PART

One

Structure of the Water Business

CHAPTER 1

Water for People and the Environment

The water business is about the handling of water from the global environment all the way to your tap. It deals with global climate change and the health of the oceans, but it also delivers safe and palatable water to your tap. These broad responsibilities create a giant water industry across the world. But aside from scary headlines—like flood and drought—how do people learn about water as a business? To be told, most of the water business operates under the radar, and the goal of this book is to shine a light on it and explain it from A to Z. Let's begin with a big-picture look at the water business.

MEET THE WATER BUSINESS

Given their broad scope, water issues provide much content for the media, and you can choose what to believe about them. There are scary forecasts about climate change, drought, flooding, disease outbreaks, and legal gridlock. The people who make the forecasts benefit from a good headline, but the water stories soon recede from the public view. We are left to wonder: Will society drown in these crises or will it solve water problems?

When you think optimistically and consider our capacity to manage water systems, these forecasts don't look so scary. In fact, I believe that society will find ways to address its water problems responsibly and one at a time, mainly with local solutions. However, these won't always be pretty because water involves a lot of politics and arguments about money and value systems. If you detect an air of pessimism, it is because our success depends more on finding political will than it does on technology and money. For that reason, the subject of this book—the water business—must work within social, political, and legal systems to find its opportunities and

markets. Its high level of politics is the attribute of water as a business that distinguishes it from similar businesses.

Having acknowledged that the water business can't divorce itself from politics, let's think of the opportunities in it. Water services must be provided to billions of people around the world, and this creates a gigantic business. People need drinking water, cooking and bathing water, sewage treatment, pumps, wells, and myriad other products and services. On top of all of this is a layer of government involvement that creates many jobs on its own. Both business and government are entrenched in the water business and will continue to be so.

At its core, the water business is about obtaining, processing, and selling a precious resource that has many uses. Along the way, however, these activities lead to many paths that make water a diverse and little-understood business. For example, the water business is about much more than selling water. To illustrate, I explained to friends that you don't always make money by selling water, but you can make money by saving it (promoting conservation). A friend chimed in, "Yes, you also make money by litigating over it."

Another anecdote explains a common misunderstanding about paying for water. A nun protested a water-rate increase by saying that since God provided the water, it ought to be free. The water manager replied, "Sister, we agree the water should be free, but who will pay for the pipes and pumps?" This anecdote was told by Tracy Mehan (2007), a former EPA assistant administrator for water, who explained how the pipes and pumps make up the capital of the water industry and account for much of its business activity, but there are many more pipes and pumps than you would ever imagine. In fact, just for water supply there are upward of two million miles of underground distribution pipes in the United States.

These anecdotes about pipes, pumps, conservation, and litigation illustrate just a few aspects of the water business, which faces conundrums such as that you can lose money by saving water, a lesson learned by utilities that promote conservation only to find their revenues falling and their risks increasing. A utility faces either a conflict of interest or a moral hazard. Should it neglect conservation (and the environment), or should it sell less and charge more (thus making consumers mad), or does it sell less and try to put itself out of business without government subsidies?

Although its revenues are not quite as large as giant industries such as electric power or telecommunications, the water business has megaimpacts on many sectors of the economy and society. It often flies below investors' radar because its economic statistics are dispersed, but when they are aggregated they help identify and trace how the water business affects critical issues such as energy production, housing costs, industrial development, food supplies, and environmental integrity.

IS THERE A WATER CRISIS?

People sense the importance of the water industry, but they often cannot explain it beyond saying that water is essential to life and a compelling issue around the world. Headlines about it range from drought in Africa to spectacular water-main failures caused by aging infrastructure in big cities. A story may describe a megascale project, such as China's Three Gorges Dam, or it might be about a local issue, such as the hot-button issue of where fast-growing Atlanta will get water for the future. China's massive new dam supplies hydroelectricity for a large share of the rapidly developing nation and is paired with the country's new south-to-north water-transfer scheme to win the global contest for large-scale infrastructure projects hands-down. Although not as visible on the world scene, Atlanta's water problems have been seen as a trillion-dollar issue involving the city's future.

As we will see in the next chapter, the uses of water form a spectrum according to needs that range from drinking water for life support through uses of water for recreation and discretionary activities. Naturally, the values inherent in these uses vary from one extreme, where a person dying of thirst will pay any price, to the other extreme, where people waste water without a thought. As a result, the divergent values of water applied to various uses become a core issue in decisions about managing it.

On an overall basis, it is the aggregated importance of water that is so impressive. At the microscale, every one of the world's citizens (nearly seven billion and increasing) requires a minimum amount of clean water every day for drinking, cooking, and hygiene. There is no way around this requirement, so the business of supplying water to people will always be with us. Then, businesses require water to offer their products and services and manufacturing industries use vast quantities of water. Irrigated agriculture is the largest water user in dry regions, and electric power producers require vast quantities to produce energy. When you add up all of these needs, you begin to see the big picture of water's importance.

Attention to the water business around the globe sometimes reflects balanced scientific views and sometimes it is based more on advocacy and even superstition. For example, the European Public Health Alliance (2010) publishes dramatic statistics about water on its web site. It wrote that the global demand for water has doubled in the last 50 years and that in the next 20 years the average supply of water worldwide per person is expected to drop by a third as agriculture becomes more intensive and industry and population grow. This sounds alarming. It also wrote that waste management is not keeping pace, mentioned Belgium as a European country that lags in sewage treatment, and rated and a few countries in Central and Eastern Europe and Central Asia below some African countries.

It described climate change as being responsible for 20 percent of the increase in water scarcity up to 2050 with desertification a concern even in parts of Europe. It raised an alarm about water scarcity caused by vegetables and flowers being grown for export, golf tourism, and bottled-water production. Of course, the problem of lack of access to safe water and sanitation facilities is mentioned, along with the fact that even in Europe, many people live without piped water, such as in Romania, where all of the rural population does not have access to improved drinking water sources. This account concluded by identifying the impacts on vulnerable children, who die from waterborne diseases and are exposed to threats from arsenic, fluoride, and nitrates. Also, climate change is said to raise threats of water-related vector diseases, such as malaria. They blame global mismanagement of water resources with inertia at the leadership level and ignorant populations. These result in slow reforms and global competition in the water market. They say that water has become big business with annual profits of the water industry at 40 percent of oil and higher than the pharmaceutical sector.

Do these claims ring true? They should be subjected to a truth test, as newspapers do for election campaigns. As I look at them, it seems that each allegation is connected to an important water issue but the claims seem dramatic and difficult to prove. It is like each claim is a worst-case scenario and when you add them up, it makes a scary story. Let's take the claim that the demand for water has doubled in the last 50 years. This is certainly not true in the United States. Although the population has increased, the largest uses of water, for thermoelectric cooling and irrigation, have actually dropped. Industrial water use has also dropped considerably, and even the per capita use of municipal water has decreased. Similar water use conclusions might hold up for other developed countries, but it will also be true that in emerging and industrializing nations there will be rising demands for water caused by agriculture and industrial and population growth. So, my conclusion about the claim is that it contains elements of truth but is too dramatic and simplistic.

Scary stories about water do make for compelling reading and keynote speeches. In fact, we who work in the water industry like them because they assure us that we are doing important work and will have future opportunities. An example is a recent book about the water crisis that presents similar cases as the European Public Health Alliance, but in a well-written and entertaining style. Glennon (2009) explained a range of problems in the United States, including big issues such as the future water supply for megacities like Las Vegas and Atlanta and how some scientists predict that Lake Mead could dry up by 2021. Most of the issues he explains seem like small-scale local and regional water issues that could be solved with enough political will. Examples include the drying up of farms in Colorado (where I live), how the small Tennessee town of Orme ran out of water and had to

truck it in, how Bowater (a South Carolina paper company) could not discharge wastewater due to low flows and cut jobs, how due to lack of streamflow the Southern Nuclear Corporation was not allowed by the Nuclear Regulatory Commission to build two new reactors in Georgia, and several other local or regional issues.

Publications and media accounts about the water crisis do us a favor by sounding the alarm, but they seem sometimes to go off the deep end in describing the issues. As an engineer and manager, I may see solutions where others just see problems, but I have to temper my optimism with the same statement—a lot of the problems require political will and changes in human behavior that won't come easily.

The publicity about emerging threats and their implications for the water industry are discussed in more detail in Chapter 10.

WHAT IS THE WATER BUSINESS?

Chapter 2 presents a model of the water business, which can be explained in different ways. You can see water through a utility view (as a narrow utility-based business), or through a popular view (as a giant crisis), or through an academic and policy view (as a comprehensive and complex web of interrelated activities that focus on handling water). The approach taken here mixes these three to view the water business as a complex arena with many producers, suppliers, regulators, and customers and to explore its corners and niches.

While this view is ambitious and might seem superficial to someone looking for an in-depth treatment, it explains how the complex arena of the water industry is an important business sector with many parts. It presents a realistic view of the business that is devoid of sensationalism and even explains why the exposés and media stories of a water crisis can easily mislead us. The book discusses the readily apparent utility businesses of selling water and treating wastewater, but also probes important water-handling services that are not so apparent and fly below the radar, such as risk management for flood damage mitigation and dam safety.

To create a model of the multifaceted water industry a coherent framework is required. Otherwise the business is described as a collection of odds and ends. The organizing concept for this framework is that the water business is built around a set of water handlers that have major responsibility for the management of water. These water handlers become the producers of the goods and services provided by water and its management. An example of a good is the supply of potable water. A service can be the prevention of flood damage through water handling.

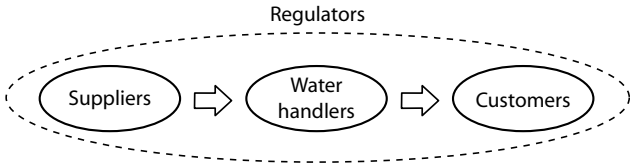

FIGURE 1.1 Water-industry players

Given the heavy regulation of water use, government regulators are also an essential part of the industry. Its other part comprises the array of suppliers of equipment and services that keep the pumps and pipes going. When you add these to its customer base, the water industry looks like other industries, with its own producers, suppliers, regulators, and customers (Figure 1.1). These players are discussed in more detail in Chapter 2.

In spite of this straightforward concept, there is no consensus about the status of the water business as a unified industry. For example, Steve Maxwell (2010), a management consultant who follows the water business closely, concluded that there is no such thing as a water industry, but instead it is a balkanized bazaar of quite different businesses focused on delivery of clean water. I think this is a valid point, and it illustrates how many of the players in the water industry also play in other industries.

It is true that that the water business is balkanized and includes many parts. In fact, water is more like an input to many industries than it is an industry itself. In that sense, it is a crosscutting industry, not one that produces distinct products and services itself. However, I believe that you can frame the business coherently by its focus on water handling as the organizing concept and that enables us to identify its suppliers, customers, and regulators to see the full picture of the business.

To its participants, the water business involves different businesses: the utility business, the point-of-use supply business, the irrigation business, the dam-building business, and several others. These players might work as utility operators, plumbers, contractors, consulting engineers, farm operators, or industrial facility managers, among other occupations. Our view of the water business depends on whether we focus on one part of it or the overall industry.

Given that the water business meets many purposes at different levels, I'd like to present a few examples of scales of business activity along the chain of water management from stream diversions to end uses. Figure 1.2 shows a map of water-industry activities that vary in scale and the split between public and private management. The examples shown range in scale from the household level to large river basins, like New York's Hudson River or even the Mississippi River. The public-private split is a variable to show whether the activity is mostly market driven or controlled by the public sector.

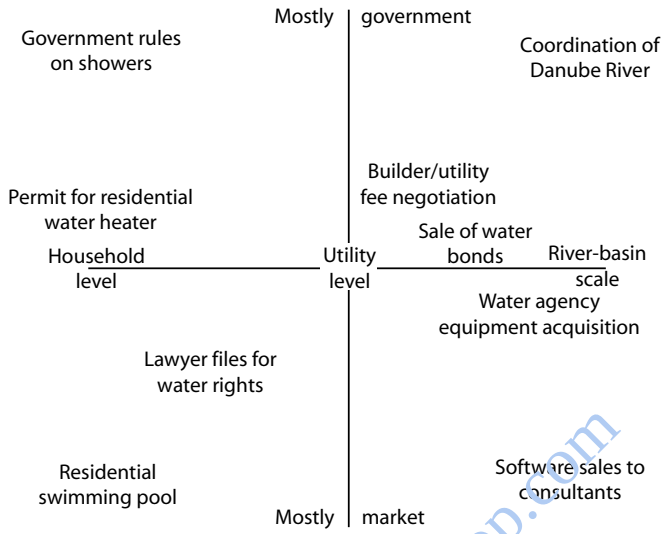

FIGURE 1.2 Water-business activities by scale and market intensity

This provides four quadrants: large scale and government driven, large scale but private, small scale and government driven, and small scale and private.

Looking at the lower left of Figure 1.2, you see a residential swimming pool, which requires pumps, pipes, and water-treatment chemicals. It involves the handling of water at a small scale and can be supplied entirely by private business, although it is subject to regulatory controls. This example and many other plumbing and household-level water-handling cases form the smaller end of the water industry. Each of these examples has larger variants, such as an Olympic-size swimming pool or even a water park, which would require much larger water-handling facilities.

Now look at the upper right quadrant. You see a builder negotiating with a utility on a water connection fee for a house, which can be as high as $30,000 for a single modest home where I live. Another example is the sale of water bonds, which might finance a new pipeline. At the highest end are the activities to coordinate a giant river basin, like the Danube River, which flows through 19 countries in Europe. While the controls on this will mainly be by government, the activity can involve river forecast software, new locks and dams, and other water-handling products or services.

These large- and small-scale examples are but a few of the many that frame the water business, which involves many types of products and services for different scales or activity and variations of involvement of the

private and public sectors. A model of the overall business will be explained in the next chapter, and the chapters after that lay out the details of water-handling sectors.

EVOLUTION OF THE WATER INDUSTRY

How the water industry evolved makes a fascinating story, and today's water issues did not develop overnight. They evolved as the convergence of population growth and economic development created the pressure on natural systems that we now see. To see how the water business evolved, we can consider how technologies such as dams, pipes, pumps, valves, and treatment processes emerged over the centuries. The business still uses these technologies and continues to adapt new methods to them, including processes, instruments, and computer controls.

Early civilizations developed aqueducts and crude pipes to deliver water for household and irrigation use but they lacked a good understanding of how they worked. During the 1700s and 1800s, scientific techniques of fluid mechanics, hydraulics, and hydrology evolved to improve our understanding. Public health and environmental engineering began later in the 1800s with the emergence of the field of microbiology. The discovery of the cause of cholera outbreaks led to modern water-quality management.

As cities evolved, raw water, drainage and wastewater systems were installed and by the late 19th century, today's building plumbing systems had emerged. With the invention of the water closet or toilet, the present wastewater system was set. Treatment systems started with filtration in 1887, and disinfection by chlorination followed by 1909. By 1900, waterborne infectious diseases were on the decline, but chemical problems increased. The 1912 Public Health Act included controls on drinking-water quality, but was not very enforceable. Chemical problems led to the passage of the Safe Drinking Water Act (SDWA) in 1974, and this act frames our management approach to safe water today.

The emergence of the water-quality industry led to large- and small-scale plumbing industries, which require several crafts and trades. Plumbers and gas fitters were placed into a single category by the Census Bureau until the 1880s. The Plumbing-Heating-Cooling Contractors Association began as the National Association of Master Plumbers in 1883. The Mechanical Contractors Association of America and the United Association plumbers union began in 1889, and the American Society of Sanitary Engineering began about 1900.

Prior to 1900, state governments passed laws regulating water rights, but the federal government was not involved much in water management.

In 1902, the Federal Reclamation Act was passed. In 1917, Congress enacted the first Mississippi Flood Control Program. In the 1930s, the Tennessee Valley Authority's electric power, flood control, conservation, and economic development projects were initiated. The Flood Control Act of 1944 authorized the Pick-Sloan plan for the Missouri River Basin, including projects for irrigation, power, flood control, and recreation. After World War II, a Senate Select Committee set the stage for the Water Resources Planning Act of 1965. Today, federal involvement has shifted from project development to policy and regulation.

In the West, state governments became active in water development out of necessity. The 1950s California State Water Plan is the most prominent example and remains the largest state-level initiative in the nation. In the East, state governments were less active in water projects, but they became involved in health and environment issues. Today, state governments fill the gap between the federal government and local water providers.

Each city government or special district has its own story of water management. The stories range from small-town systems to giant organizations such as the South Florida Water Management District, which handles water management in the Everglades and other regions of South Florida, or the Los Angeles Department of Water and Power, which is one of the largest combined water and electric power utilities in the United States.

Dams are of strategic importance in water management. Many small dams have been built to store water and divert it into canals and diversion pipes. With the advent of modern earth-moving equipment, large dams could be built, and during the 20th century, thousands of dams of all sizes were built in the United States. Major dams of the 20th century include Hoover Dam on the Colorado River, Tennessee Valley Authority (TVA) dams, and Grand Coulee Dam. The government's Corps of Engineers and the Bureau of Reclamation are generally considered the nation's major dam builders, along with electric power companies and the TVA.

Dams made hydropower and inland navigation possible. Early hydropower was by waterwheels, which were used to grind wheat more than 2,000 years ago. By the early 1900s, hydropower furnished more than 40 percent of U.S. electric power. After World War I, power development focused on thermal plants, and hydropower declined as a percentage of power production to about 10 percent of U.S. production now. Hydropower is still important, however, because it can be switched on and off quickly to provide peaking power and it is one of the renewable sources of energy, like wind power. New laws such as the Public Utility Regulatory Policies Act of 1978 and the 1986 Electric Consumers Protection Act changed the regulatory climate for hydropower. Now, utilities must consider energy conservation, fish, wildlife, and recreation as well as power in their license applications.

Inland navigation brought great economic benefits to 19th-century America. Built between 1817 and 1825, the Erie Canal was so successful that the construction cost was recovered from fees in just seven years. It stimulated port development and is thought to be a main cause of New York City's ascendancy as America's largest urban area.

About 1900, the nation entered a "conservation" era during the Presidency of Teddy Roosevelt. This peaked with Earth Day in 1970 and continues today. It has added an ecological thread to public health engineering and today's environmental engineers deal with fisheries, environmental impact, and wildlife, as well as public health.

With the environmental movement, it became much more difficult to build dams, especially large dams. This increases the importance of using existing water storage well. Today, removal of dams is being considered in many places in the United States, but new dams are under consideration in some developing countries.

The history of ground water and wells goes back to the beginning of mankind when humans learned to dig boreholes to obtain water supplies. With the development of pumps, people were able to lift water more easily, and with the development of diesel and electric motors, the modern groundwater development era began. Today, groundwater is used by more than half of all public water systems in the United States.

New water systems required sophisticated management organizations, and water utilities emerged along with cities. Philadelphia initiated their water supply system in 1798 after a yellow fever epidemic. It used public and private pumping facilities driven by horses. By midcentury, other large U.S. cities such as New York and Boston followed Philadelphia's lead. Today, these giant water utilities are major players in the U.S. water industry.

Prior to 1900, many water services were private. Pressure for government involvement led to conversion to public sector management. After about 1980, the pendulum swung back. Today, there is still interest in privatization, although it is not universally favored.

Consulting engineers have much influence in water engineering and management. During the 19th century, American engineers became famous for their work and consulting engineers are a major force in the water industry today. In fact, they comprise a "shadow workforce" for public water organizations. This is explained in more detail in Chapter 18.

Water industry trade associations and professional societies began to emerge in the late 19th century. The American Water Works Association began in 1881 and the Water Environment Federation began in 1926 through an effort to create a sewage works association. A complete inventory of water industry trade associations would include many significant trade, professional, and academic groups.

These are only a few of the fascinating historical developments that lay the foundation for today's water industry. Some of this history is told in more detail in Grigg (2005). For a detailed look at the public health aspects and emergence of modern utilities, *The Sanitary City* by Melosi (2008) is recommended.

WHY IS THE WATER BUSINESS HARD TO ORGANIZE?

With these many issues driving the need for water, news stories suggest that water will be a promising business in the future. However, you have to look beyond the headlines to understand the issues, and there will be pitfalls as well as opportunities. As a business, water is complex to define and has distinct parts. It is unique because it is so political, deals with personal matters as well as societal issues, and is heavily regulated. While there is a lot of rhetoric about water problems across the globe, at the end of the day it is mostly a local matter.

The aggregate of the local issues comprises the water business. Imagine if the world's seven billion people were organized into towns of 50,000 each. They would require 140,000 local water systems to serve the needs. Of course, things are not that simple. The United States alone has more than 50,000 community water systems, but many of these serve very small populations.

The balkanized businesses making up the water industry are hard to classify, and some of them are even government owned or outright government agencies. The difficulty in classification of this gigantic public-private mixture was explained in a special report on water in the *Economist* magazine, which concluded: "No wonder a commodity with so many qualities, uses and associations has proved so difficult to organize" (Grimond, 2010).

On the private side, many entrepreneurs offer products and services, but they are mostly dependent on government decisions for their sales and market opportunities. On the government side, the World Water Assessment Programme (2007) explained that in many countries water governance is in a state of confusion with a lack of water institutions or fragmentation of authorities and decision-making structures. So, while the water business is critical for our health, survival, and quality of life, as well as to sustain the environment, its many parts and unique public-private mixtures make it "hard to organize."

In the final analysis, the reason the water business is hard to organize lies in its diversity of purposes and scales. Water services have attributes of public goods and private goods, and to manage them we must traverse back

and forth between government and private sector approaches. This takes us into uncomfortable territory of embracing government and business methods simultaneously.

To serve the needs of people and the environment, water management requires many actions at scales from local homes up through river basins that cover large regions. It may be difficult at the small scale for us to connect our actions to the big picture, especially when we are balancing objectives that range from safe drinking water to using streams for recreation.

So, the water business is a mixture of activities that converge on the core issue of handling water. As it lacks identity, someone might look at the activities I include in the water business and say, "You are just adding up things that don't relate and calling it a water business!" That's an observation that you might expect, but I hold that it isn't valid because the activities do relate to one another, although it is true that sometimes the people involved in them do not recognize their relationships with others in the water business. What you can say about these activities is that while they involve water handling, most also involve other primary activities. In that sense, water is an allied industry to many others. Let me cite a few examples to illustrate this.

An employee of a company that produces, installs, or services household or business point-of-use water-treatment devices might recognize her participation in the water business but not realize how close her work is to that of a treatment plant operator working for a public water system. By the same token, a plumber would normally identify with his craft of plumbing and not primarily with the water business. Yet that same plumber deserves credit as one of the main protectors of public health by preventing waterborne disease through following codes and maintaining effective water-handling systems.

An irrigation farmer might have to learn the fine points of surface and groundwater movement, consumptive use, and water rights so that he can manage his assets productively. A landscape architect might sketch out a site drainage plan with physical and ecological features, and the plan might include the same basic analysis that a water resources engineer would perform to lay out a storm drainage plan for a subdivision. A ranger at a national park might be promoted into management and deal with permitting and access issues related to water resources, and thus deal with the same types of planning and regulatory issues as a water-resources planner.

Finally, at the residential and commercial levels, a sales team might work at a kitchen and bath exposition and explain the aesthetic and safety attributes of water-handling equipment, but think of themselves as part of the home improvement industry, rather than the water industry. All of these examples show how the water industry involves core activities of water handling, but many of the people involved in it would not identify water as their primary business.

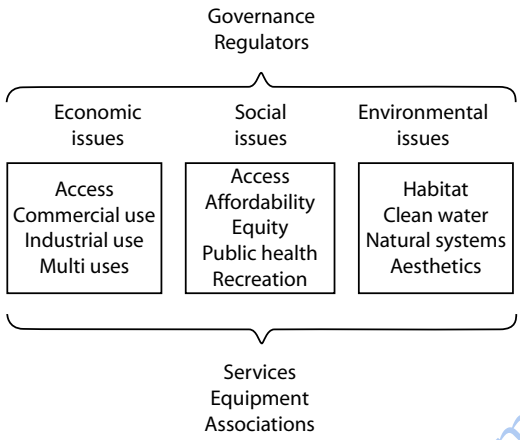

FIGURE 1.3 Water-industry interdependency

In the way of a summary of the complexity of the water business, Figure 1.3 illustrates its interdependencies among social, economic, and environmental issues and sectors and how both governance and regulators are required to deal with the many issues, while the water handlers are supported by a broad array of suppliers.

PREVIEW OF THE BOOK

The water business is organized differently from businesses that might seem similar, such as the electric power industry. The big providers of electric power are major investor-owned utilities, such as Edison International, and government utilities, such as the Tennessee Valley Authority. Also, smaller providers include cooperatives, small cities, and power districts. Electrical contractors do much of the work to hook up customers, and there is a large supplier segment that provides everything from large generators to light bulbs for appliances. Regulators consider rates, safety, and the environment.

In the water industry, the sale of water as a commodity is similar to the sale of electric power, but the water industry also provides additional services for wastewater, stormwater, and irrigation and drainage. In addition, the water industry serves instream flow and environmental water needs. It even takes care of disaster management and water drainage as water bodies pass through cities and other settlements. All of these separate facets make water different and more complex than just a commodity industry.

After the overall explanation of the water industry in Chapter 2, the book turns to the water-handling sectors: water supply, wastewater,

industrial water, stormwater, irrigation and drainage, and an environmental sector named "instream flows." This section of the book also explains dams and groundwater systems, which are two important parts of the water infrastructure.

The chapters about water handling include discussions of the water-using customers. These include sectors focused on land uses such as urban development, landscaping, and floodplain management. Farming is a customer of irrigation and drainage, and it makes many demands on water and has massive impacts on the environment. Now that renewable energy is such a fast-growing sector, its water demands have increased and thickened the web of the energy-water nexus. The major source of renewable energy is hydropower, which goes hand in hand with river navigation as a control mechanism on stream flows. Large water-dependent industries, point-of-use manufacturers, and the bottled water industry are as much a part of the water industry as the utilities are.

The next part of the book contains chapters about driving forces and issues in the water industry, such as government involvement, privatization, law and regulations, financial structure, water and health, and workforce capacity. These are introduced by a chapter that looks ahead at how the emerging water industry will respond to societal trends.

The next section of the book is about product and service suppliers. The discussion is about equipment and types of services, and it is partitioned into size groups ranging from large utilities to small systems that work in individual residences. In addition to the usual products and services you think of as connected to water, this part of the book includes discussions of financial services to the water industry and the business of commodity water, which designates attempts by some entrepreneurs to develop and sell bulk water.

This final part of the book includes a chapter on the ultimate challenge of using business and philanthropy to address the critical issue of safe drinking water and sanitation for all and a concluding chapter about water investments and careers.