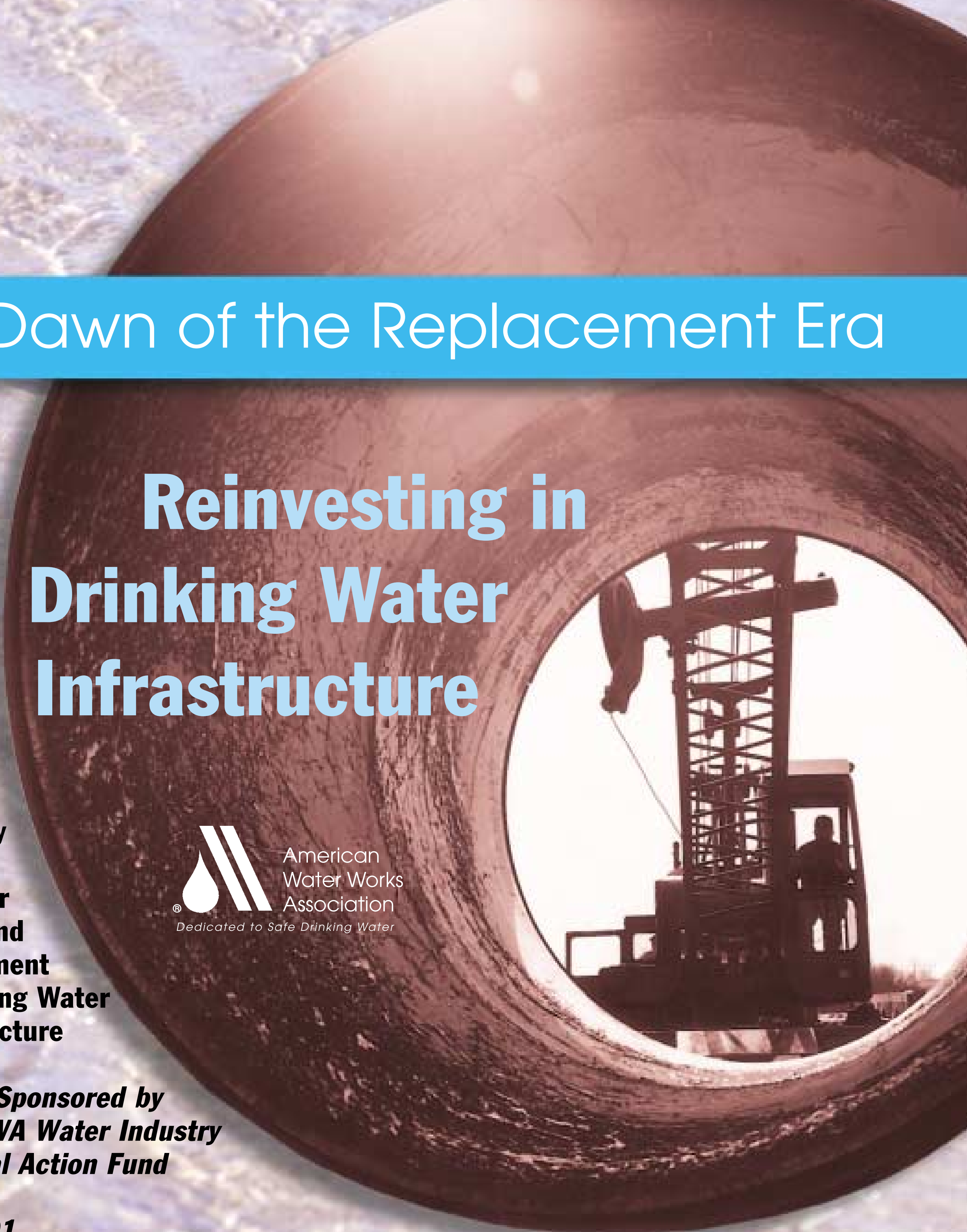
Dawn of the Replacement Era

Reinvesting in Drinking Water Infrastructure



An Analysis of Twenty Utilities' Needs for Repair and Replacement of Drinking Water Infrastructure

American Water Works Association

Dedicated to Safe Drinking Water

A Study Sponsored by The AWWA Water Industry Technical Action Fund

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EXECUTIVE SUMMARY

The importance of safe drinking water to public health and the nation's economic welfare is undisputed. However, as we enter the 21st Century, water utilities face significant economic challenges. For the first time, in many of these utilities a significant amount of buried infrastructure—the underground pipes that make safe water available at the turn of a tap—is at or very near the end of its expected life span. The pipes laid down at different times in our history have different life expectancies, and thousands of miles of pipes that were buried over 100 or more years ago will need to be replaced in the next 30 years. Most utilities have not faced the need to replace huge amounts of this infrastructure because it was too young. Today a new age has arrived. We stand at the dawn of the replacement era.

Extrapolating from our analysis of 20 utilities, we project that expenditures on the order of $250 billion over 30 years might be required nationwide for the replacement of worn-out drinking water pipes and associated structures (valves, fittings, etc). This figure does not include wastewater infrastructure or the cost of new drinking water standards. Moreover, the requirement hits different utilities at different times and many utilities will need to accelerate their investment. Some will see rapidly escalating infrastructure expenditure needs in the next 10–20 years. Others will find their investment decisions subject to a variety of factors that cause replacement to occur sooner or at greater expense, such as urban redevelopment, modernization, coordination with other city construction, increasing pipe size, and other factors.

Overall, the findings confirm that replacement needs are large and on the way. There will be a growing conflict between the need to replace worn-out infrastructure and the need to invest in compliance with new regulatory standards under the Safe Drinking Water Act. In addition, the concurrent demands for investment in wastewater infrastructure and compliance with new Clean Water Act regulations, including huge needs for meeting combined sewer overflow (CSO) and stormwater requirements, will compete for revenue on the same household bill.

Ultimately, the rate-paying public will have to finance the replacement of the nation's drinking water infrastructure either through rates or taxes. AWWA expects local funds to cover the great majority of the nation's water infrastructure needs and remains committed to the principle of full-cost recovery through rates. However, many utilities may face needs that are large and unevenly distributed over time. They must manage a difficult transition between today's level of investment and the higher level of investment that is required over the long term. Facing an inexorable rise in infrastructure replacement needs driven by demographic forces that were at work as much as 100 years ago, compounded by the negative effects of changing demographics on per-capita costs in center cities, many utilities face a significant challenge in keeping water affordable for all the people they serve.

Meeting this challenge requires a new partnership in which utilities, states, and the federal government all have important roles. Utilities need to examine their rate structures to assure long-term viability. States need to streamline their programs. And the federal government needs to significantly increase assistance for utilities.

To better understand this problem, the American Water Works Association undertook studies of 20 large and medium utilities. The findings and recommendations of this report provide the basis for this new partnership to achieve the goal to which we all aspire—the provision of safe and affordable drinking water for all Americans.

Findings:

- Water utilities must make a substantial reinvestment in infrastructure over the next 30 years. The oldest cast iron pipes, dating to the late 1800s, have an average life expectancy of about 120 years. Because of changing materials and manufacturing techniques, pipes laid in the 1920s have an average life expectancy of about 100 years, and pipes laid in the post-World War II boom can be expected to last about 75 years. The replacement bill for these pipes will be hard on us for the next three decades and beyond.

- Most utilities are just now beginning to face significant investments for infrastructure replacement. Indeed, it would have been economically inefficient to make large replacement investments before now. The utilities we studied are well managed and have made the right decisions. But the bills are now coming due, and they loom large.

- On average, the replacement cost value of water mains is about $6,300 per household in today's dollars in the relatively large utilities studied. If water treatment plants, pumps, etc., are included, the replacement cost value rises to just under $10,000 per household, on average.

- Demographic shifts are a significant factor in the economics of reinvestment. In some older cities, the per-capita replacement value of mains is more than three times higher than the average in this sample due to population declines since 1950.

- By 2030, the average utility in the sample will have to spend about three and a half times as much on pipe replacement due to wear-out as it spends today. Even so, the average utility will also spend three times as much on repairs in that year as it spends today, as the pipes get older and more prone to breakage.

- The water utilities studied concurrently face the need to replace infrastructure and upgrade treatment plants to comply with a number of new regulations to be implemented under the Safe Drinking Water Act. Many municipalities also face significant needs for investments in wastewater infrastructure and compliance. This concurrent demand significantly increases the financial challenge they face.

- Overall, in the 20 utilities studied, infrastructure repair and replacement requires additional revenue totaling about $6 billion above current spending over the next 30 years. This ranges from about $550 per household to almost $2,300 per household over the period. These household impact figures do not include compliance with new regulations or the cost of infrastructure replacement and compliance for wastewater.

- The pattern and timing of the need for additional capital will be different in each community, depending on its demographically driven replacement "wave."
- Household impacts will be two to three times greater in smaller water systems ($1,100 to $6,900 per household over 30 years) due to disadvantages of small scale and the tendency for replacement needs to be less spread out over time.
- Because of demographic changes, rate increases will fall disproportionately on the poor, intensifying the challenge that many utilities face keeping water affordable to their customers.

Recommendations:

America needs a new partnership for reinvesting in drinking water infrastructure. There are important roles at all levels of government.

1) Measures by Utilities and Local Governments

Although the AWWA analysis has looked at the infrastructure issue in the aggregate, many key issues must be addressed at the local utility level. Utilities should develop a comprehensive local strategy that includes:

- Assessing the condition of the drinking water system infrastructure.
- Strengthening research and development
- Working with the public to increase awareness of the challenge ahead, assess local rate structures, and adjust rates where necessary.
- Building managerial capacity.

2) Reform of State Programs

The states too have an important role to play in addressing our infrastructure funding needs. States may need to match an appropriate share of any new federal funds that are provided for infrastructure assistance. Moreover, states need to reform their existing programs to make them more effective. States should commit to:

- Respecting the universal eligibility of all water systems for federal assistance.
- Streamlining their programs for delivery of assistance and allow alternative procurement procedures that save money.
- Making their financing mechanisms more attractive by committing to grants and very low or negative interest loans.
- Using federal funds in a timely fashion or face the reprogramming of those funds to other states.

3) A Significant Increase in Federal Assistance

The federal government has a critical role to play in preventing the development of a gap in water infrastructure financing. AWWA recommends either changing and expanding the existing Drinking Water State Revolving Fund and other drinking water programs, or creating a new, infrastructure-focused fund. The federal role should include:

- Significantly increased federal funding for projects to repair, replace, or rehabilitate drinking water infrastructure.
- An increase in federally supported research on infrastructure management, repair and replacement technologies.
- Steps to increase the availability and use of private capital.

Reinvesting in Drinking Water Infrastructure

Dawn of the Replacement Era

Introduction

The importance of safe drinking water to the nation's public health and economic welfare is undisputed. About 54,000 community drinking water systems provide drinking water to more than 250 million Americans. By keeping water supplies free of contaminants that cause disease, our public water systems reduce sickness and related health costs as well as absenteeism in the workforce. By providing safe and sufficient supplies of water, America's public water systems create direct economic value across nearly every sector of the economy and every region of the country. However, significant economic changes are confronting the water profession as we enter the 21st Century. The new century poses new challenges in sustaining the infrastructure—particularly the underground pipes—that provides the broad public benefits of clean and safe water.

Recognizing that we are at the dawn of a major change in the economics of water supply, the American Water Works Association (AWWA) has undertaken an analysis of the infrastructure challenge facing utilities. The project involved correlating the estimated life of pipes with actual operations experience in a sample of 20 utility systems geographically distributed throughout the nation (see Figure 1). Projecting future investment needs for pipe replacement in those utilities yields a forecast of the annual replacement needs for a particular utility, based on the age of the pipes and how long they are expected to last in that utility. This analysis graphically portrays the nature of the challenge ahead of us. It also serves as the foundation for AWWA's call for a new national partnership to address the looming need to reinvest in our drinking water infrastructure.

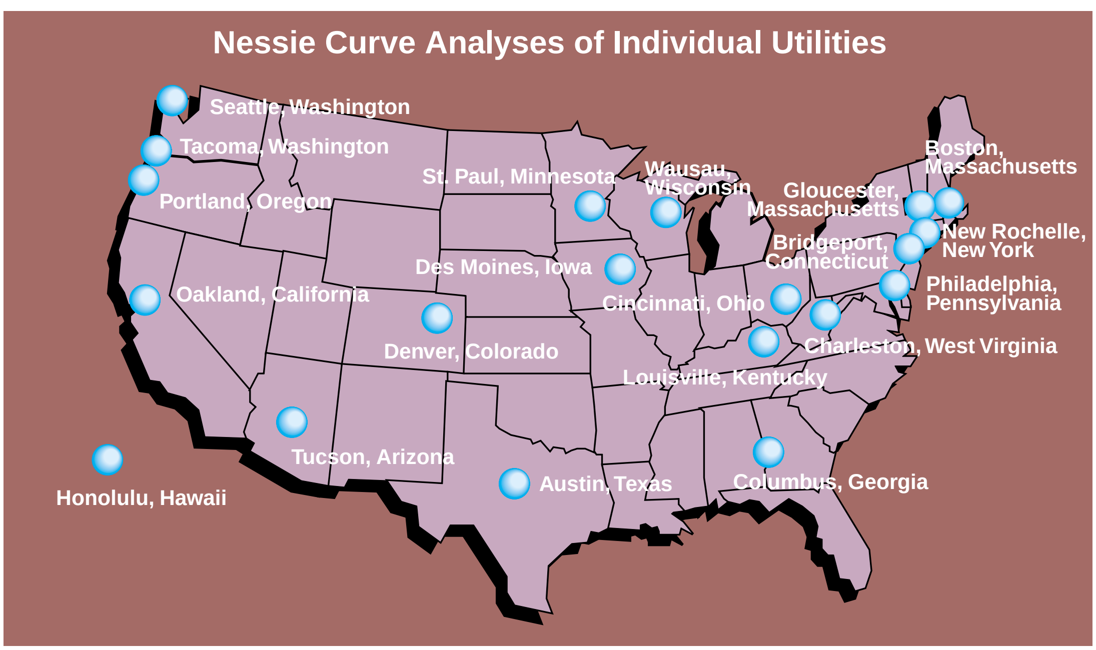


Figure 1

FINDINGS

Pipes are expensive, but invisible.

Most people do not realize the huge magnitude of the capital investment that has been made to develop the vast network of distribution mains and pipes—the infrastructure—that makes clean and safe water available at the turn of a tap. Water is by far the most capital intensive of all utility services, mostly due to the cost of these pipes, water infrastructure that is literally a buried treasure beneath our streets. But buried means out of sight. And as the old saying goes, out of sight means out of mind. Moreover, most of our pipes were originally installed and paid for by previous generations. They were laid down during the economic booms that characterized the last century's periods of growth and expansion. So not only do we take these pipes for granted because we can't see them, we also take them for granted because, for the most part, we didn't pay for them initially. What's more, they last a long time (some more than a century) before they cost us very much in maintenance expense near the end of their useful lives or ultimately need replacement. For the most part, then, the huge capital expense of the pipes is a cost that today's customers have never had to bear. It has always been there, but it's always been invisible to us.

The original pattern of water main installation from 1870 to 2000 in 20 utilities analyzed by AWWA is graphically presented in Figure 2. This graph reflects the total cost in current dollars of replacing the pipes laid down between 1870 and 1998 in the 20 utilities studied. It is a reflection of the development of these utilities, and in turn, mirrors the overall pattern of population growth in large cities across the country. There was an 1890s boom, a World War I boom, a roaring '20s boom, and the massive post-World War II baby boom.

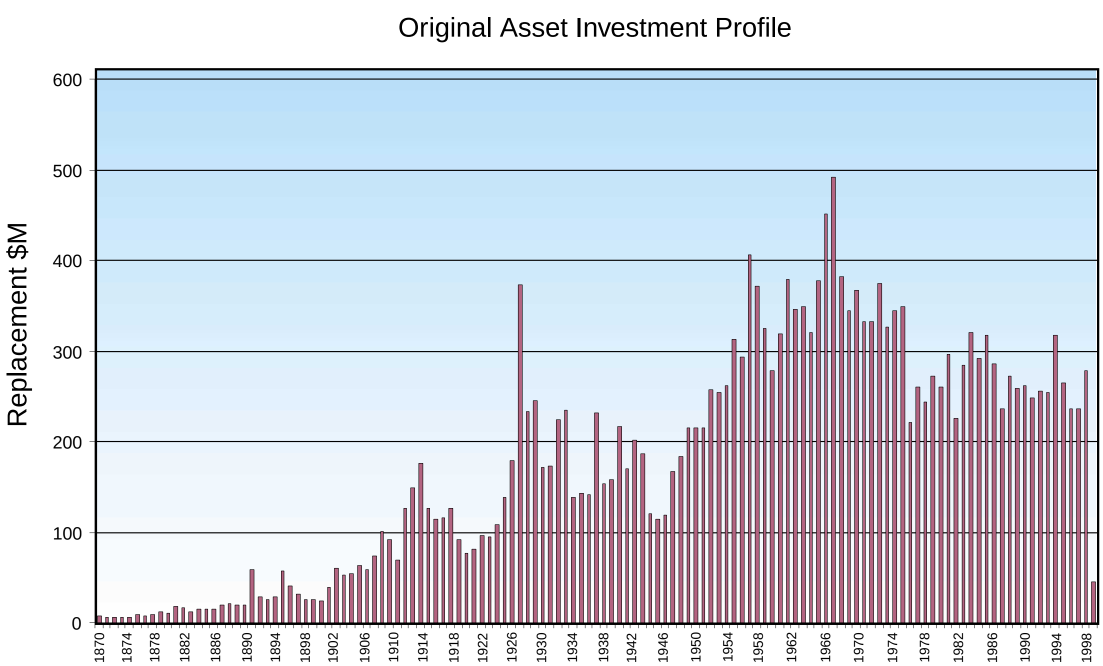


Figure 2

The cumulative replacement cost value of water main assets (that is, the cost of replacing water mains in constant year 2000 dollars) has increased steadily over the last century in our sample of 20 utilities. In aggregate across our sample of utilities, the replacement value of water mains in today's dollars is about $6,300 per household. If water treatment plants, pumps, etc., are included, this figure rises to just under $10,000 per household. This is more than three times what it was in 1930 in constant dollar terms. The difference is not due to inflation; rather, there is simply more than three times as much of this infrastructure today as there was in 1930, in order to support improved service standards and the changing nature of urban development.

In general, then, there is a lot more water infrastructure in place today on a per-capita basis, implying an increased per-capita share of the liability for replacing these assets as they wear out. This invisible replacement liability has been accumulating gradually over several generations of water system customers, managers and governing boards. They have not had to recognize this liability because the bill was not yet due. For many utilities, board/council/commission relationships and customer relationships have developed in recent decades in the absence of a recognized need for significant investment in replacing the utility's assets as they age and wear out.

Pipes are hearty, but ultimately mortal.

The oldest cast iron pipes—dating to the late1800s—have an average useful life of about 120 years. This means that, as a group, these pipes will last anywhere from 90 to 150 years before they need to be replaced, but on average they need to be replaced after they have been in the ground about 120 years. Because manufacturing techniques and materials changed, the roaring '20s vintage of cast-iron pipes has an average life of about 100 years. And because techniques and materials continued to evolve, pipes laid down in the Post-World War II boom have an average life of 75 years, more or less. Using these average life estimates and counting the years since the original installations shows that these water utilities will face significant needs for pipe replacement over the next few decades.

The modern public water supply industry has come into being over the course of the last century. From the period known as the "Great Sanitary Awakening," that eliminated waterborne epidemics of diseases such as cholera and typhoid fever at the turn of the last century, we have built elaborate utility enterprises consisting of vast pipe networks and amazing high-tech treatment systems. Virtually all of this progress has been financed through local revenues. But in all this time, there has seldom been a need to provide for more than modest amounts of pipe replacement, because the pipes last so very long. We have been on an extended honeymoon made possible by the long life of the pipes and the fact that our water systems are relatively young. Now that honeymoon is over. From now on and forevermore, utilities will face significant requirements for pipe repair, rehabilitation, and replacement. Replacement of pipes installed from the late1800s to the 1950s is now hard upon us, and replacement of pipes installed in the latter half of the 20th Century will dominate the remainder of the 21st.

We believe that we stand today at the dawn of a new era—the replacement era—for water utilities. Over the next three decades, utilities will be in an adjustment period during which they will incorporate the costs of pipe replacement in routine utility spending. This will require significant adjustments in utility revenues. The magnitude of the need and the invisibility of that need to the person on (top of) the street will make this a particularly challenging adjustment. The need for significantly greater investment in pipe replacement is all the more difficult to convey because it was never there before. It's hard to explain why it's going to cost more to do the same job in the future than it cost in the past.

Many water systems all across America have seen this day coming and have already begun to ramp up their expenditures on pipe rehabilitation and replacement. But for many utilities this problem is just emerging and is enormous in scope. For them the water supply business will never be the same.

Back to the future: pipe replacement needs are a "demographic echo."

To understand the nature and scope of the emerging infrastructure challenge, AWWA undertook an analysis of 20 utilities throughout the nation. The analysis projects future investment needs for pipe replacement in the 20 utilities and provides a forecast called a "Nessie Curve." The Nessie Curve is a graph of the annual replacement needs in a particular utility, based on when pipes were installed and how long they are expected to last in that utility before it becomes economically efficient to replace them. There are, of course, a number of factors that can require the replacement investment to be made earlier. In many cities, for example, there are urban redevelopment efforts or similar major construction projects that could require up-sizing or other modernization of the pipe network before the pipes reach the end of their useful lives.

Data on repair and replacement needs for each of the 20 cities in our sample is presented in Appendix A. This information is presented for each city as a "Nessie Curve," that is, a projection of the city's economically efficient investment in pipe repair and replacement, based on the city's original pipe installation profile and how long the pipes last in that utility. The aggregate Nessie Curve for all 20 utilities is presented in Figure 3. The rising wave shape suggests why the curve is named after the Loch Ness Monster.

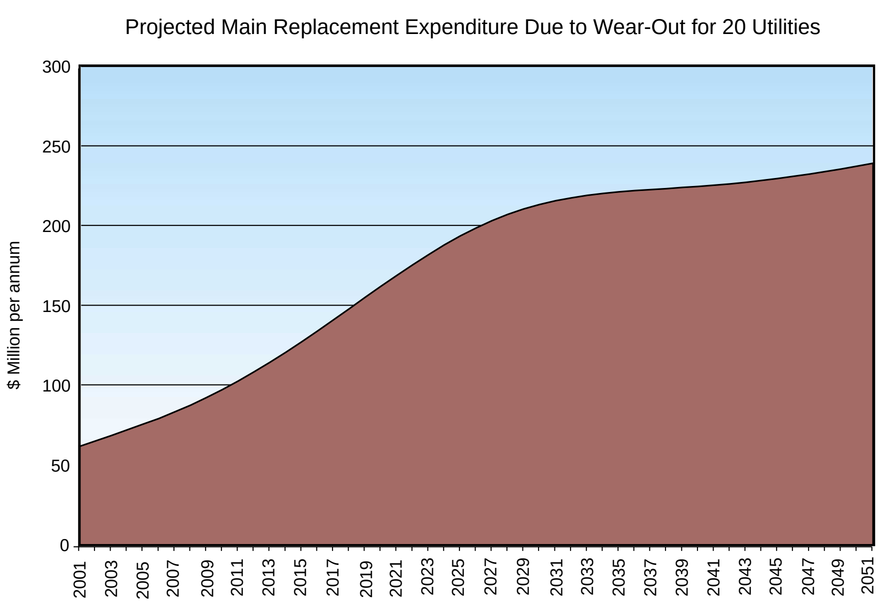


Figure 3

The Nessie Curve reflects an "echo" of the original demographics that shaped a particular utility. It is very similar to the echo of demographics that predicts future liabilities for the Social Security Trust Fund. Indeed, this is exactly the same type of problem that faces Social Security. Historical demographic trends—in our case, pipes laid down as long as a century ago—created a future financial obligation that is now coming due. By modeling the demographic pattern and knowing the life expectancy of the pipes, we can estimate the timing and magnitude of that obligation.

Just as in Social Security, a threat to affordability arises when there were powerful demographic and economic trends at work originally, but the liability arrives at a later time when the demographic and economic conditions have changed. In the water business, the challenge is magnified by pipes that last through several generations of customers before they need to be replaced.

Reflecting the pattern of population growth in large cities over the last 120 years, the Nessie Curves in Appendix A forecast investment needs that will rise steadily like a ramp, extending throughout the 21st Century. The curves show that replacement expenditures will have to rise steadily for the next 30 years. By 2030, the utilities in our sample of 20 will have to spend on average over three-and-a-half times as much per year as they do now (in constant dollars) to replace pipes that have reached the end of their economic lives. Some of the utilities in our sample will encounter the steepest part of the incline in the first 10 years. Others will encounter most of the rise over 20 years, while some will experience a sustained increase over 30 years.

Of course, every city has a different demographic history. In addition, numerous local factors will affect the life of a utility's pipes and therefore its Nessie Curve. Each utility has a unique set of circumstances and therefore a different set of infrastructure funding challenges in the future. Nonetheless, demographics will produce the same type of lagged replacement schedule in any major city.

If that were not enough of a challenge, there is an important corollary. As pipe assets age, they tend to break more frequently. But it is not cost-effective to replace most pipes before, or even after, the first break. Like the old family car, it is cost-efficient for utilities to endure some number of breaks before funding complete replacement of their pipes.

Considering the huge wave of aging pipe infrastructure created in the last century, we can expect to see significant increases in break rates and therefore repair costs over the coming decades. This will occur even when utilities are making efficient levels of investment in replacement that may be several times today's levels. In the utilities studied by AWWA, there will be a three-fold increase in repair costs by the year 2030 despite a concurrent increase of three and a half times in annual investments to replace pipes.

It is important to note that a Nessie Curve is a prediction, not a destiny. That is, a utility can choose to manage its infrastructure replacement needs in various ways. For example, the utility may accept increased break repair costs up to a point and delay the replacement of an old pipe, rehabilitate certain pipes to "buy time," or adopt other asset management techniques to extend the life of the pipes as long as possible. Nevertheless, it appears inevitable that many utilities will face substantial increases in infrastructure investments over the next 30 years, to replace pipes laid down as long as 120 years ago.

A final observation from our sample of 20 Nessie Curves is that the large "demographic wave" of replacement needs is only just now upon us. We are just now at the time when there is a compelling need to significantly increase the levels of replacement spending in most utilities. Importantly, there is no evidence that utilities are "behind the curve" or that America is in ruins. That is not the nature of the challenge. We are not faced with making up for a historical gap in the level of replacement funding. In fact, break rates in our sample of 20 utilities are within a range that is considered representative of best management practices for water utilities, indicating that the utilities have made efficient decisions and managed well up to this point. The challenge is ramping up utility budgets to prevent a "replacement gap" from developing in the near future. Unfortunately, keeping up with replacement needs is about to get a lot harder than ever before, and it's going to stay that way. We are coming face-to-face with a serious challenge that could become a crisis if we ignore it.

Water infrastructure is local and therefore vulnerable to demographic changes.

Water utilities are the last natural monopolies. The large investment required in pipe networks makes it impossible to have more than a single provider of water service within a given area. These large investments are also a major source of financial vulnerability for water utilities as the result of the very fixed nature of the assets and the very mobile nature of the customers. When populations grow, the infrastructure is expanded, but when people move away, the pipe assets and the liability for repair and replacement remain behind, creating a financial burden on the remaining customers.

Figure 4 is a plot of U.S. Census population data for Philadelphia from 1850 to 1996. Over the 100 years from 1850 to 1950, the population grew from 100,000 to 2 million people. But from 1950 to the end of the century, Philadelphia lost 25 percent of its population, dropping to 1.5 million. This picture tells a story that was replicated again and again

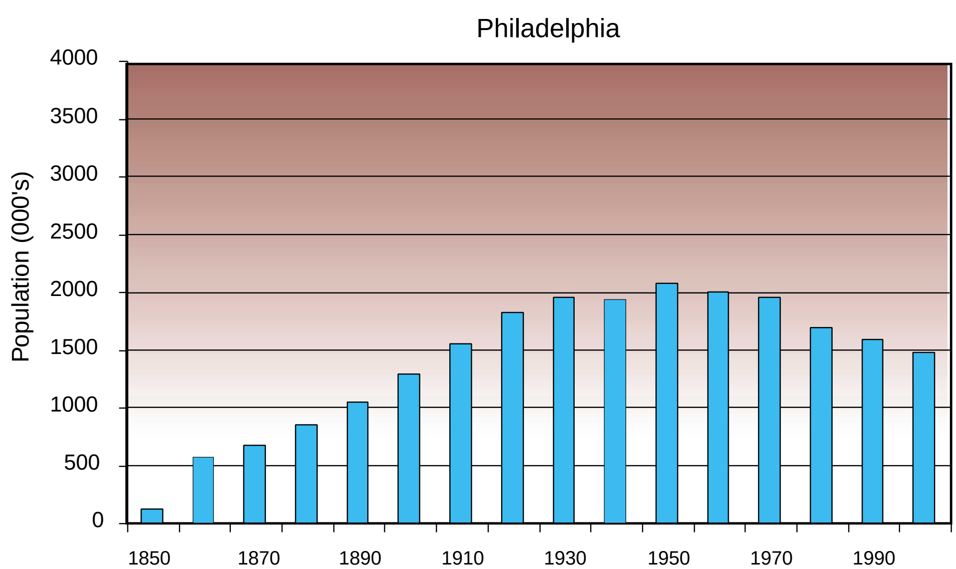


Figure 4

throughout the Rustbelt cities of the Northeast and Midwest. The effect is to significantly increase the burden of replacement funding on the remaining residents of the city.

As previously discussed, the average per-capita value of water main assets in place today across our sample of 20 utilities is estimated to be three times the amount that was present in 1930. In Philadelphia, however, that ratio is almost eight times the value in 1930 due to population declines since about 1950. This problem, known as "stranded capacity" (essentially, capital facilities that are not matched by rate revenue from current customers), is typical of Rustbelt demographics and adds considerably to the challenge of funding replacement in these cities.

Urban demographic history also explains many other dimensions of the infrastructure replacement challenge facing the water industry. Both gains and losses in urban populations created small system infrastructure problems in their wake. During the first half of the 20th Century, many of the people swelling the populations of the urban centers came from smaller rural towns, leaving small water system infrastructure behind to struggle with fewer customers. In the latter half of the century, the departure of big city residents for the suburbs fueled an explosion of new, small water systems in suburban areas. Today about half of all small water systems are within Standard Metropolitan Statistical Areas defined by the U.S. Census. Built in boom times, many of these suburban systems were not built to enduring standards, creating another liability. When these systems are absorbed by larger metropolitan systems, it is commonly necessary to completely rebuild them.

The pattern reflected in Sunbelt cities is the other side of the story from that in the Rustbelt. These cities are experiencing rapid growth and expansion which places capital financing demands upon them that are truly the opposite side of the coin. When water utilities are expanding, they must build some of the most expensive components—new source development, storage facilities, transmission mains, and treatment plants—in advance of population growth in order to serve people when they arrive. This is, in effect, another form of stranded capacity—capital facilities that must be paid for despite the fact the customers are not yet in place. Investor-owned utilities are, in fact, generally prohibited by state regulatory commissions from recovering such costs in rates.

Demographic change thus places financial strain on all our public water systems. It is the same whether they are large or small; urban or rural or suburban; and Rustbelt or Sunbelt. The inescapable fact is that water infrastructure is fixed while populations are mobile. The result is a form of "market failure"—an adverse side effect of market activity that creates an unfunded liability. America derives tremendous economic strength from the fact that it has a highly mobile labor force. When people move around, however, there are costs imposed on the local water infrastructure. It is the same whether it is people moving from rural towns to the city, from the city to the suburbs, or from the Rustbelt to the Sunbelt. Our labor mobility imposes a significant cost on water utilities on both the giving end and the receiving end of this market process, while the benefits are generally disseminated throughout the national economy.

Replacement of water treatment plants is also coming due.

Replacement of water treatment assets presents a different picture from that of the pipes, but greatly complicates infrastructure funding for utilities. Major investments in water and wastewater treatment plants were made in several waves following the growing understanding of public health and sanitary engineering that evolved during the 20th Century. Of course, the installation pattern of treatment assets also reflects major population growth trends. But whereas pipes can be expanded incrementally to serve growth, treatment must be built in larger blocks. Investments in treatment thus present a more concentrated financing demand than investments in pipes.

Treatment assets are also much more short-lived than pipes. Concrete structures within a treatment plant may be the longest lasting elements in the plant, and may be good for 50 to 70 years. However, most of the treatment components themselves typically need to be replaced after 25 to 40 years or less. Replacement of treatment assets is therefore within the historical experience of today's utility managers. Even so, many treatment plants built or overhauled to meet EPA standards over the last 25 years are too young to have been through a replacement cycle. Many are about due for their first replacement in the next decade or so.

The concurrent need to finance replacement of pipes and of treatment plants greatly increases the challenge facing utilities. Figure 5 presents a Nessie Curve showing both pipe replacement and treatment replacement needs for the Bridgeport Hydraulic Company. Similar Nessie curves for a number of other utilities are included in Appendix A.

The distinguishing characteristic of this graph is the manner in which spending for the replacement of pipes rises like a ramp over the first part of the century, pushing up the overall level of annual expenditure required. Whereas pipe repair and replacement are generally funded out of current revenues, treatment costs are typically debt-financed. As

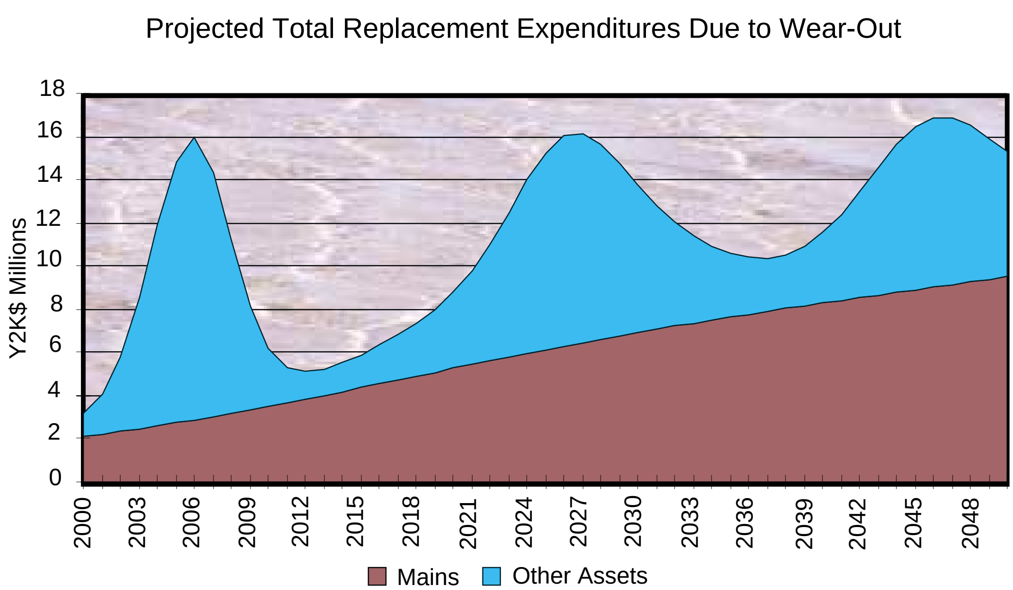


Figure 5

utilities face ever rising costs for repair and replacement of pipes, more and more of the utility's rate revenue will be required for those investments. This will leave the utility with increasingly weakened credit every time it gets to another "treatment hump," unless rates can be raised to match the slope of the curve. A final point to note about the treatment cost estimates used in developing Figure 5 and others like it in Appendix A is that these do not include the cost of new drinking water regulations likely to be implemented over the coming decades.

Increased expenditures are needed to climb the ramp and avoid a gap.

The Water Infrastructure Network (WIN) has developed a "gap analysis" to estimate the total increased spending that is required by water and wastewater utilities in order to avoid getting behind in funding infrastructure replacement over the next 20 years.[1] The first step in the WIN estimate is accomplished by extrapolating from Census data on historical utility expenditures for 20 years into the future. The resulting baseline expenditure forecast is then examined to see how much it must be increased in order to meet new expenditure "needs" for both new EPA compliance requirements and infrastructure repair and replacement over the same 20-year period. The "gap" between the baseline expenditure forecast and the future "needs" forecast is the amount of additional expenditure that must be forthcoming in order for water and wastewater utilities to maintain their critical infrastructure in a healthy condition.

The findings of this "gap analysis" indicate that the baseline expenditures of water utilities must be increased by about $300 billion over 20 years to keep up with both compliance and infrastructure needs. In similar fashion, the baseline expenditure trend in wastewater utilities must be increased by about $400 billion to meet such needs. Taken together, and accounting for the cost of capital, WIN has estimated that water and wastewater utilities together need to increase their investments in infrastructure by almost $1 trillion over the next 20 years.

The WIN "gap analysis" is easily misunderstood. Many have interpreted it to mean that a trillion-dollar deficiency already exists. It is important to stress that the gap estimate represents the challenge ahead—the ramp that we must climb—in increasing utility expenditures in order to avoid such a deficiency. The AWWA Nessie Curve analysis of 20 utilities indicates that we are not now behind in maintaining our water infrastructure. There is no current crisis in these 20 utilities. Rather, they are challenged with finding significant additional funds over the next 30 years for investments in repair and replacement, in order to avoid getting behind.

Extrapolation from aggregate baseline trends, such as in the WIN gap analysis, is akin to "technical analysis" of the stock market using charts, graphs and trending techniques. Investment analysts typically like to supplement such "technical analysis" with "fundamental analysis" of the situation existing within individual companies. The AWWA Nessie Curve analysis provides this type of supplemental perspective on increased expenditure needs.

[1]Water Infrastructure Network (WIN), Clean & Safe Water for the 21st Century, April 2000.

As illustrated in Figure 5, the Nessie Curve analysis indicates that expenditures on infrastructure repair and replacement must be significantly ramped-up over a period extending from 2000 through 2030. The steep rise is shown to level off after that, but it does not go away. Expenditures will have to continue to climb, albeit more gradually, throughout most of the rest of the 21st Century. This shape is the signature pattern of the new replacement era that we have entered. It is not a short-term "hump" that we have to get over. The shape of the challenge is that of a sustained rise in expenditures. This period of ramping-up is going to be a period of significant adjustments.

The Nessie Curves of the individual utilities shown in Appendix A present wide-ranging needs for increased expenditure for replacement of pipes and treatment assets due to wear-out. In the 20 utilities studied, such needs total about $6 billion above current spending over the next three decades. On a household basis, needs range from $550 to $2,300 over 30 years. These figures do not include the prospective costs of numerous new SDWA regulations likely to be implemented over the coming decade, nor any costs from the wastewater or stormwater side of the urban utility business. Moreover, as seen in Appendix A, the utilities vary widely in the timing of these needs; some face sharp needs in the next 10 years, while others don't face their highest needs for 10 or 20 years. The slope and the "humpy" patterns of increasing capital requirements are unique to each utility.

Our sample of 20 utilities represents relatively large water utilities. On a per household basis, the total 20-year capital needs for replacement illustrated in our sample is about the same as that estimated by EPA for large water systems in their newly released Drinking Water Needs Survey.[2]

The EPA Drinking Water Needs Survey uses a site visit methodology and a large sampling program to document needs in small systems and is probably the best information available on small system needs. Extrapolating from EPA's estimated 20-year capital need for small systems, we project the total 30-year expenditure for infrastructure repair and replacement in small systems might be in a range of $1,490 per household to $6,200 per household.

The result of this "fundamental analysis" using Nessie Curves is not inconsistent with the order of magnitude of the need that WIN estimates to be facing water utilities ($300 billion over 20 years). Extrapolation from our 20 sets of Nessie Curves suggests that the need might be on the order of $250 billion nationally and extend over three decades. However, the Nessie Curve forecast is based on an assumption that pipes are left in the ground until their economic life is over. The reality in utility operation is that myriad other influences can cause the replacement need to arise sooner. These include urban redevelopment, modernization, coordination with other city construction schedules, increasing pipe size, and other factors.

[2] U.S. Environmental Protection Agency, 1999 Drinking Water Infrastructure Needs Survey (EPA 816-R-01-004), February 2001.

Addressing affordability is the heart of the challenge.

The central question for policy makers and utilities is whether the increased rate of infrastructure spending that utilities must face over the next 30 years can be financed by the utilities themselves at rates customers can afford. AWWA remains, committed to the principle that utilities should be self-sustaining through their rates. For many utilities, however, the degree of change involved in adapting to the dawning replacement era, the adverse effect of demographic change on per household costs, and the competing demand for investment in wastewater and other municipal services, will combine to present a significant affordability challenge.

There are two related dimensions to the affordability concern. First is the ability of utilities to finance the needed additional expenditures within their rates. Second is the impact of higher rates on households.

In developing this study, AWWA brought together a group of utility managers from across the country to discuss infrastructure issues. This group characterized the question from a local perspective as an "affordability gap" or a "reality gap" and defined it as "the difference between what you think you should be spending on infrastructure and what you or your customers can afford to spend in reality." This characterization of the problem reflects the difficulty of obtaining significant utility rate increases. Rate increases are best received when implemented gradually in a number of installments over several years. Unfortunately, the rate increases required to meet the challenges of pipe replacement that utilities now face cannot be smoothly implemented in many cases.

There is small likelihood that the \$550 to \$2,300 per household projected to be required for infrastructure repair and replacement in our 20 utilities over the next 30 years can be spread evenly or taken on gradually over that period. As illustrated in Appendix A, some Nessie curves present a steeper funding challenge and some present a gentler slope due to local variations in the historical demographic trends. There are "humps" on the up-ramp for replacement of treatment plants and other equipment. Additional "humpy" expenditures for compliance with anticipated new regulations are not included. In small systems, the estimated \$1,490 to \$6,200 range of household impact is likely to be even more concentrated since the original demographics were themselves more concentrated.

Compliance-driven requirements to replace treatment plants and invest to meet new mandates will also dominate expenditures and push aside the more subtle need for investments in pipe replacement. This is exacerbated by the fact that the costs of water and wastewater service appear on the same bill in most communities. Thus, the needs to replace wastewater treatment plants and to replace wastewater lines compete with drinking water needs for the same consumer dollar. Sewer pipes generally impose higher unit replacement costs than water pipes, owing to their inherent characteristics (size, depth, etc.). Figure 6 presents a Nessie curve for a combined water and wastewater utility showing replacement funding needs for both water and wastewater pipes and other assets (treatment, pumping, etc.). The figure illustrates the typical relationship between water supply and wastewater costs—wastewater facilities cost noticeably more to replace.

The combined repair and replacement needs for water and wastewater infrastructure amount to a significant financing challenge in their own right. But the cost of compliance

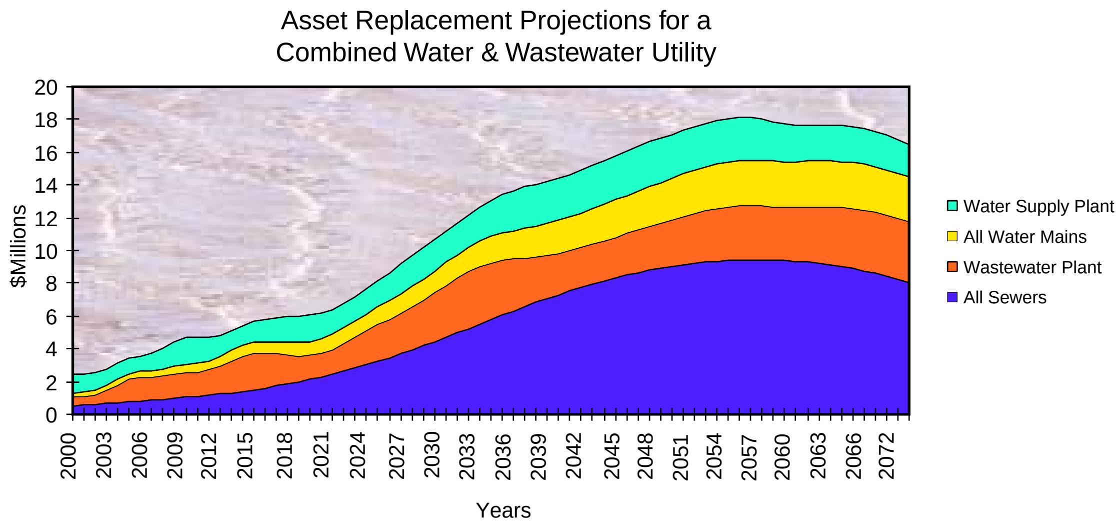


Figure 6

with combined sewer overflow (CSO) and stormwater regulations may dwarf everything else in water and wastewater utilities. The scale of the expenditure required in these programs may sweep everything else aside in some utilities, causing deferral of other needs and allowing a "gap" to open up. Note that CSO and stormwater compliance costs are not included in Figure 6.

To avoid an infrastructure gap, utilities are going to have to increase expenditures to keep up with both compliance requirements and infrastructure replacement. If rate increases do not keep pace with the increased rate of expenditures, the financial ratios used to evaluate a utility's creditworthiness will deteriorate, making it more difficult and more expensive to raise capital.

If a utility attempts to balance a deficiency in allowable rates by deferring infrastructure expenditures, then the stage is set for an infrastructure investment gap to begin to develop, creating a future liability for the utility and its customers. With the new accounting requirements being implemented under the Governmental Accounting Standards Board Statement No. 34 (GASB 34), such a deferral of infrastructure expenditures will be reported to the financial markets and begin to impair the utility's credit rating and ability to raise capital.

Since the Nessie Curve represents replacement timing based on the economic life of the pipes, it follows that deferral of replacement will produce higher overall costs due to increased repairs than would be the case if replacement occurred on time. If replacement is deferred too far beyond the economic trade-off point between replacement and repair costs, the repair cost burden will spiral upwards and have significant impacts on utility cash flows. Such a scenario will indeed impair a utility's ability to repay debt and will be made plain to the credit markets by the new GASB 34 requirements.

In either of these scenarios—rates that don't keep up with expenditures or expenditures that don't keep up with needs—the bottom line is the same. If both expenditures and rate revenues cannot be increased at the required rate, then the utility's credit may be impaired, and it may face even higher costs as a result. For some utilities, there is the potential for this to become a vicious cycle—a financial trap. These systemic financial risks are the reason why we have a clear and present need for an enhanced partnership between utilities, states and the federal government. We need to provide the means to assist utilities "up the ramp and over the humps." We need to minimize the credit risks utilities face over the next three decades as we make the adjustments in rates required to assure sustainability in the new replacement era.

The second, and all important, dimension of the affordability challenge is the bottom-line impact of increased water rates on household budgets. AWWA believes it is critical to avoid sudden and significant changes in rates that can induce "rate shock" among customers. The broader issue involved in rate shock ties back to the pivotal role of safe drinking water in promoting public health.

America has by far the safest drinking water in the world. Standards promulgated under the Safe Drinking Water Act aspire to the highest levels of technology and treatment optimization known to science. As we push farther into the limits of science and technology, we unavoidably encounter diminishing returns in terms of quantifiable health benefits at the same time that we must take on increasing marginal costs. Many new standards relate to very subtle health concerns that are difficult to substantiate and quantify. Yet, to be protective of health, there is a tendency to err on the side of safety, especially when the threats may relate to sensitive subpopulations such as children, the unborn, the elderly and the health-impaired.

This is where the issue of rate shock must be brought into focus as a public health concern. Whenever the sensitive subpopulations we are striving to protect are also among the low-income segment of the population and are forced to forego medical care or nutrition in order to pay their utility bills, we could be doing more harm than good. The fact that we are now entering a significantly more expensive replacement era in water infrastructure makes it all the more difficult to maintain the right balance in this aspect of public health. By some comparisons, it may appear that water is still cheap and there is room to increase water rates. But such comparisons are not relevant to low-income households. The only comparison that matters in these households is the size of the incremental increase. If it is large enough to trigger a budget substitution that negatively affects family health—for example, giving up a prenatal visit in order to pay a utility bill—then we may be losing ground.

Over the past decade, utilities have formed an increasingly closer partnership with EPA, states, the environmental community, the public health community and other groups to continue to make progress for public health despite significant scientific challenges. This partnership must now be broadened to address the financial challenges of infrastructure replacement in order to preserve the fruits of our labors in the public health arena.

RECOMMENDATIONS

Considering all of these facts, the American Water Works Association believes it is time for a new American partnership for clean and safe water. This partnership requires that all levels of government and utilities play a role in working through the significant challenges ahead. Specifically, we recommend:

1) Measures by Utilities and Local Governments

The infrastructure funding issue varies from place to place, reflecting the age, character and history of the community. Although AWWA has looked at the infrastructure issue in the aggregate, many key questions must be asked and answered at the local utility level. The development of a comprehensive local strategy can bring these elements into focus and create a new "reality" that will help make infrastructure repair and replacement more affordable. Such a comprehensive strategy includes:

- **Assessing the condition of the drinking water system infrastructure.** Over the last few decades, utilities around the world have been developing innovative new approaches to managing long-lived buried infrastructure. In North America and overseas, some utilities are already taking advantage of tools such as geographic information systems, using new information to advance the state of the art and aggressively managing infrastructure replacement. Planning tools can help identify and plan for needed investment decades in advance of the actual need for funds. We should learn from, adapt, and use such tools.
- **Strengthening research and development.** Although there is not likely to be a single "silver bullet" to solve infrastructure management problems, an impressive array of technological tools have been moving through the research and development process in recent years. Efforts to develop and deliver such tools should be strengthened.
- **Working with the public to increase awareness of the challenge ahead, assess local rate structures, and adjust rates as necessary.** For many years, water and wastewater utilities have been nicknamed "the silent service." Utilities have quietly provided an extremely reliable supply of high-quality water at relatively low rates compared to other public utilities and services. Partly as a result, a large number of utilities, particularly smaller ones, do not have appropriate rate structures. The 1996 SDWA requirement for Consumer Confidence Reports provides a vehicle for many utilities to take the first step in broadening their dialogue with customers and the public at-large. Comprehensive, focused, and strategic communications programs serve the dual function of providing consumers with important information about their water systems and building support for needed investments in infrastructure.
- **Building the managerial capacity of many water systems.** Congress took new steps in the 1996 SDWA Amendments to assure the institutional capacity of small systems applying for state revolving fund loans. Much more remains to be done in this area. EPA, in conjunction with water associations, could sponsor training programs on appropriate rate structures, designed specifically to deliver assistance to small systems in planning for full cost recovery through rates.

2) Reform of State Programs

The states, too, have an important role to play in addressing our infrastructure funding needs. States may need to match an appropriate share of any new federal funds that are provided for infrastructure assistance. Moreover, they need to reform their existing programs to make them more effective. For example, some states have not allowed larger systems to access the existing state revolving fund, or have excluded investor-owned systems. Some states encumber their revolving funds with nonproductive red tape, charge high loan origination and other fees, or charge loan rates that are equivalent to market rates. Some states preclude the use of alternate procurement methods that minimize infrastructure procurement costs. For example, the “design/build” process for infrustructure procurement has been documented to save 20–40% of construction costs for new treatment plants in some cases. Public procurement laws in many states, while not explicitly banning design/build, mandate a process that prevents its use where local authorities have determined it would be advantageous.

The result is that, in many states, revolving loan funds have not proved to be useful or attractive even to drinking water utilities desperately in need of capital. States should commit to:

- Respecting the universal eligibility of all water systems for federal assistance.
- Streamlining their programs for delivery of assistance and allowing alternative procurement procedures that save money.
- Making their financing mechanisms more attractive by committing to grants and very low or negative interest loans.
- Using federal funds in a timely fashion or facing the reprogramming of those funds to other states.

3) A Significant Increase in Federal Assistance

After accounting for the cost savings that can come from best practices in asset management, the development of new technologies, efforts to increase ratepayer awareness and support, and possible alternative compliance scenarios, for many utilities there is likely to remain a gap between the required expenditure increases and the practical ability to raise water rates. This gap could grow over the next few decades as infrastructure built in the late-1800s to mid-1900s must be repaired, replaced, and rehabilitated at the same time that we are trying to enhance the level of water treatment under the Safe Drinking Water Act (SDWA).

AWWA remains committed to the principle that utility operations should be fully supported by rates. In the long run, the objectives must be to manage the costs of replacing pipes and treatment plants and ensure financial sustainability through local rate structures. However, many utilities are going to face a period of adjustment in adapting to the new reality of the replacement era described in this report. Many utilities and their customers will need additional assistance in working through extraordinary replacement needs in the next 20 years.

The difference between drinking water utilities’ current expenditures for infrastructure replacement and the needed level of expenditure is estimated by WIN to be about $11 billion per year over the next 20 years. If the federal government were to provide half the cost of this gap, the federal share of total utility spending would amount to under 12 percent of total utility spending. For comparison, the federal share of investment in roads, bridges, and airports is 80 percent.

To prevent the development of a gap in critical water infrastructure financing, AWWA recommends either changing and expanding the existing Drinking Water State Revolving Fund and other drinking water programs or creating a new, infrastructure-focused fund. Such a fund should provide:

- Significantly increased federal funding.
- Clear eligibility of projects to repair, replace, or rehabilitate drinking water infrastructure.
- Universal eligibility of all water systems, both public and investor owned, regardless of size.
- Ability to make grants or loans in any combination and to use other financing tools to leverage public and private capital.
- Reasonable terms and conditions such as demonstration of system viability and ability to repay a loan.
- Streamlined procedures for those accessing the funds.

Research is a critical component of a comprehensive federal program on infrastructure. Research stimulates the development of new techniques and unleashes American ingenuity. It offers the chance to save billions of dollars over the years to come through more efficient management, repair, and replacement technologies. The federal government should significantly increase its support for research on infrastructure management, repair and replacement technologies, methods for extending pipe life, and other means of advancing the art while lowering the cost of infrastructure management.

Finally, the federal government should take other important steps to better access and leverage public and private capital. Congress should consider:

- Development of a national water infrastructure financing bond bank similar to Fannie Mae.
- Tax code and other reforms to increase the availability and use of private capital. This could include steps such as the removal of constraints on private activity bonds, development of subsidized bond insurance, provision of federal loan guarantees, and improved investment tax credit incentives.

CONCLUSION

Considering when pipes were laid down in many water systems and how long they can be expected to last, it is clear that a new age—the replacement era—has arrived for water utilities. Over the next 30 years, infrastructure replacement needs will compete with compliance needs for limited resources. Clearly, infrastructure needs and compliance with the Safe Drinking Water Act can't be approached as separate issues, but need to be addressed together.

Only in the true spirit of a new partnership, as outlined in this report, can we think most broadly about these issues. Only in this spirit can we achieve the goals to which we all aspire: the provision of safe and affordable water to all Americans.

Reinvesting in Drinking Water Infrastructure

Dawn of the Replacement Era

APPENDIX A

20 Sets of Nessie Curves

This appendix presents results of infrastructure expenditure needs analyses conducted for 20 water utilities across the United States. The "Nessie Curve" technique employed in this study produces a forecast of water main and other asset repair and replacement expenditure requirements based on how those assets "wear out" over the course of their economic life. While this study has focused on projecting economically efficient replacement and repair costs from wear-out, there are other reasons why assets might be replaced sooner, such as needs relating to urban redevelopment, system improvements, coordination with other city construction, and increasing pipe size. The curves also focus only on existing assets and take no account of new assets needed to support growth or compliance with new SDWA regulations in the coming decades.

For each utility, results are summarized in several Nessie Curves illustrating different perspectives. For each utility there is an estimate of the total replacement cost value of the utility's assets in today's dollars. There is also an indication of whether the utility was studied with respect to mains only, or whether it was studied with respect to a wider range of assets (including treatment plants). In viewing the charts, it is important to remember whether the utility is an "apple" (mains only) or an "orange" (all assets).

The charts presented cover the next 50 years, primarily to better illustrate the characteristic shapes of the replacement "echo" while also identifying differences in the timing of major replacement requirements between the participating utilities. All values are constant year 2000 dollars. The forecasts assume zero inflation.

The first chart is entitled. "Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)." In this graph, the total cost for replacement and repair due to aging is projected over the next 50 years at the household level.

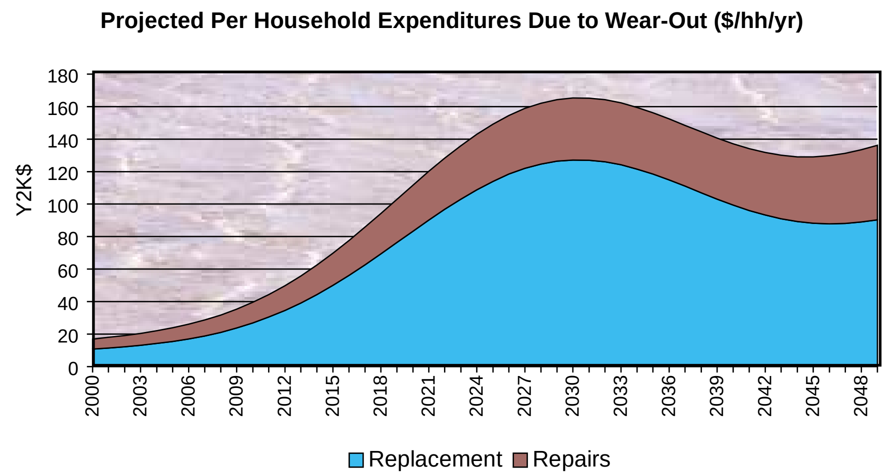
The second chart, entitled "Projected Total Expenditures Due to Wear-Out" is similar to the first chart, showing the relative requirements for replacement expenditures and repair expenditures for the assets studied in each utility, expressed in total dollar outlays for the utility.

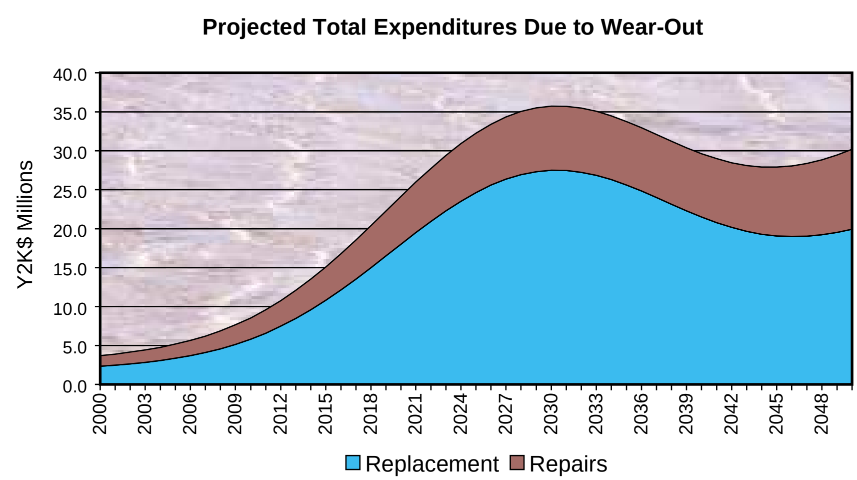
For the utilities that were studied with respect to all assets, there is a third chart on the page entitled, "Projected Total Replacement Expenditures Due to Wear-Out." This chart projects replacement investment only, showing the relative contributions to 50-year replacement needs of mains versus other assets (treatment, pumping, etc.). For utilities that were studied only with respect to mains, this third chart is omitted from the summary page for that utility.

Index of Nessie Curves

Austin, Texas

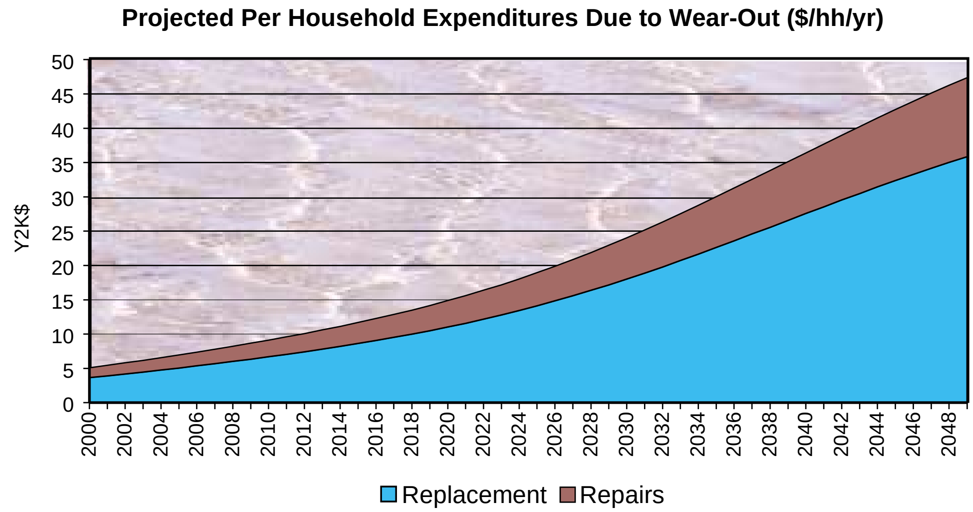
Asset Sets Modeled: Water Mains —
Estimated Replacement Value $2,348 M

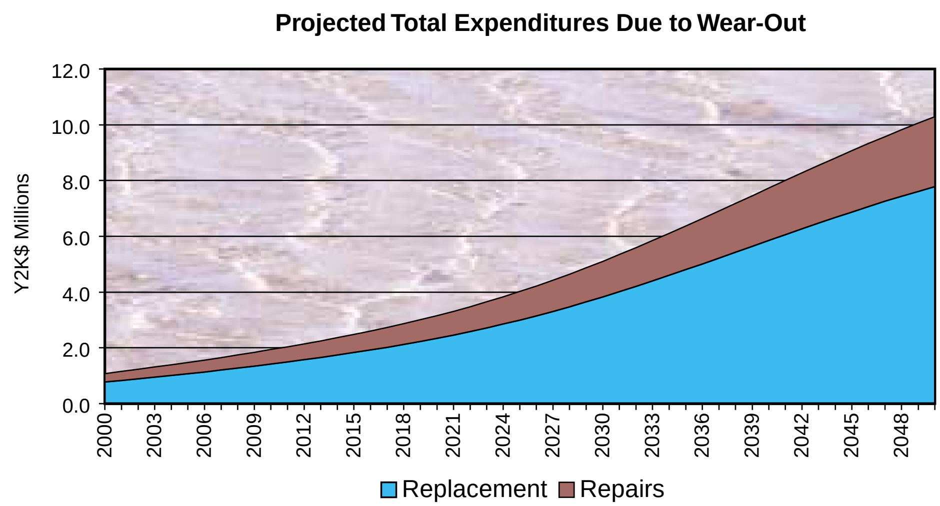




Boston, Massachusetts

Asset Sets Modeled: Water Mains —
Estimated Replacement Value $694 M

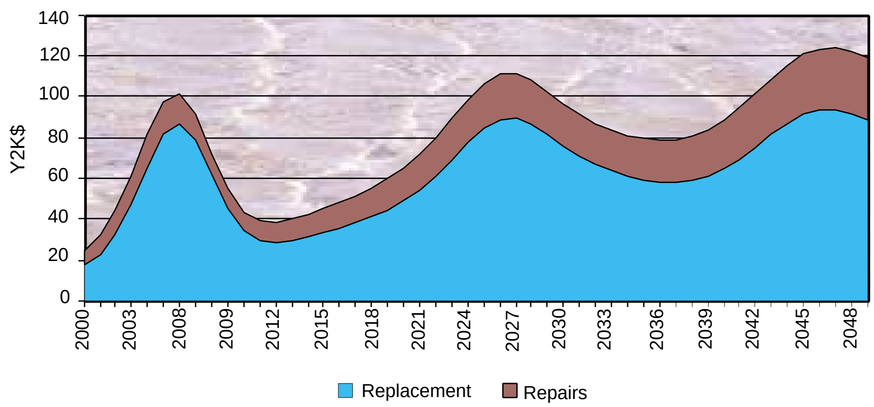




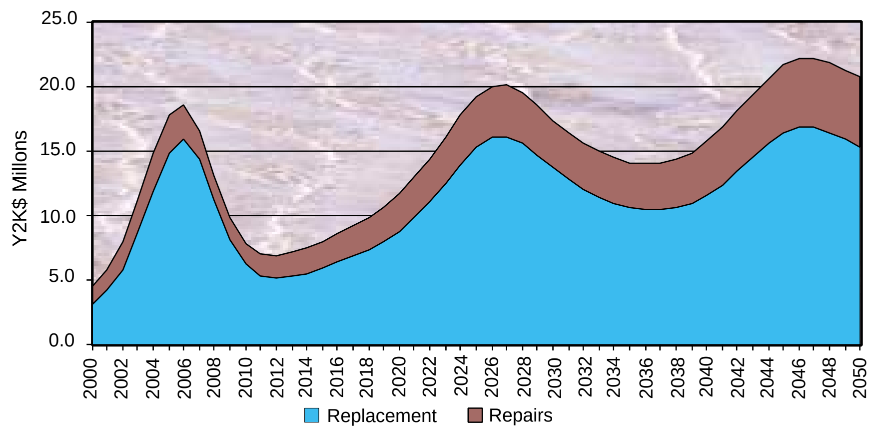
BHC, Bridgeport, Connecticut

Asset Sets Modeled: Water Mains & Water Supply Plant —
Estimated Replacement Value $1,663 M

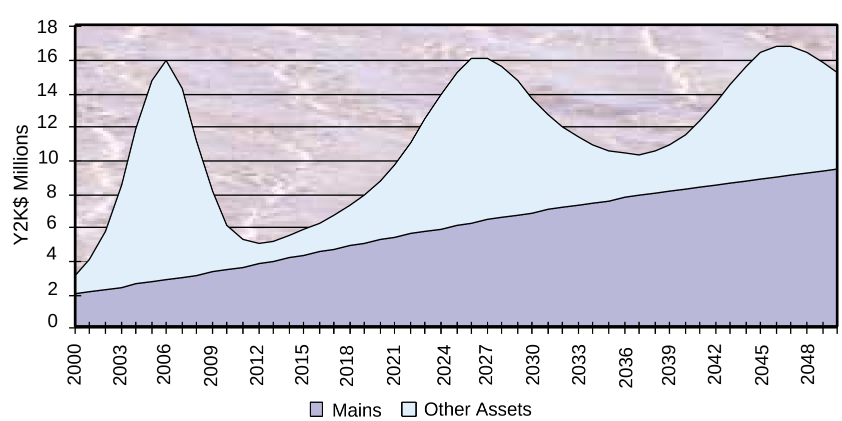
Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)



Projected Total Expenditures Due to Wear-Out



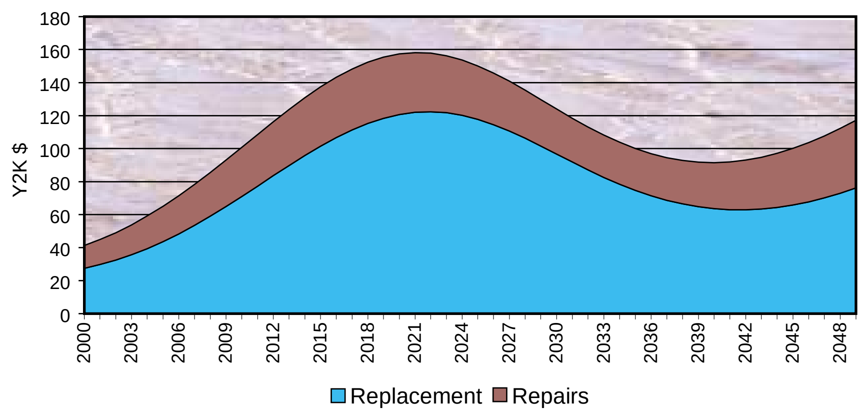
Projected Total Replacement Expenditures Due to Wear-Out



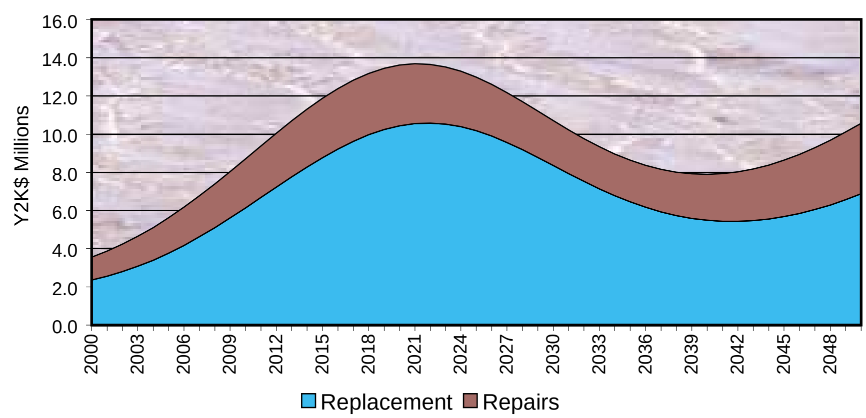
West Virginia American, Charleston, WV

Asset Sets Modeled: Water Mains & Water Supply Plant —
Estimated Replacement Value $650 M

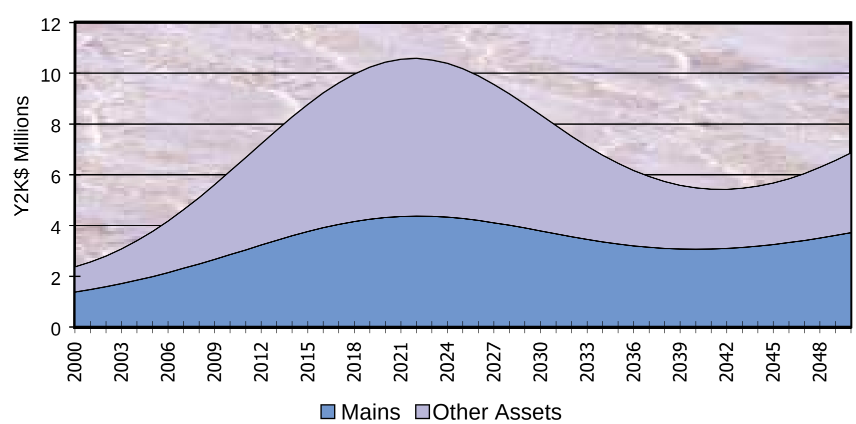
Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)



Projected Total Expenditures Due to Wear-Out



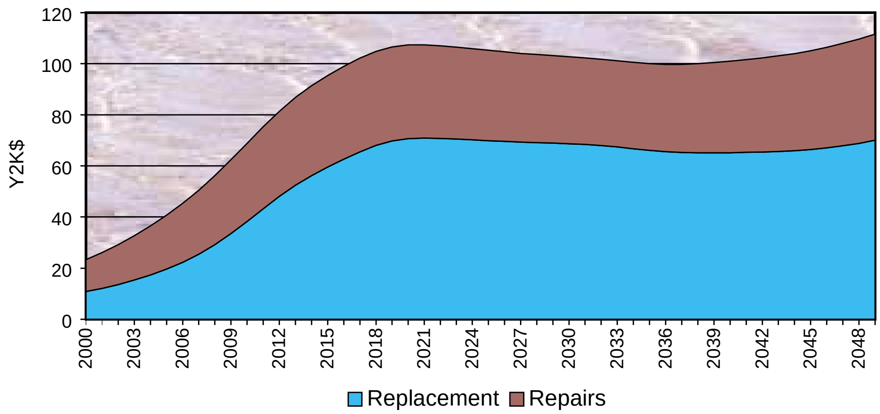
Projected Total Replacement Expenditures Due to Wear-Out



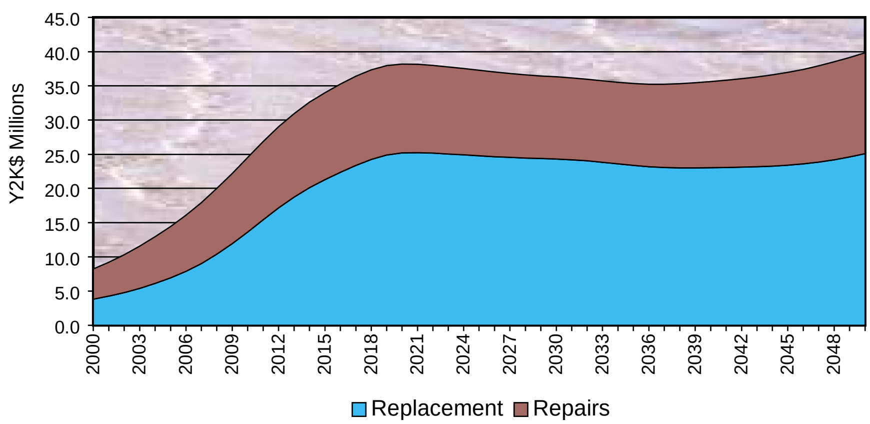
Cincinnati, Ohio

Asset Sets Modeled: Water Mains & Water Supply Plant — Estimated Replacement Value $2,042 M

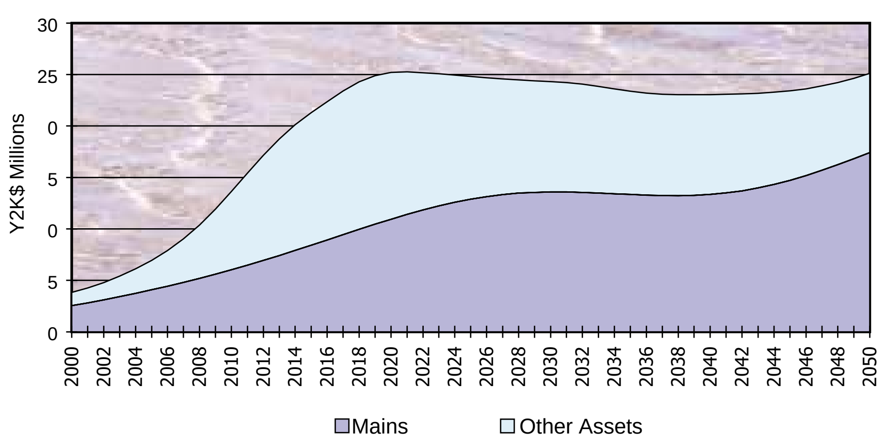
Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)



Projected Total Expenditures Due to Wear-Out

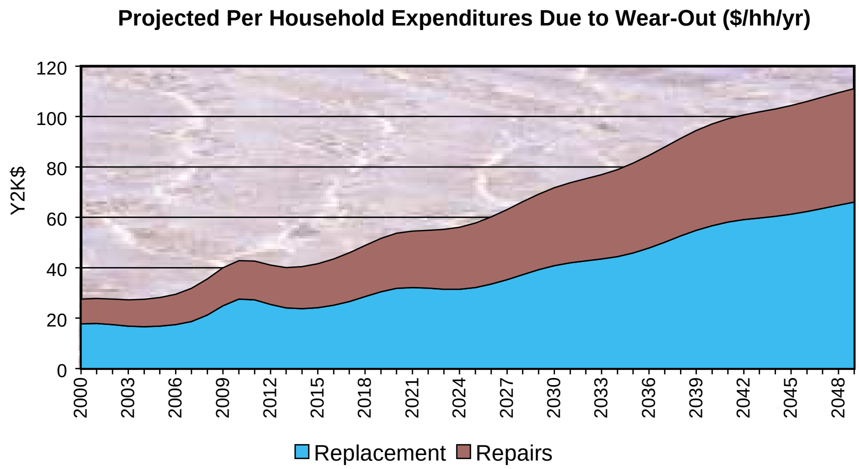


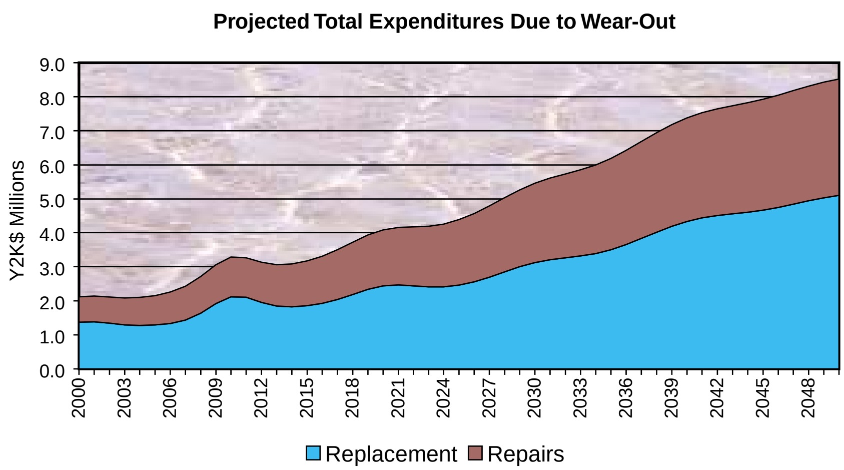
Projected Total Replacement Expenditures Due to Wear-Out

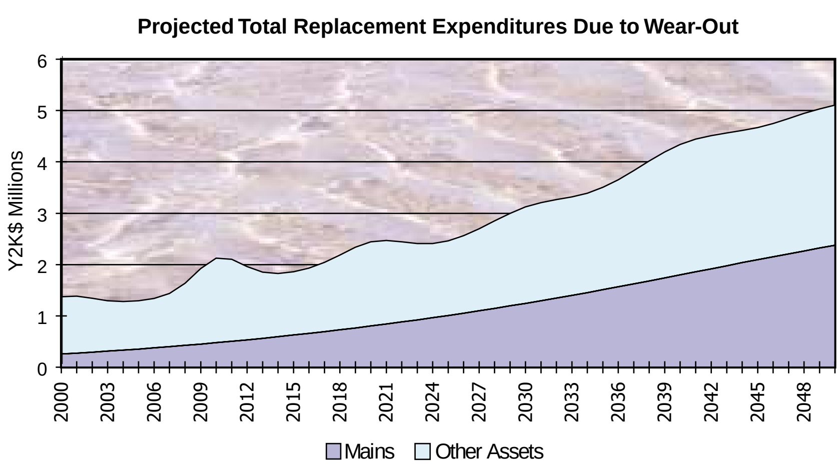


Columbus, Georgia

Asset Sets Modeled: Water Mains & Water Supply Plant —
Estimated Replacement Value $648 M



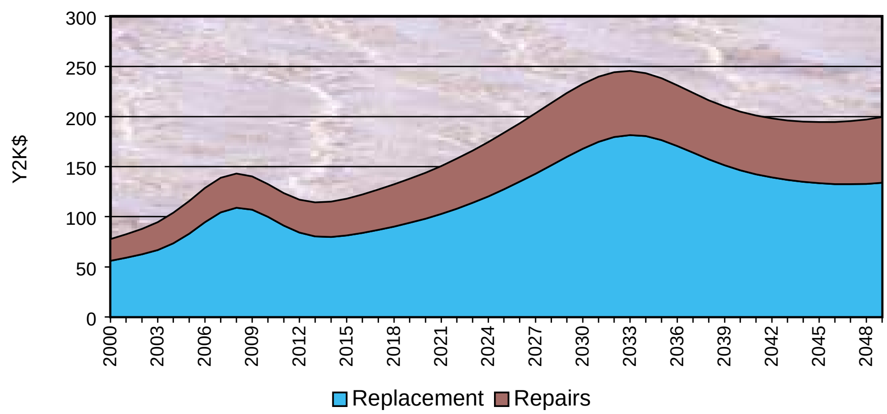




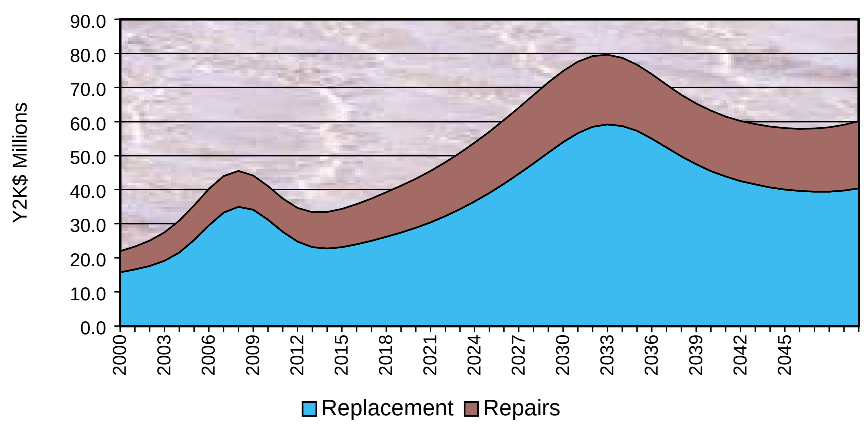
Denver, Colorado

Asset Sets Modeled: Water Mains & Water Supply Plant — Estimated Replacement Value $5,583 M (Includes Major Dams)

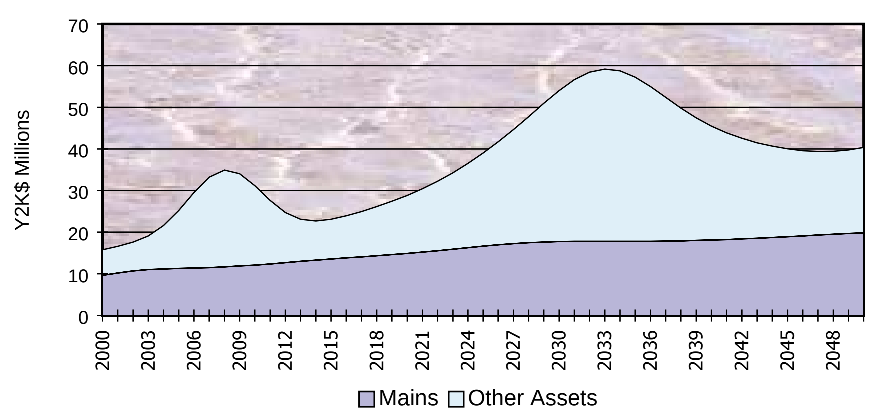
Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)



Projected Total Expenditures Due to Wear-Out

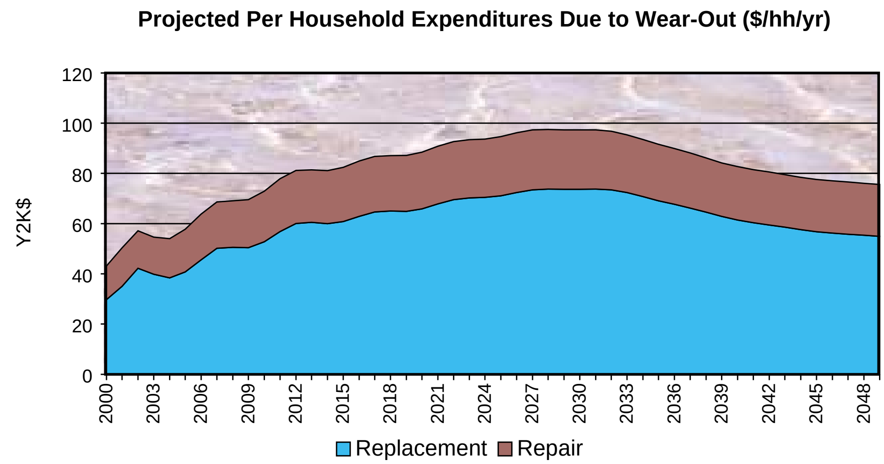


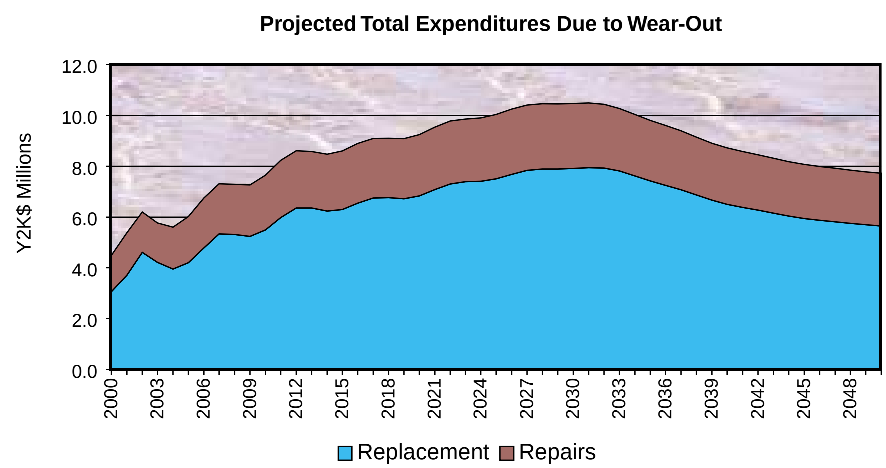
Projected Total Replacement Expenditures Due to Wear-Out

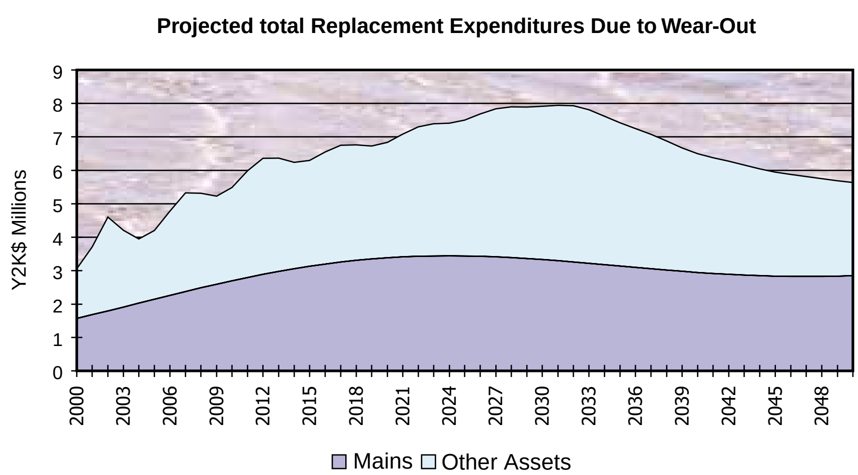


Des Moines, Iowa

Asset Sets Modeled: Water Mains & Water Supply Plant — Estimated Replacement Value $524 M

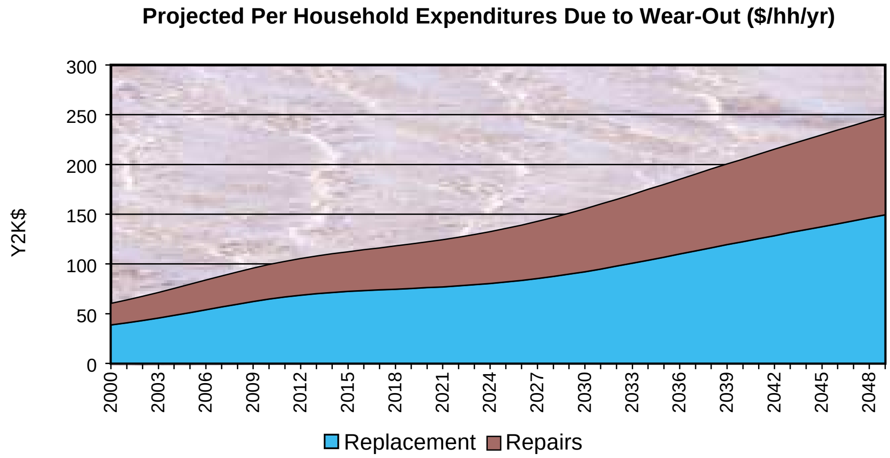


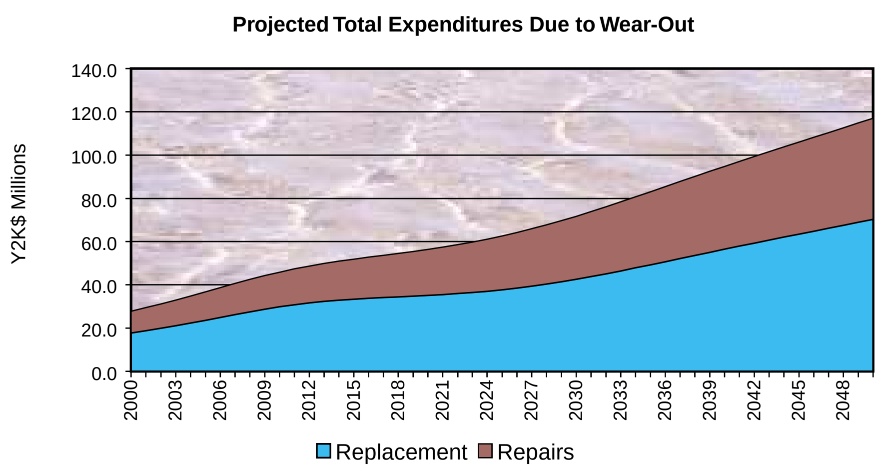


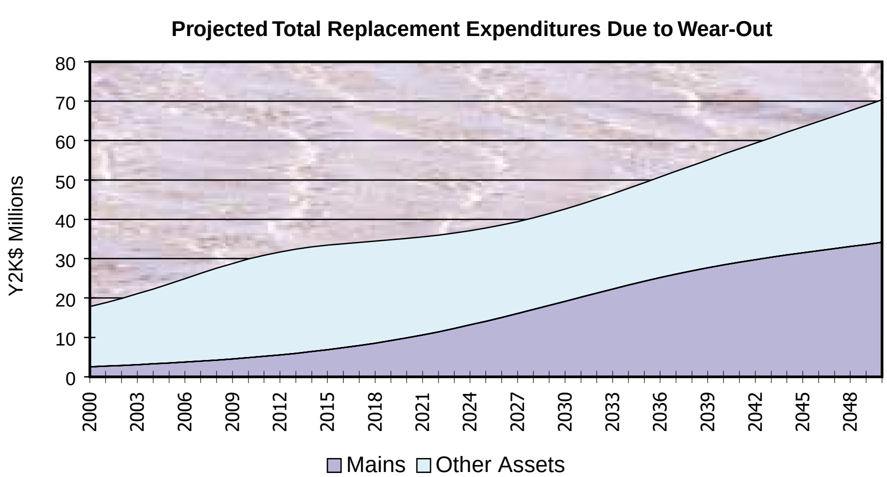


East Bay MUD, Oakland, California

Asset Sets Modeled: Water Mains & Water Supply Plant —
Estimated Replacement Value $8,110 M

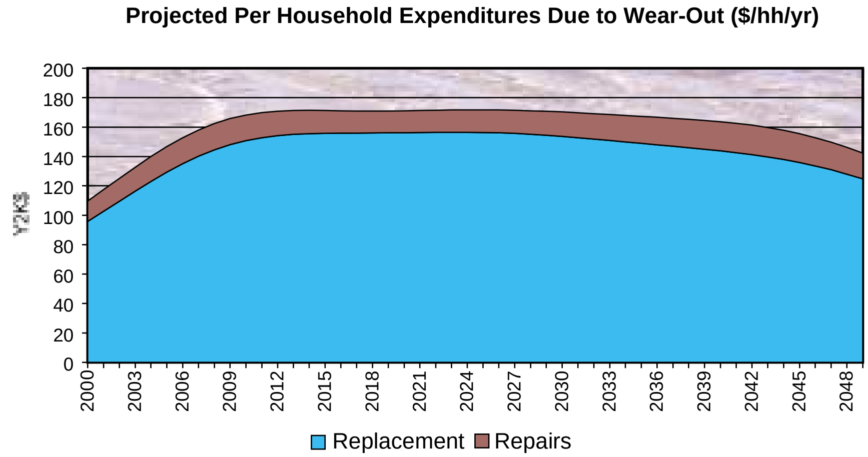


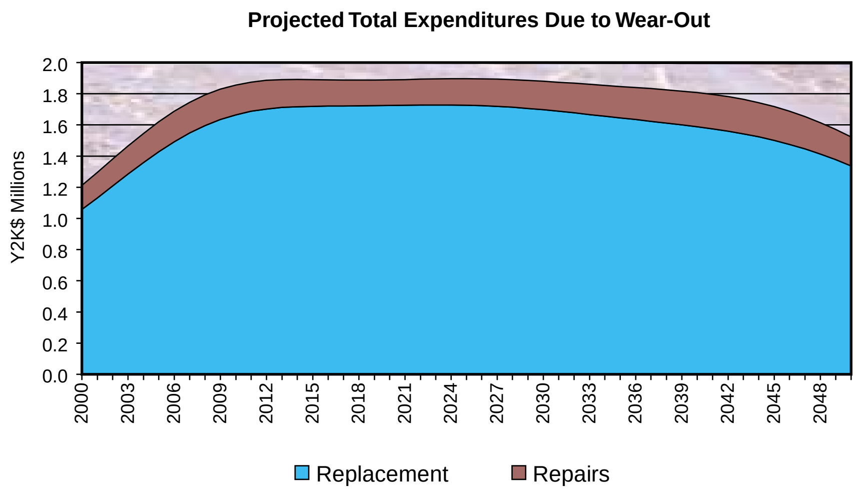


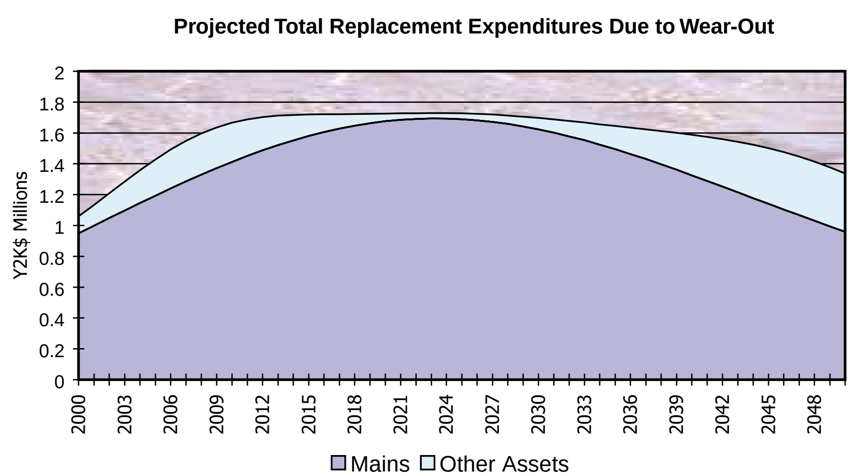


Gloucester, Massachusetts

Asset Sets Modeled: Water Mains & Water Supply Plant —
Estimated Replacement Value $116 M

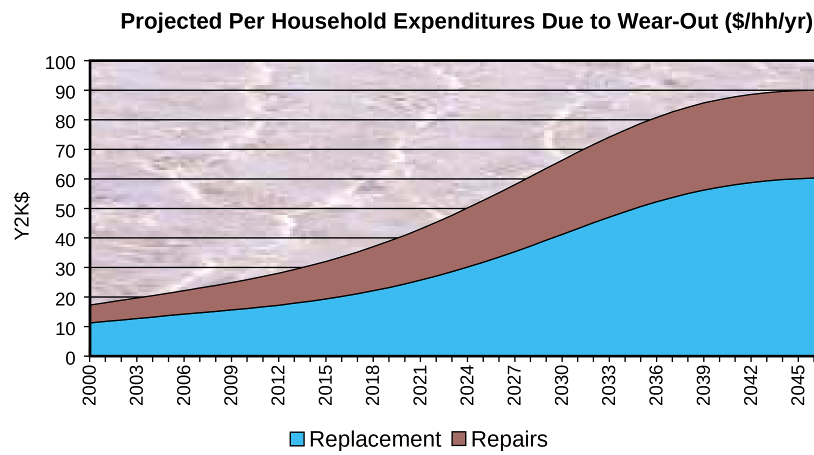


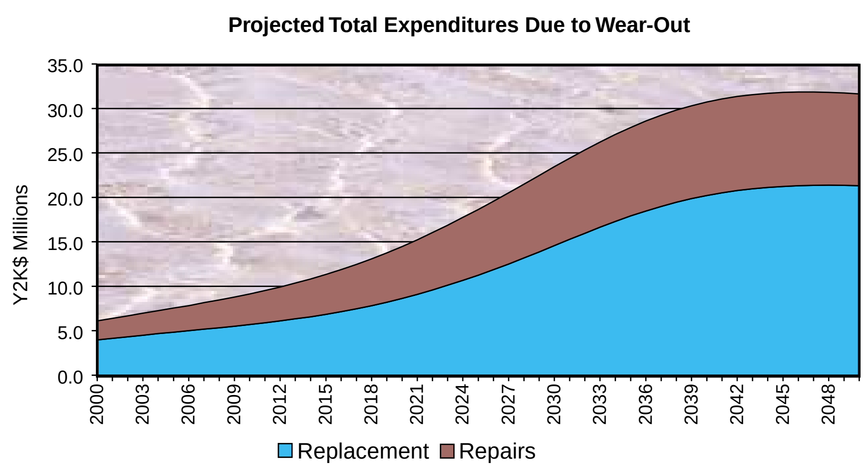


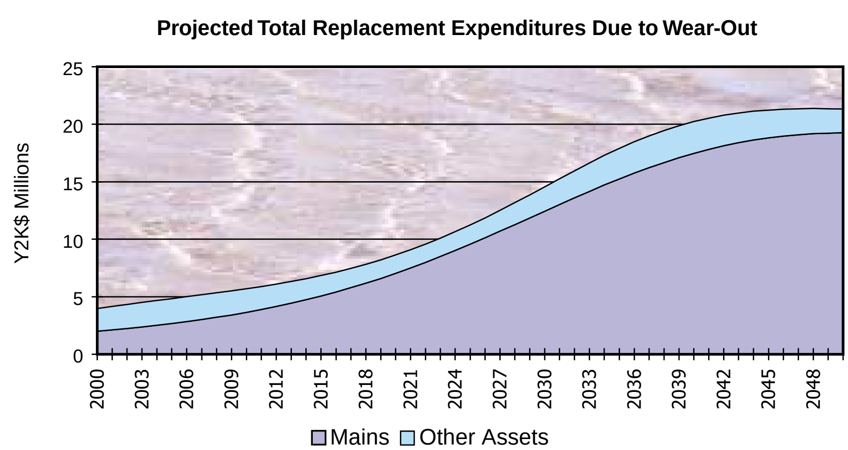


Honolulu, Hawaii

Asset Sets Modeled: Water Mains & Water Supply Plant — Estimated Replacement Value $1,272 M



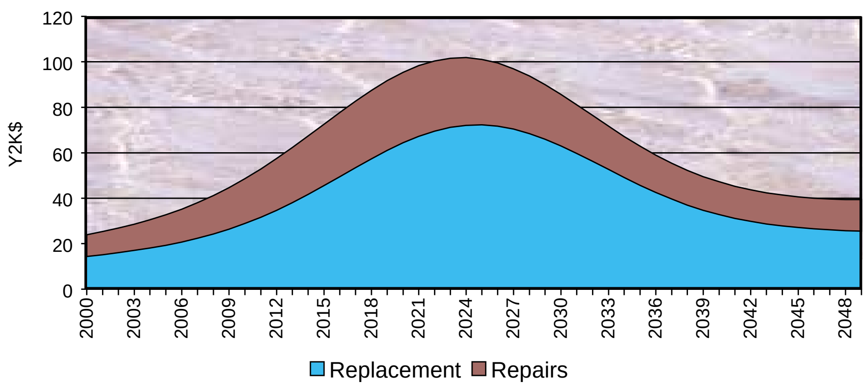




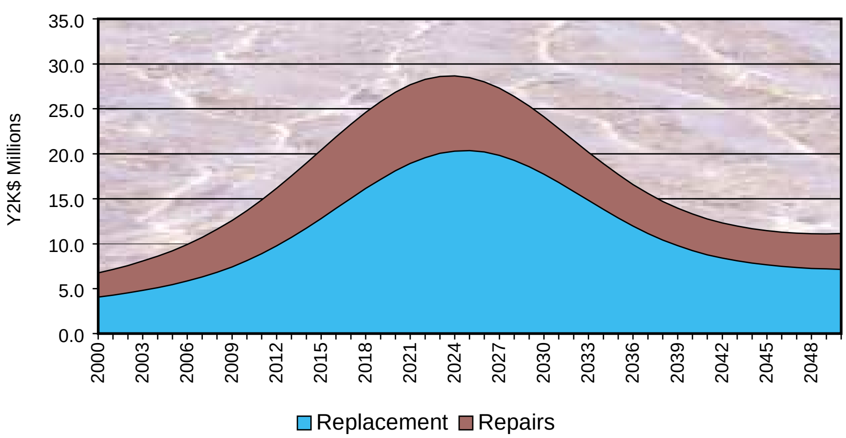
Louisville, Kentucky

Asset Sets Modeled: Water Mains —
Estimated Replacement Value $1,343 M

Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)

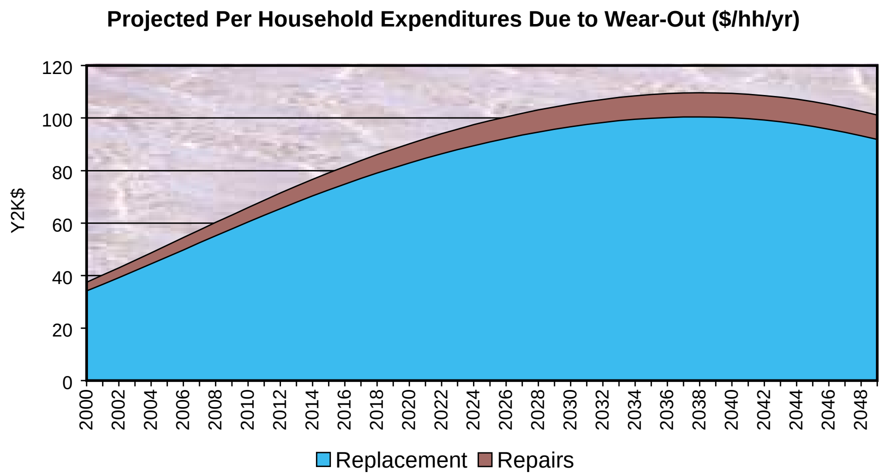


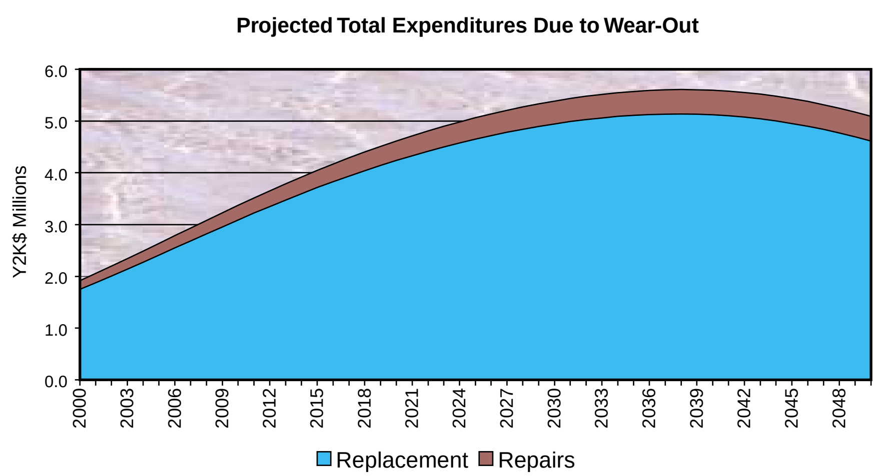
Projected Total Expenditures Due to Wear-Out



United Water, New Rochelle, New York

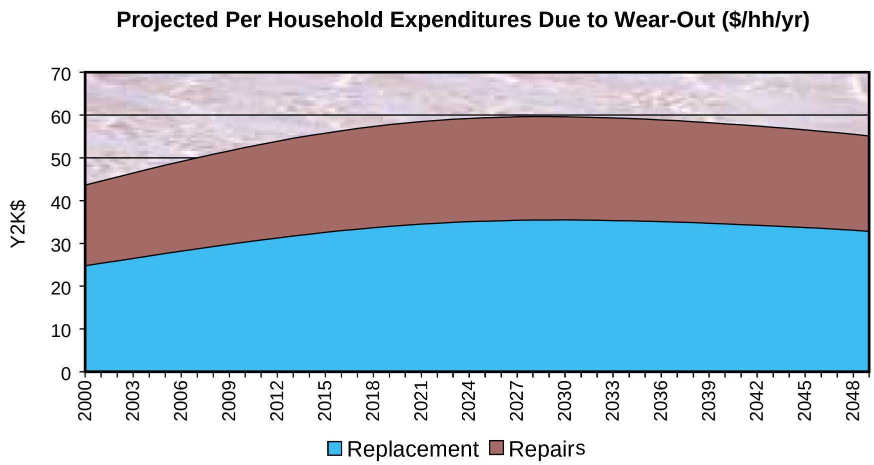
Asset Sets Modeled: Water Mains —
Estimated Replacement Value $325 M

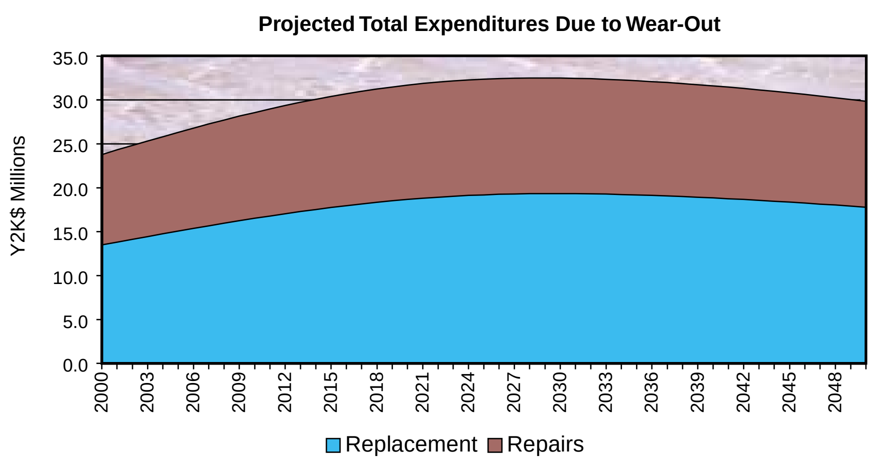




Philadelphia, Pennsylvania

Asset Sets Modeled: Water Mains —
Estimated Replacement Value $2,438 M

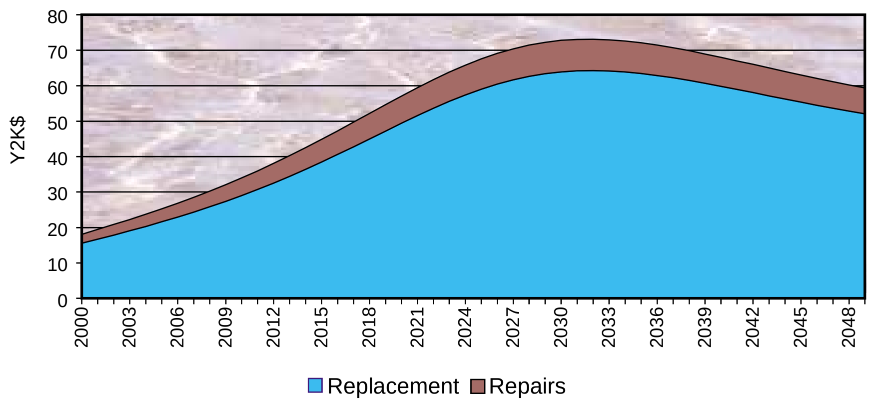




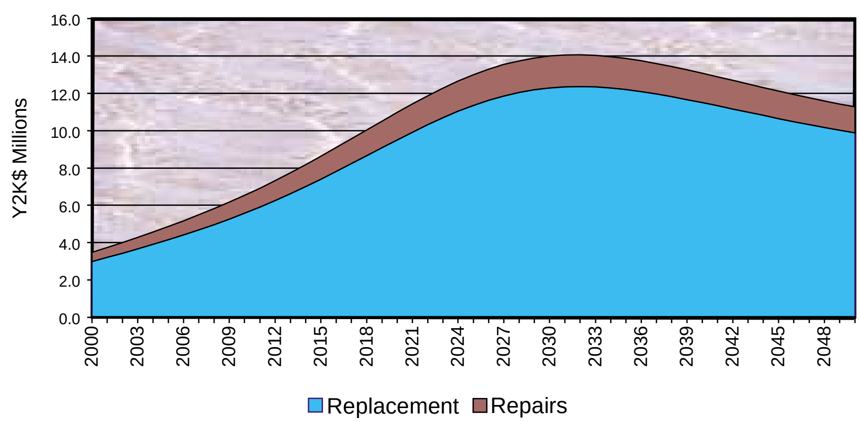
Portland, Oregon

Asset Sets Modeled: Water Mains —
Estimated Replacement Value $1,257 M

Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)



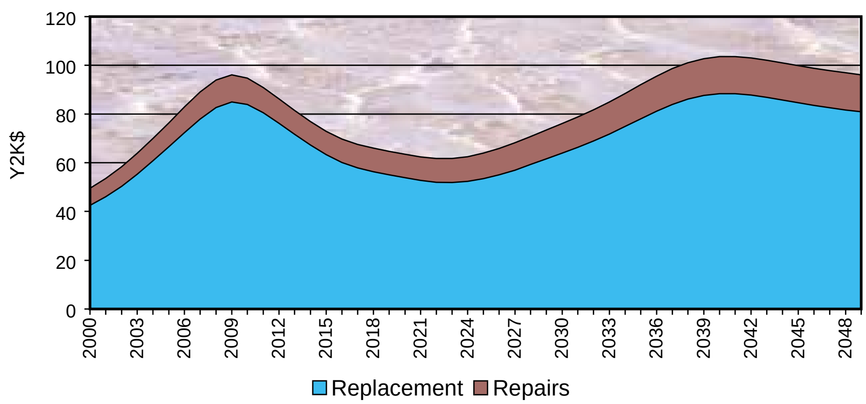
Projected Total Expenditures Due to Wear-Out



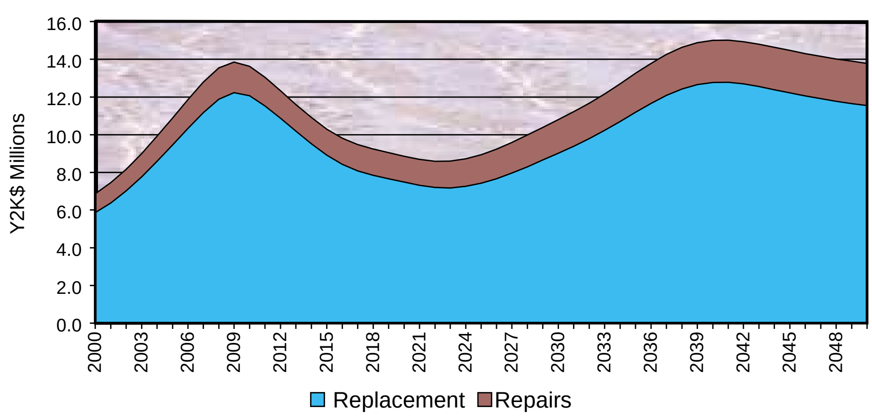
St. Paul, Minnesota

Asset Sets Modeled: Water Mains & Water Supply Plant —
Estimated Replacement Value $1,005 M

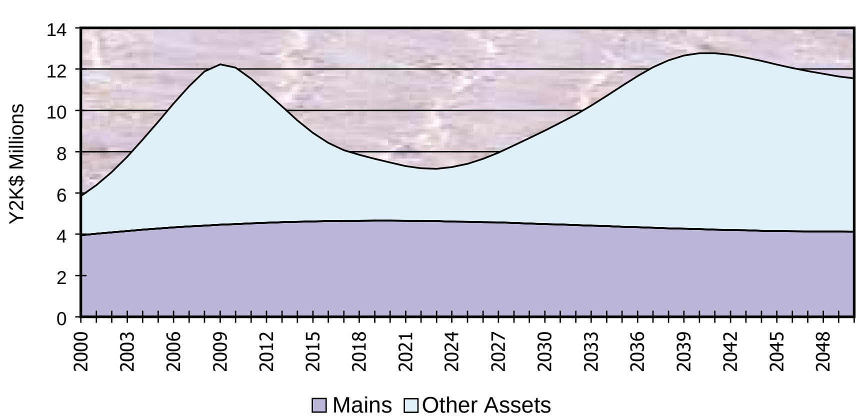
Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)



Projected Total Expenditures Due to Wear-Out

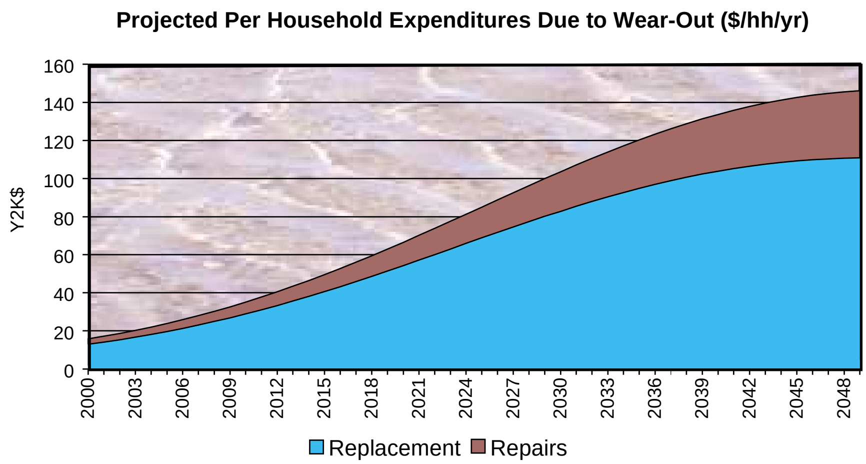


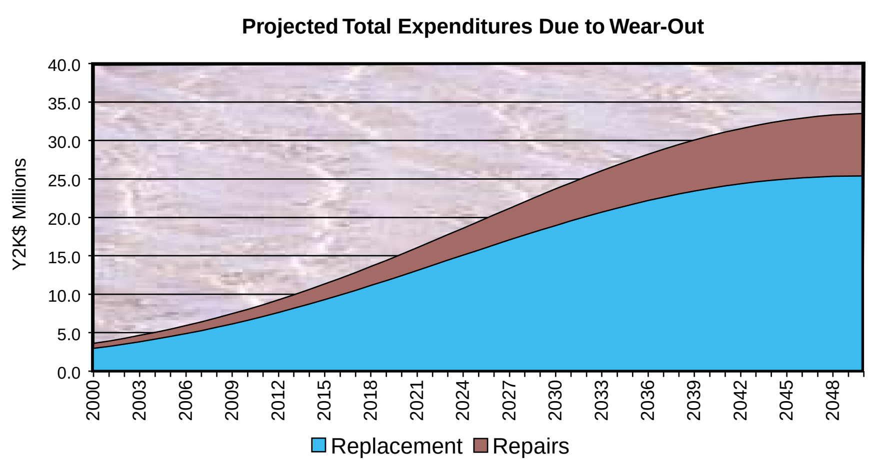
Projected Total Replacement Expenditures Due to Wear-Out



Seattle, Washington

Asset Sets Modeled: Water Mains —
Estimated Replacement Value $1,713 M

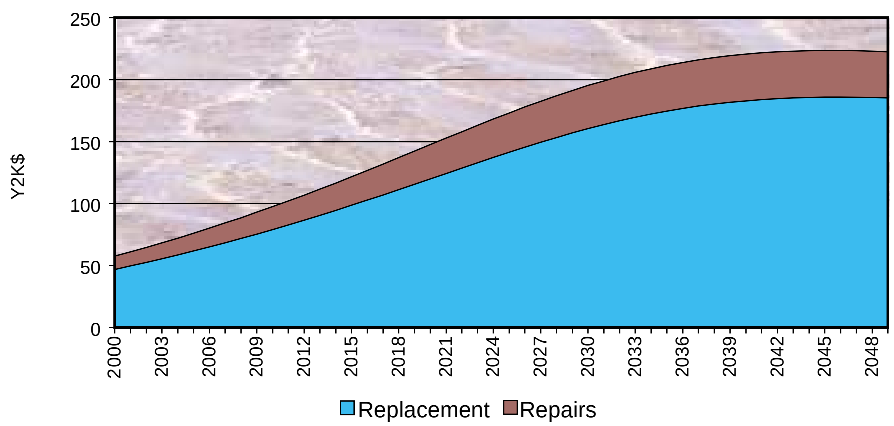




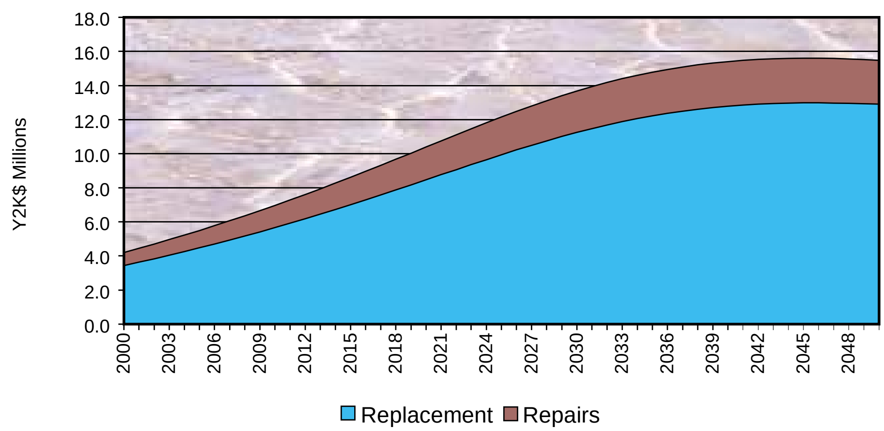
Tacoma, Washington

Asset Sets Modeled: Water Mains & Water Supply Plant — Estimated Replacement Value $1,100 M

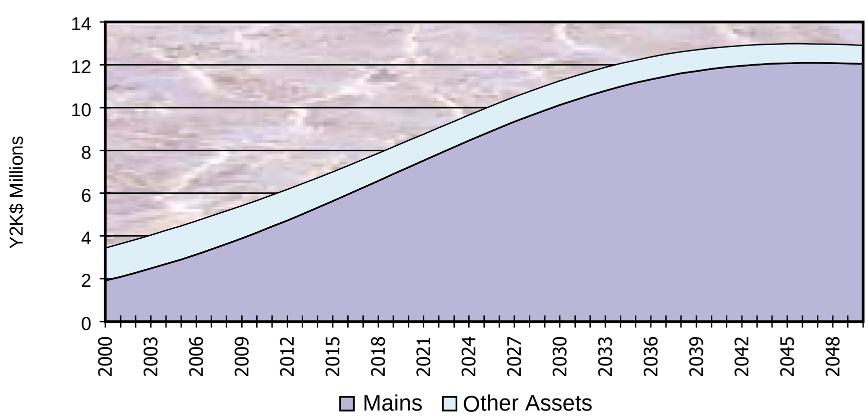
Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)



Projected Total Expenditures Due to Wear-Out



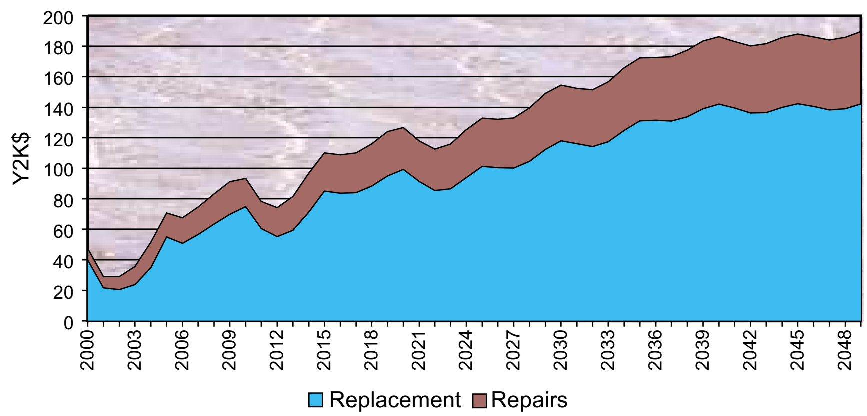
Projected Total Replacement Expenditures Due to Wear-Out



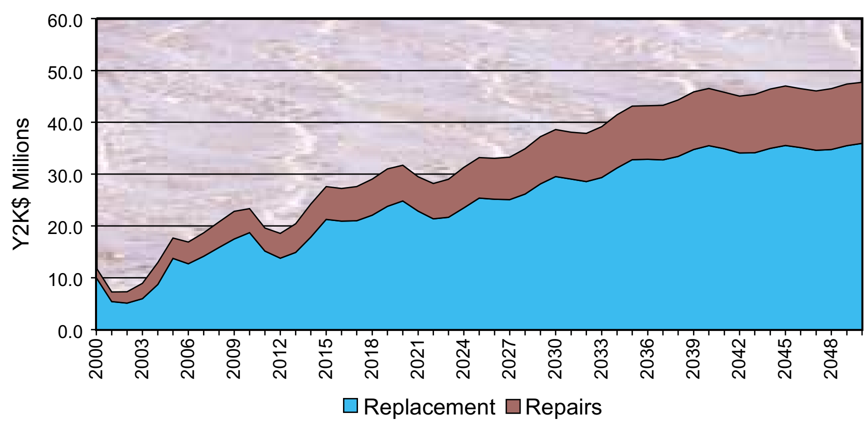
Tucson, Arizona

Asset Sets Modeled: Water Mains & Water Supply Plant —
Estimated Replacement Value $1,852 M

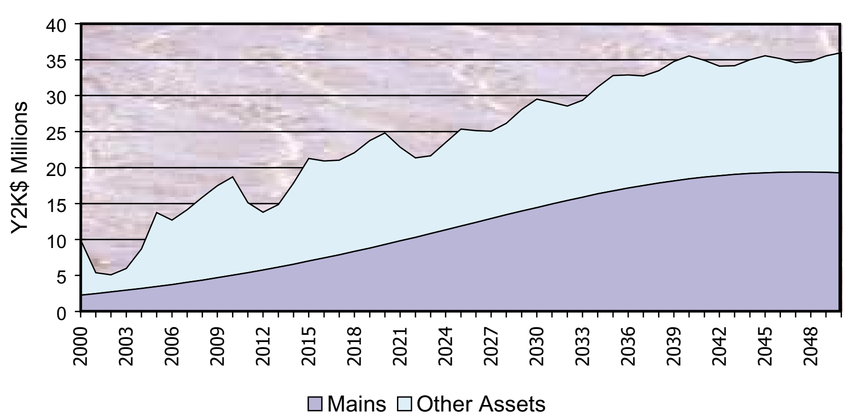
Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)



Projected Total Expenditures Due to Wear-Out



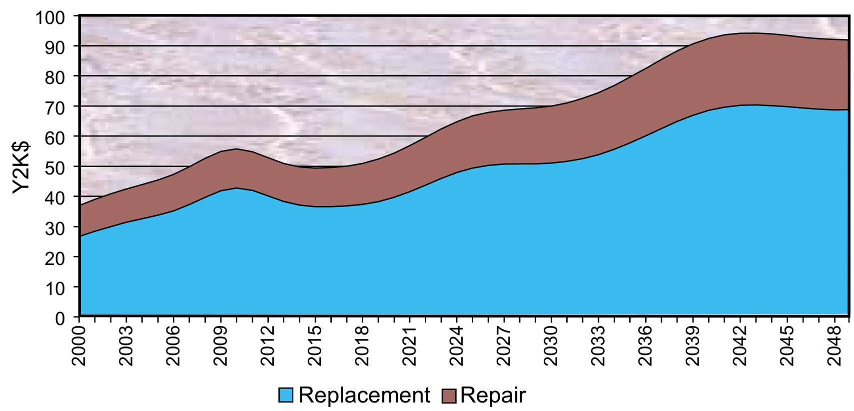
Projected Total Replacement Expenditures Due to Wear-Out



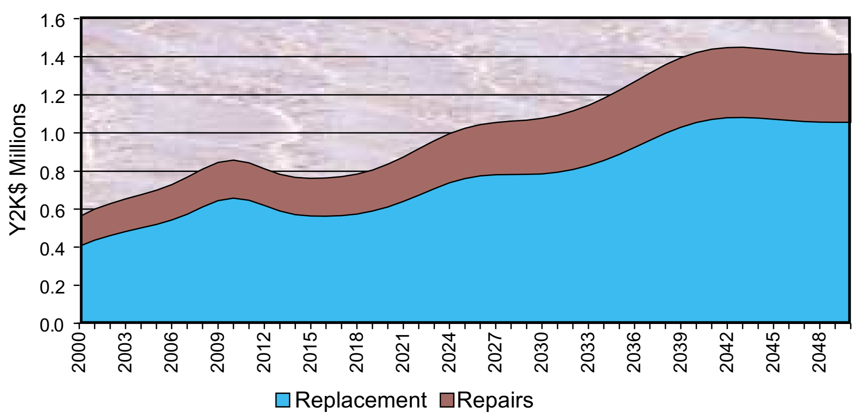
Wausau, Wisconsin

Asset Sets Modeled: Water Mains & Water Supply Plant — Estimated Replacement Value $84 M

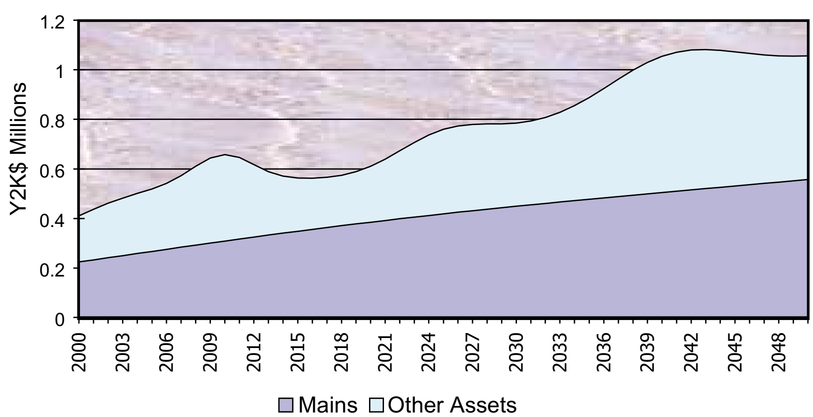
Projected Per Household Expenditures Due to Wear-Out ($/hh/yr)



Projected Total Expenditures Due to Wear-Out



Projected Total Replacement Expenditures Due to Wear-Out



APPENDIX B

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Austin, Texas

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Boston, Massachusetts

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Bridgeport, Connecticut

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Charleston, West Virginia

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Cincinnati, Ohio

Columbus Water Works
Columbus, Georgia

Denver Water Board
Denver, Colorado

Des Moines Water Works
Des Moines, Iowa

East Bay Municipal Utility District
Oakland, California

City of Gloucester
Gloucester, Massachusetts

Board of Water Supply
Honolulu, Hawaii

Louisville Water Company
Louisville, Kentucky

United Water New Rochelle
New Rochelle, New York

Philadelphia Water Department
Philadelphia, Pennsylvania

Portland Water Bureau
Portland, Oregon

St. Paul Regional Water Services
St. Paul, Minnesota

Seattle Water
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Tucson Water
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