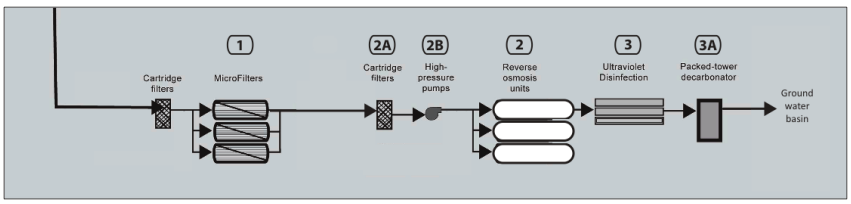
force of gravity.) Too much salt would make the water in the basin undrinkable.

Phil Anthony and the other water utility directors looked for help from the Orange County Sanitation District. The sanitation district is tasked with treating and disposing of wastewater from the 2.3 million residents of the county, which is quite a job: for every ounce of water used, another ounce must be treated and disposed of, usually into a river, bay, or ocean. Phil Anthony determined that this "sewer water" should not be wasted, but should instead be cleaned and reused to supplement their local water supply.

The Orange County method for recycling sewer water is through an elaborate three-step process involving *microfiltration*, *reverse osmosis*, and *ultraviolet light* treatment. One of the key components is the reverse osmosis (RO). In the RO process, water is forced through a membrane with holes so small that pesticides, pharmaceuticals, and viruses—which have much larger molecules—are filtered out.

After the sewer water goes through the three-step process, it is safe to inject it into the groundwater basin, where it mixes with Orange County's other water sources, including water from the Delta and the Colorado River. Then, the mixture goes through the drinking water treatment process (see pages 16–17.) Surprisingly, the cleanest water going into that drinking water treatment plant is the recycled water. Experts who understand the science behind recycling agree that consumers' fears about the purity of recycled water are not warranted.

Let's take you through the three-step process:



It starts with Microfiltration (Step 1).
Microfiltration (1) is a purification method commonly used to purify baby food and sterilize medicines. The microfiltration process uses straws with tiny holes in the sides that are 300 times smaller than a human hair. By drawing water through these holes, all bacteria and viruses are filtered out.

It continues with Reverse Osmosis (Step 2).
This step begins with the water moving through the **cartridge filters** (2A) which take out any remaining particles before the water goes on to the **reverse osmosis units** (2). Reverse osmosis or RO is one more of the unique technological advancements in the last few decades. The RO process uses **pressure** (2B) to force water with all its impurities through a very fine, plastic sheet-like membrane. The impurities are held back by the membrane allowing only the pure water to pass through to the other side, resulting in purified, near-distilled quality water. It is called reverse osmosis because in the normal osmosis process there is no pressure applied to move solution from one side of a membrane to another.

It finishes with Ultraviolet Light (UV) (Step 3).
If any impurities remain after Step 2, the water is blasted with hydrogen peroxide to eliminate any trace contaminants, and is then treated with **ultraviolet light** (3). The UV process can be compared to exposing water to concentrated sunlight and is similar to the way in which hospitals and dental offices sterilize instruments. In the UV system, the water is exposed to several cylinders containing 144 high-powered lamps. By the time the water has passed through the UV system, it has been exposed to 3800 high-powered lamps. After this three-step process, the water goes through a **decarbonator** (3A) which acts to aerate the water and stabilize its pH level. Then finally, the water is directed back into the County's groundwater basin.

Figure 2.2 Three-Step Recycling Process

Consider the words of the utility manager from neighboring San Diego County, Maureen Stapleton: "Concerns about recycled water are ludicrous. Do people think that the water from the Delta or the Colorado hasn't been used before? They've got to be kidding." This assessment is right on the mark. Whether we realize it or not, for decades treated sewage has been discharged into lakes and rivers that supply our drinking water, including the Great Lakes, the Mississippi and the Colorado rivers, and many of those in Northern California.

There were practical reasons why the Orange County Sanitation District was happy to share its sewer water with the county's water district. With the area's increasing population, the sanitation district's

sewage treatment plant and its ocean outfall pipe—a pipe 10 feet in diameter that disperses the sewer water into the ocean—were nearing capacity. Unless some of the sewer water was recycled, the sanitation district would need to enlarge its treatment plant and build a new ocean outfall, expansions that would cost millions of dollars and raise objections from environmentalists. Orange County has more to offer its residents than simply its proximity to Disneyland. Among the premier attractions are the beautiful beaches that are cherished and protected by well-organized advocacy groups. Some of those groups were among the strongest proponents of the recycled water project because they saw the benefits of filtering and recycling water instead of building a new large pipe to dump it into the ocean.

Orange County Delivers

The recycled water program became a winner for Orange County. As the county reduced its dependence on imports from Northern California and the Colorado River, the residents got a more reliable source of water, and the project's up-front costs of $480 million are being offset by savings to the water and the sanitation districts. For the water district, the cost of recycled water is about two-thirds the price of imported water and about one-quarter of the cost of desalinated seawater. (As we pointed out in Chapter 1, desalination uses a lot of fossil fuel energy and is very expensive.) The project saved the

sanitation district from the expense of having to expand its sewage treatment plant and build an expensive outfall pipe—not to mention the legal fees that likely would have been incurred to counter environmental opposition to the expansion.

In early 2008, Orange County received approval from state health authorities to begin producing 70 million gallons of water a day from its wastewater. It would be enough water for 500,000 residents of Orange County.

The recycled water program has many environmental benefits, including less wastewater being pumped into the ocean, and the recycled water process uses only half the energy it would take to transport the water from the Delta. Additionally, Delta water not used by Orange County is now available for other communities.

Orange County is way ahead of its Southern California neighbors in reducing its dependence on dwindling and expensive imported water, and is setting a good example for San Diego and Los Angeles. In 2008, several environmental groups sued the city of San Diego for increasing the amount of wastewater being dumped into the ocean. As part of the settlement, the city agreed to reduce the amount of ocean discharge by recycling some of its sewer water.

Los Angeles is now implementing a water recycling program. Due to a worsening drought, climate change, and the environmental