THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

Report

Engineering Services

• Capital Investment Plan: Evaluation and Prioritization Process

Summary

Metropolitan's Capital Investment Plan (CIP) is prepared on a biennial basis and establishes a baseline of planned capital expenditures over the upcoming two fiscal years for over 300 projects. In order to meet various resource, budgetary, and operational constraints, the projects are prioritized via a comprehensive evaluation process. This process establishes an attainable expenditure forecast and ensures the planned capital investments are aligned with Metropolitan's objectives of reliability, quality, environmental stewardship, and safety. The purpose of this report is to describe the CIP evaluation and prioritization process conducted for each budget cycle to determine the mix of projects to be undertaken that best meets Metropolitan's strategic objectives. Finally, an estimation of potential jobs (direct, indirect, induced) created from Metropolitan's CIP is presented.

Purpose

Informational

Attachment

CIP Proposal Scoring Sheet Guidelines

Detailed Report

Background

With over 300 projects currently underway within Metropolitan's CIP, and 50 to 60 new projects identified with each new budgeting cycle, multiple factors must be considered in order to determine the necessity and urgency of commencing work on each project. Without this consideration, the near-term CIP expenditure forecast would be both excessive and unattainable based on budget constraints and staffing limitations.

In preparation for the Fiscal Year (FY) 1999/2000 budget cycle, Metropolitan adopted a new project evaluation process to identify and prioritize the increasing number of refurbishment and replacement (R&R) projects in the CIP. The first step in developing this process was changing the name of the capital program from Capital Improvement Program to Capital Investment Plan. This name change highlighted the recognition that significant capital improvement efforts such as the construction of Diamond Valley Lake, Inland Feeder, and the Oxidation Retrofit Program were going to transition to projects that centered around rehabilitation and refurbishment of existing aging infrastructure.

Development and Evaluation Process

Commensurate with this name change, a formalized project evaluation and prioritization process was established. The new project evaluation process established the concepts of major goals and drivers as a context for evaluating each of the projects. The process was conducted by a diverse team of stakeholders within Metropolitan.

For the last 20 years, two primary strategic goals have been the cornerstone of Metropolitan's Capital Investment Plan (CIP) evaluation process:

Reliability - Ensuring a reliable and adequate supply of water to Metropolitan's service area. This major goal addresses the need for new facilities as well as projects that are needed to refurbish or replace existing facilities including technology infrastructure and software required to maintain business and information systems. The score for a project in this category requires determining the urgency to complete the project, and the magnitude of the consequences of deferral. Another factor is loss of vendor support for a specific piece of equipment or software.

Water Quality - Ensuring full compliance with all primary drinking water standards. Projects that are directly required to meet water quality regulations are assigned a high priority depending on the timing of the required compliance and schedule for completion of the needed project. Projects that enhance water quality through process improvements and/or source protection are also scored in this category.

Additional strategic goals that are a part of the CIP evaluation process are:

Cost Efficiency & Productivity – This category includes projects that significantly increase efficiency through such measures as lower energy costs, reduced staffing, and better communication.

Regulatory/Permit & Code Compliance/Health & Safety (non-water quality) – Some projects are required in order to comply with regulations under the jurisdiction of cities, counties, the state, and the Federal Government that are not drinking water quality regulations. Again, these projects are prioritized depending on the timing of the required compliance and schedule for completion of the needed project. Projects submitted under this category also consider whether compliance by Metropolitan is required or just recommended.

Stewardship – This scoring category is intended to recognize projects that will result in other benefits associated with environmental stewardship such as efficient energy management.

In the evaluation/prioritization process, the strategic goals listed above are addressed through a series of scoring categories, including a high-level qualitative risk assessment multiplier (**Attachment 1**). The evaluation criteria is designed to prioritize projects that directly support reliability, quality, and safety for inclusion in Metropolitan's proposed CIP. Total scores under each category are added up and then multiplied by the risk factor for a final total score.

In order to be evaluated, project proponents are required to submit proposals for projects to be considered for inclusion into the CIP. For newly proposed projects, proposals must include scope, justification, alternatives, impact of re-scheduling work for a later time, impact on operations and maintenance costs, and an estimate of total project cost. For existing projects, staff must provide justification for continuing the project, explain any changes to the project since the proposal was last evaluated, and finally describe critical phases for the upcoming years.

Under the current process format, a diverse group of shareholders within Metropolitan comprises the evaluation team. The team includes staff from Water System Operations, Water Resource Management, Real Property, Engineering Services, Finance, Information Technology, Environmental Planning, and External Affairs. This team evaluates and scores all submitted projects. The team visits project sites and gathers additional information, as needed, from project proponents.

The evaluation effort results in an iterative process by the evaluation team to first score and rank every new and existing project, and then solicit feedback from project sponsors, customers, resource providers, and Group and Executive Management. The outputs of this effort establish project schedules, resource needs, and cash flow requirements. These schedules, along with analyses of facility shutdown requirements, environmental permitting timeframes, and contracting process requirements, also enable resource managers to identify labor requirements, both in-house staff and consultants. The results of this comprehensive effort form the final schedule and implementation plan for each two-year capital budget. Information on project budgets and objectives are summarized under each of the individual Program narratives in the CIP Appendix that is attached to Metropolitan's overall budget documents.

Prioritization Process

Prior to the current budgeting process for FYs 2020/21 and 2021/22, project proponents were required to submit project proposals for evaluation regardless of what stage of development the project was in at the start of the budgeting cycle. Recognizing that projects in design or in construction were rarely stopped, the process was modified in mid-2019.

For the current budgeting effort just completed, project sponsors were required to submit project proposals for projects that were either new, or had not yet moved into the final design phase. A second change to the process was to add additional project ranking criteria based on a project's actual status. Table 1 reflects the seven levels of project prioritization that were developed to reflect project status. Projects that had project status in the first four categories (1-4) were rated at the top of the list, and were ranked as the highest priority projects in the FYs 2020/21 and 2021/22 CIP. CIP funding for the upcoming biennium was allocated to these projects. Projects in the final three categories (5-7) were placed into a secondary priority and remaining CIP funding was allocated to these projects. If funds for this second tier of projects were not available in the upcoming biennium, these projects were deferred to future budget cycles.

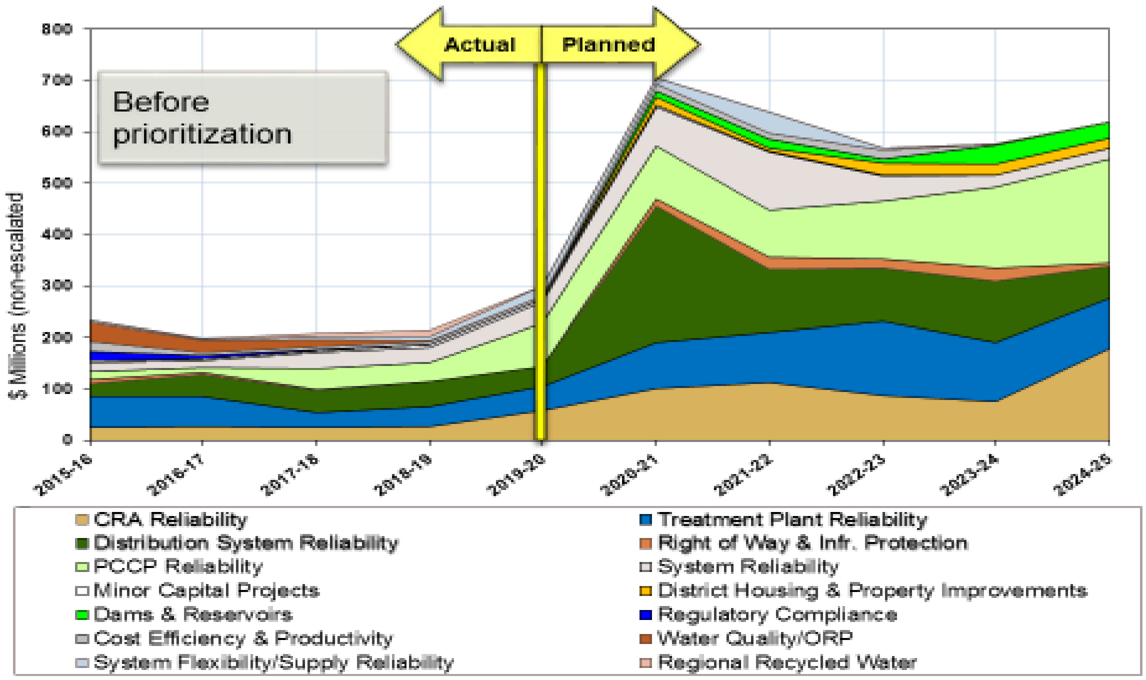
Priority Ranking	Project Status
1	In construction
2	Business system priority
3	In Procurement
4	In Final design
5	In Preliminary design
6	In Study
7	New/not yet started

Initial CIP Expenditure Projections

During the lead up to the CIP evaluation/prioritization process, staff estimated starting dates and durations for existing and new project phases along with estimates for internal labor, consultant and construction contract costs, and other miscellaneous categories based on their best knowledge. These initial forecasts did not consider project priorities or resource constraints. Consequently, the resulting forecast resulted in a projected spike of capital expenditures early in the next fiscal year followed by similarly high expenditure forecasts for subsequent years. Prior to applying the prioritization results, the estimated CIP expenditures for FY 2020/21 were about $700 million, and $650 million in FY 2021/22.

Figure 1 is a chart of the actual and forecasted CIP expenditures for FYs 2015/16 through 2024/25 prior the prioritization effort.

Figure 1. Actual and Forecasted Capital Expenditures Before Prioritization - FY 2015/16 – 2024/25

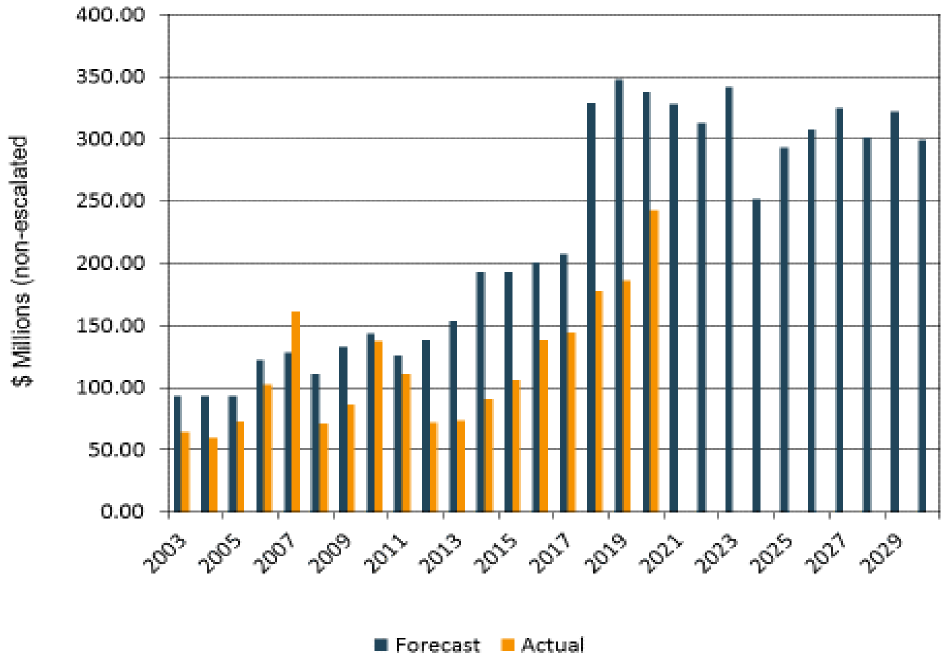


Asset Replacement Funding Model forecast of CIP expenditures

The Asset Replacement Funding Model was developed in 2002 to establish a methodology to both estimate future total annual funding needs for R&R projects, and to balance the use of bond financing and operating revenues (pay-as-you-go) to maintain financial flexibility when funding the capital investment plan. For the purposes of modeling, Metropolitan's facilities were categorized into asset classes and standard service lives were assigned to each class. Projected expenditures budgeted in the CIP are used in the model by assuming that each capital project will place a new or refurbished asset into service in the fiscal year after the cash flow projections "stop". At that time, the model "takes over" as far as updating future refurbishment/replacement spending. With these inputs, the model calculates a refurbishment schedule for each asset based on its asset replacement class and its age.

The model is updated regularly based on each new CIP budget as well as actual R&R expenditures. Near-term R&R needs are addressed directly by the CIP budget through specific projects. The model is used to forecast potential longer-term funding needs for planning purposes. This approach takes into account any project deferrals and scope changes as well as each new capital project added with every budget cycle. Figure 2 is the graph of the current asset replacement funding estimate along with actual and projected R&R expenditures currently proposed as part of the CIP budget. The model proposes an eventual planned ramp up in CIP expenditures to more than $300 million per year for long-term expenditures on Metropolitan's R&R projects. Note that the actual expenditures shown in this graphic reflect those associated only with R&R projects. CIP expenditures in other categories have not been included.

Figure 2. Actual and Projected R&R Expenditures



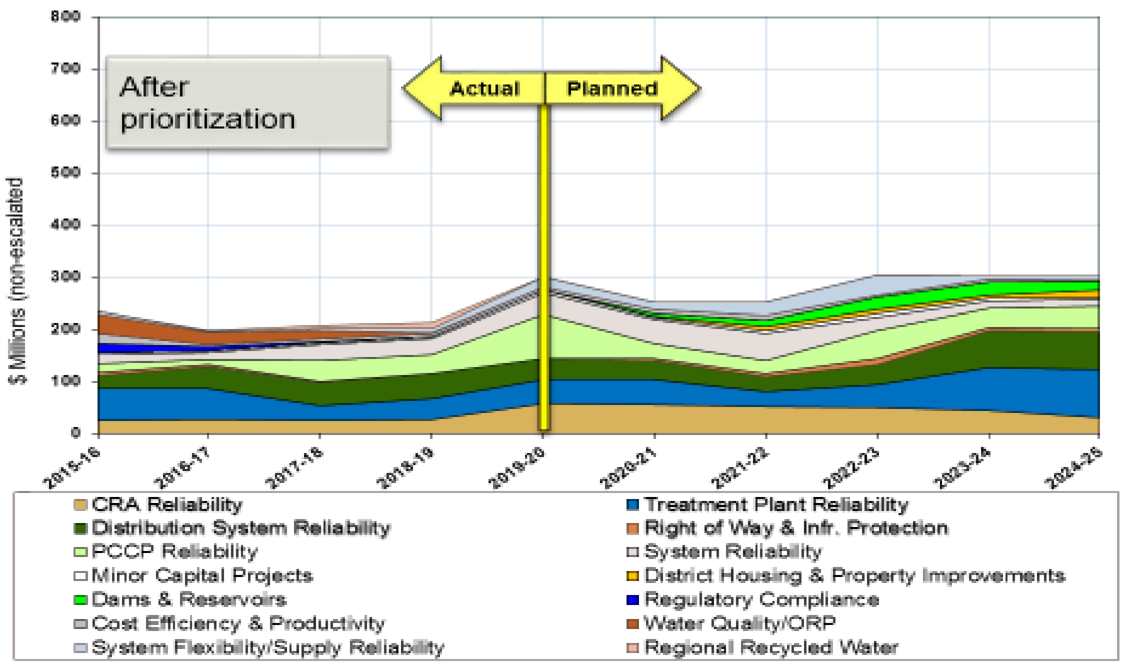
Final FY 2020/21 and 2021/22 CIP Planned Expenditures

With initial unprioritized FY 2020/21 – 2021/22 CIP expenditures estimated at close to $700 million and $600 million respectively, and with the asset replacement model suggesting the need to expend up to $300 million per year in the upcoming biennium on R&R efforts, staff undertook the rigorous project prioritization process that was previously described. The goal of this process was to reschedule planned projects to reduce annual planned CIP expenditures in the upcoming biennium to approximately $250 million per year. This target of $250 million per year was coordinated with Metropolitan's overall budget process for the FYs 2020/21 – 2021/22 biennial budget and rate setting process.

The FY 2020/21 - 2021/22 planned capital expenditures "After Prioritization" forecast is shown in Figure 3, and is reflected in the current CIP Appendix that was adopted by the Board in April 2020. The planned spending is based on resource loaded project schedules accounting for anticipated project progress and estimated costs for all ongoing and planned work for the new biennium budget period. Once prepared, the project schedules were revised to reflect the priority rankings in order to maintain capital spending within the prescribed limits. Examples of both high priority and deferred projects are shown in **Attachment 2**. The prioritization process resulted in the reduction of the near-term forecast by over sixty percent when compared to the initial expenditure projections shown in Figure 1. It should be noted that the current CIP expenditure plan of $250 million per year is also below the funding level forecasted by the Asset Replacement Funding Model.

Figure 3 is a chart of the actual and forecasted CIP expenditures for FYs 2015/16 through 2024/25 resulting from the prioritization effort.

Figure 3. Actual and Forecasted Capital Expenditures After Prioritization - FY 2015/16 – 2024/25



Future CIP Planning and the Potential for Jobs Creation

Since its original introduction in 1999, the CIP evaluation and prioritization process has been modified as business plans and new policies (such as energy management, conservation, and the climate action plan) are adopted. The underlying need to establish achievable R&R plans will continue to be based on Metropolitan's strategic goals of reliability, quality, environmental stewardship, and safety. Future modifications to the CIP evaluation and prioritization process, and revisions to project schedules will continue to evolve. Drivers for this future process evolution will include updated seismic design criteria, source of supply and demand updates, and the impact of the current COVID–19 pandemic on Metropolitan's resources and priorities.

As Metropolitan's CIP is developed to achieve the strategic goals listed above, another aspect to be considered is the potential socio-economic benefit associated with the implementation of the CIP in the form of potential job creation. Numerous studies have been conducted over the previous decades to ascertain the potential for investment of capital funds in infrastructure projects to stimulate job creation. These studies appear to indicate that the potential for job creation is specific to each industry. Consequently, the number of jobs created by capital spending on highways and transportation infrastructure is not necessarily equivalent to the number of jobs created by capital spending on infrastructure projects in the water and wastewater industry.

While the job creation potential for various projects may differ from one segment of the industry to another, the type, or classification of jobs created by the capital investment have been uniformly grouped into three categories: direct, indirect and induced jobs.

Direct jobs – Direct jobs are jobs related directly to the construction of the project and the operation and maintenance of the project once completed.

Indirect jobs – Indirect jobs are those jobs that would be created in order to supply the new demand for the construction supplies such as manufacturing, mining, and transportation jobs.

Induced jobs – Induced jobs are those jobs that would be created due to the new spending habits of those who have benefited from the direct and indirect jobs that were created. These jobs would belong to retail type industries.

In 2008, during the previous recession, Metropolitan staff researched publications and reports to determine estimates of the potential for job creation resulting from capital investment in water infrastructure. This effort was part of a larger undertaking to support Metropolitan Member Agencies in their applications for recession stimulus funds. The research at that time estimated that approximately 13 direct, indirect, and induced jobs would be created for every $1 million spent on water infrastructure projects.

In the development of this current board report, staff researched recent publications for information pertaining to job creation as a result of water infrastructure capital spending. From this research, an article published in 2017 by the Value of Water Campaign entitled “The Economic Benefits of Investing in Water Infrastructure” (**Attachment 3**) appeared to be most relevant to the topic of potential job creation attributed to Metropolitan’s CIP. In the development of this paper, the Value of Water Campaign commissioned an economic impact analysis to understand how increasing investments in the nation’s water infrastructure can affect economic growth and employment. The comprehensive study found that for every $1 million invested in public water infrastructure, a total of up to 15 jobs (consisting of direct, indirect and induced jobs) were created. This finding correlates closely with the staff’s 2008 research findings that were discussed above. By using the findings from the 2017 Value of Water Campaign research, it is estimated that Metropolitan’s two-year CIP planned expenditures of $500 million of Fiscal years 2020/21 and 2021/22 has the potential to create approximately 7,500 jobs consisting of a combination of direct, indirect and induced jobs.

Attachment 1 – CIP Proposal Scoring Sheet Guidelines
Attachment 2 – CIP Prioritization Examples
Attachment 3 – Economic Impact of Investing in Water Infrastructure

CIP Proposal Scoring Sheet Guidelines

Points are given for project proposals based on the number and degree to which each of the following categories are addressed by a project. Point allowances are determined by the CIP Evaluation Team.

Site visits to facilities are conducted prior to the submittal of proposals in order to provide project sponsors with the proposal guidelines and to allow sponsors to describe project needs.

Justification (why is project needed)

<u>Primary Goals</u>

Supply Reliability

Operational flexibility:	Addition of new or retrofit of existing facility to allow sharing of water between water supply zones for operational flexibility
New facility expansion:	Expansion projects that would allow more of existing water supply to be introduced to Metropolitan's or member agencies water supply zone(s) (e.g., new water treatment plant or modules)
New water supply:	New water supply for Metropolitan (e.g., Hayfield GW recovery and regional recycled water treatment)

Infrastructure Reliability

Aging infrastructure – deteriorated/failure

- Infrastructure that has failed due to its age or operating conditions and need permanent fix; failure of equipment at one location may apply to other locations (e.g. fluoride tank replacement).
- Infrastructure that has not failed but likely to fail without replacement/rehabilitation

Process – improvement/failure

- Process that no longer supports its objective(s), which it was designed to support, and need a complete new solution
- Process that has not failed but can be improved for greater efficiency/reliability (e.g., Weymouth chlorine system upgrades, seismic retrofit projects)

Damaged/stolen/vandalized

- Damage is caused outside of normal operations (i.e., intentional or by accident)
- Equipment or facility that no longer works and need to replace or repair
- Equipment or facility that was damaged/stolen/vandalized but is still operational

Maintenance capability

- Only when the project is necessary to facilitate system maintenance
- Addition of new equipment or facility, which does not exist, that is necessary to facilitate maintenance
- Addition of new equipment or facility, which does not exist, that is not necessary but will aid in facilitating maintenance

Seismic

- Occupied building or facility
- Unmanned facility

Obsolete

- Parts are no longer manufactured and supported by the manufacturer and commercially available and need to refurbish these parts or have to resort to buying the parts on EBay or other secondary market
- Parts are no longer manufactured but are commercially available and are supported by the manufacturer

Security

- Projects that are necessary to meet Department of Homeland Security regulations or industry standards
- Projects that will enhance security but are not necessary to meet Department of Homeland Security regulations but to meet industry standards

Regulatory Compliance

- Project's main driver is to comply with regulatory compliance
- Project's main driver is to implement voluntary compliance or recommendations by regulatory agencies

GM Business Plan

- Projects that support GM's strategic priorities outlined in the GM's and Group's business plans whether or not projects are mentioned by project name.
- Group's own business initiatives outlined in Group business plans but not specified in the GM's business plan

<u>Other Goals</u>

- Projects that provide cost savings, revenue generation, energy savings, or increased productivity

Directive

Regulatory/Legal Settlement

- Project necessary to comply with a written citation
- Project necessary to comply with verbal or written directive with no citation (includes environmental mitigation mandated by EIR)
- Project identified by Metropolitan to avoid a citation or directive

Special Initiative/Directive

- Projects approved in previous budgets
- Projects previously authorized for Study, Preliminary design, or Final design
- Project proposals accompanied by an inspection report

Service Disruption

Business operations

- Primary/Secondary financial, communication, or information system

Water system operations

- Single non-redundant delivery or treatment component
- Cascading impact due to problems/concerns with:
  - Control system
  - Maintenance/fabrication shops
  - Warehouse/storage facilities
  - Administration building
  - Access and roads
- One of multiple parallel supply or treatment component

Cost/Productivity/Sustainability

Cost/Benefit Analysis

- Payback of 5 years or less
- Payback of 6 to 10 years
- Some demonstrated cost savings

Sustainability

- Energy savings/generation
- Water savings
- Waste reduction

Customer Service (Internal and/or external)

- Innovative new service or innovative new approach to existing service to internal or external customers.

Risk multiplier

- Likelihood of facility/component/process failure
- Likelihood of health, safety, water quality, or environmental impact
- Likelihood of missed opportunity (available resources, planned shutdown, revenue generation or outside funding, cost savings, additional supply)
- Likelihood of not meeting service demands (water or other customer service)

CIP Prioritization Examples

The evaluation and prioritization of capital projects is conducted based on the best information available at the time proposals are submitted. It is not uncommon for plans to change in the interim after the CIP Appendix is published but before final approval of the capital budget.

During the most recent CIP development process for the Fiscal Years 2020/21 and 20221/22 budget cycle, more than 450 potential CIP projects were evaluated, scored and prioritized based on Metropolitan's strategic goals and anticipated CIP planned expenditures. Rather than listing all of these projects, a list of examples for 'high priority" and "deferred" projects was developed and is shown below. As discussed in the body of this report, some projects may receive relatively low evaluation scores, but since they determined to be "business system priorities" at the time of the CIP evaluation process, these projects are awarded a relatively high priority score. Two examples of this scoring approach and prioritization approach are shown in the Table 1 below for the projects at Diamond Valley Lake. In similar fashion, a project may receive a high score, but since it has a relatively low priority due to its early stage of overall development. Examples of these projects are shown in Table 2.

The list of example projects in Tables 1 and 2 below is based on the evaluation and prioritization that was completed in December 2019 and may not reflect current plans and schedules. Ongoing studies and assessments can result in a project that has been deferred to be moved up in priority by the start of or during the new fiscal year. Likewise, better-than-anticipated progress on a construction project, or changes in planned operations can move the initially planned expenditures ahead of or after the new fiscal year. An example of the former is the Lake Skinner Outlet Tower Seismic Upgrade. The recently completed initial assessment has indicated the need for a more detailed study of alternatives. The latter situation is the case for the Second Lower Feeder PCCP Reach 2 Rehabilitation and the Headquarters Improvement projects where construction progress has been faster than planned.

Other factors contributing to project deferrals include ongoing projects or studies that can influence another projects scope. Installation of the cathodic protection on the Santa Monica Feeder has been deferred pending completion of a study of a more comprehensive pipeline rehabilitation. Rehabilitation of some pressure control structures are on hold pending more urgent valve replacements under the Minor Capital Projects Program.

Note: A score of 1,000 was assigned to any project in construction or final design. The Priority Code identified the project's status for prioritization consideration.

Table 1: Representative Examples of High Priority Projects

Program	Project Name	Priority Code	Score
Dams & Reservoirs	Diamond Valley Lake Dam Monitoring System Upgrades - Stages 1 & 2	1	1,000
Supply Reliability/System Flexibility	Greg Avenue PCS - Pump Modifications and New Control Building	1	1,000
PCCP Rehabilitation	Second Lower Feeder PCCP Rehabilitation - Reach 2	1	1,000
Treatment Plant Reliability	Diemer West Basin & Filter Building Rehabilitation	1	1,000
CRA Reliability	CRA Pump Plant Sump System Rehabilitation	1	1,000
System Reliability	Headquarters Improvements	1	1,000
System Reliability	Control System Upgrade - Phases 1 to 3	2	1,000
System Reliability	Security Operations Center	2	1,000
CRA Reliability	Copper Basin Reservoirs Discharge Valve Rehabilitation & Meter Replacement	3	1,000
Distribution System Reliability	Casa Loma Siphon Barrel No. 1 - Permanent Repairs	3	1,000
Dams and Reservoirs	Garvey Reservoir Cover and Liner Replacement	5	425
System Reliability	Datacenter Modernization Upgrade Phase 2	2	412
Cost Efficiency & Productivity	Budget System Replacement System	2	272
Cost Efficiency & Productivity	Diamond Valley Lake Floating Wave Attenuator	2	45
Cost Efficiency & Productivity	Diamond Valley Lake - Lake Skinner Trail	2	40

Table 2: Representative Examples of Deferred Projects

Program	Project Name	Priority Code	Score
Distribution System Reliability	Santa Monica Feeder Cathodic Protection	4	1,000
Distribution System Reliability	Washington Street Pressure Control Structure Valve Replacement & Security Upgrades	7	390
Distribution System Reliability	108th Street Pressure Control Structure Valve Replacement	7	315
Distribution System Reliability	Coyote Creek HEP/PCS Emergency Standby Generator Replacement	7	300
Distribution System Reliability	Lake Skinner West Bypass Screening Structure Rehabilitation	5	240
Treatment Plant Reliability	Jensen Hazardous Waste Containment Facility	6	350
System Reliability	Eagle Rock Security Project	7	240
Cost Efficiency & Productivity	AP Imaging Replacement	7	189
Treatment Plant Reliability	Skinner Ozone Contactor Roof Elastomeric Coating	7	135
CRA Reliability	Intake Pump Plant Road Improvements	7	140
Treatment Plant Reliability	Skinner WTP Service Building 1 Rehabilitation	7	340
Dams & Reservoirs	Lake Skinner Outlet Tower Seismic Upgrade	6	220
Distribution System Reliability	East Lake Skinner Bypass and Bypass No. 2 Screening Structure Upgrade	6	340
Distribution System Reliability	Hollywood Tunnel North Portal Equipment Upgrades	6	400
Dams & Reservoirs	Etiwanda Reservoir Rehabilitation	7	320

Value of Water
CAMPAIGN

The Economic Benefits of Investing in Water Infrastructure

About the Value of Water Campaign

The Value of Water Campaign educates and inspires the nation about how water is essential, invaluable, and in need of investment. Spearheaded by top leaders in the water industry, and coordinated by the US Water Alliance, the Value of Water Campaign is building public and political will for investment in America's water and wastewater infrastructure through best-in-class communications tools, high-impact events, media activities, and robust research and publications.

The campaign is supported by a diverse group of leaders in the water industry, including:

Alexandria Renew Enterprises
American Society of Civil Engineers
American Water
American Water Works Association
Association of Metropolitan Water Agencies
Atlanta Department of Watershed Management
Black & Veatch
Boston Water and Sewer Commission
CH2M
DC Water
Detroit Water and Sewerage Department
Dow Chemical
Greeley and Hansen
Hampton Roads Sanitation District
Hazen and Sawyer
Kansas City Water Services
Los Angeles Sanitation
Louisville Metropolitan Sewer District
Metropolitan Sewer District of Greater Cincinnati
Metropolitan Water Reclamation District of Greater Chicago
MWH Global—now part of Stantec
National Association of Clean Water Agencies
National Association of Water Companies
Northeast Ohio Regional Sewer District
Philadelphia Water Department
San Francisco Public Utilities Commission
Santa Clara Valley Water District
Sewerage and Water Board of New Orleans
Tucson Water
US Water Alliance
Veolia
Water Environment Federation
Xylem Inc.

To learn more, visit www.thevalueofwater.org

The Economic Benefits of Investing in Water Infrastructure

Purpose of the Report

The Value of Water Campaign commissioned an economic impact analysis to understand how increasing investments in the nation's water infrastructure can affect economic growth and employment. The study reviews the projected capital needs of water, wastewater, and stormwater utilities, and estimates the associated economic benefits that would be realized if the nation chose to make these investments. These benefits include the economic opportunities created by water infrastructure projects, the long-term productivity savings to the customers of water utilities, as well as the avoided costs of frequent disruptions in water and wastewater service to business. Because many sectors are reliant on water, a disruption of water and wastewater service, even for one day, can cost businesses significant amounts of revenue and almost instantly shrink the annual national Gross Domestic Product (GDP).

The analysis builds on a previous report, "National Economic and Labor Impacts of the Water Utility Sector," published by the Water Research Foundation and the Water Environment Research Foundation, which evaluates the economic contributions of 30 of the nation's largest water and wastewater utilities serving 25 percent of the nation's population.

Introduction

Water is essential to all aspects of life. Water sustains families and communities. It supports economic productivity. From semiconductor manufacturing, to agriculture, to hotels and restaurants, virtually all sectors of the economy rely on water.

In this report, the term "water infrastructure" is used to encompass the structures and facilities that are operated by water, wastewater, and stormwater utilities, both public and investor-owned. These may include important infrastructure assets such as pipes, pumps, treatment plants, and more. In the US, approximately 52,000 water systems deliver drinking water to homes and businesses and approximately 16,000 centralized treatment plants collect and treat wastewater so it can be recycled or returned to the environment (EPA 2016b, Shifrin 2014). Many wastewater utilities also manage stormwater either through combined systems that handle both stormwater and wastewater, or separate stormwater systems. While publicly-owned utilities serve most homes and businesses, investor-owned utilities also play an important role, directly serving 50 million Americans and making up 15 percent of the US municipal water sector based on population served (Bluefield Research 2016).

Many of the nation's water and wastewater systems have been in operation for a century or more. As pipes, pumps, and plants reach the end of their expected lifespan, water infrastructure capital needs are growing rapidly, yet investment in water infrastructure is not keeping pace. Based on a 2016 assessment by the American Society of Civil Engineers (ASCE), this study estimates that the US needs to invest an additional $82 billion per year in water infrastructure at all levels of government over the next 10 years to meet projected capital needs.

If the estimated investment gap were closed, it would result in **over $220 billion** in total annual economic activity to the country. These investments would generate and sustain approximately **1.3 million jobs** over the 10-year period.

Furthermore, the value of safe provision, delivery, and treatment of water to customers results in significant avoided costs for businesses that would otherwise have to provide their own water supplies. These investments would save US businesses approximately **$94 billion a year** in sales in the next 10 years and as much as **$402 billion a year** from 2027 to 2040.

The US is funding just **one-third of its water infrastructure needs.**

Current national capital need: $123 billion per year

Water utilities serve 86 percent of the national population and provide approximately half of the freshwater used by commercial and industrial businesses (USGS 2014). On a daily basis, water utilities distribute 42 billion gallons of clean water (USGS 2014). Wastewater utilities serve 75 percent of the population while collecting and treating 32 billion gallons of wastewater daily (Shifrin 2014). Providing this scale of service requires significant ongoing capital investment to repair or replace the distribution lines, conveyance systems, treatment plants, and storage tanks that keep water, wastewater, and stormwater systems working.

Currently, capital needs of water, wastewater, and stormwater utilities are on the rise as infrastructure built decades ago nears the end of its useful life. Based on ASCE's estimates of water infrastructure needs (ASCE 2016), the US needs to invest a minimum of $123 billion per year in water infrastructure over the next 10 years (in current 2016 dollars) to achieve a good state of repair.

Projected capital needs are distributed throughout the nation with 23 percent of needs reported in the Midwest, 20 percent in the Northeast, 23 percent in the West and 34 percent in the South (see Figure 1). Note that capital needs presented in this report **represent the minimum investment required** to bring water, wastewater, and stormwater systems to a state of good repair. They do not account for costs associated with adding capacity in high-growth regions, responding to natural disasters, or developing new sources of water.

Investment needs grow as water infrastructure reaches the end of its lifespan

The reason for the surge in nationwide replacement needs can be explained by the timing, lifespan, and design of investments in water infrastructure over the last century. With a lifespan of 75 to 100 years, much of the nation's underground pipes are due for replacement. Based on analysis by the American Water Works Association (2011), approximately one-third of water mains nationwide will require replacement by 2040. As an indication of mounting needs, water mains currently experience an estimated 240,000 breaks per year (ASCE 2013). Wastewater systems face distinct, but equally pressing challenges. Many wastewater systems built in the first half of the twentieth century were designed to collect stormwater and wastewater as part of a single, combined system. During storm conditions, combined systems can overflow, causing untreated wastewater and stormwater to enter waterways. Every year, 900 billion gallons of untreated wastewater and stormwater are released to water bodies without being treated (Galavotti 2015). As a result of greater frequency and intensity of storm events in many communities, combined sewer systems have become even more susceptible to overflows.

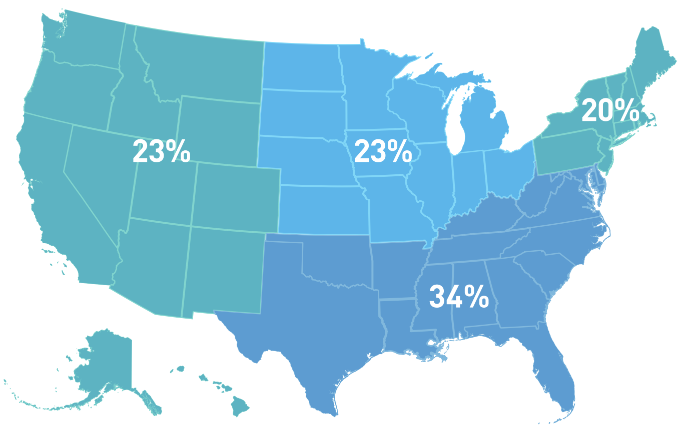
National investment gap: $82 billion per year

Aggregate capital spending on water infrastructure at the local, state, and federal level currently totals $41 billion per year—significantly below the minimum annual need. Without additional investment, only one-third of capital needs will be funded over the next ten years, representing an annual funding gap of $82 billion per year. If current needs are left unaddressed, the annual gap is projected to rise to $109 billion by 2026 and $153 billion by 2040, as needs from prior years accumulate (see Figure 2).

The US needs to invest a total of **$123 billion per year** in water infrastructure over the next 10 years (in current 2016 dollars) to achieve a good state of repair.

Figure 1

Regional Distribution of Capital Needs



Census Region	Share of Capital Needs
Midwest	23%
Northeast	20%
South	34%
West	23%
US Total	**100%**

Sources:

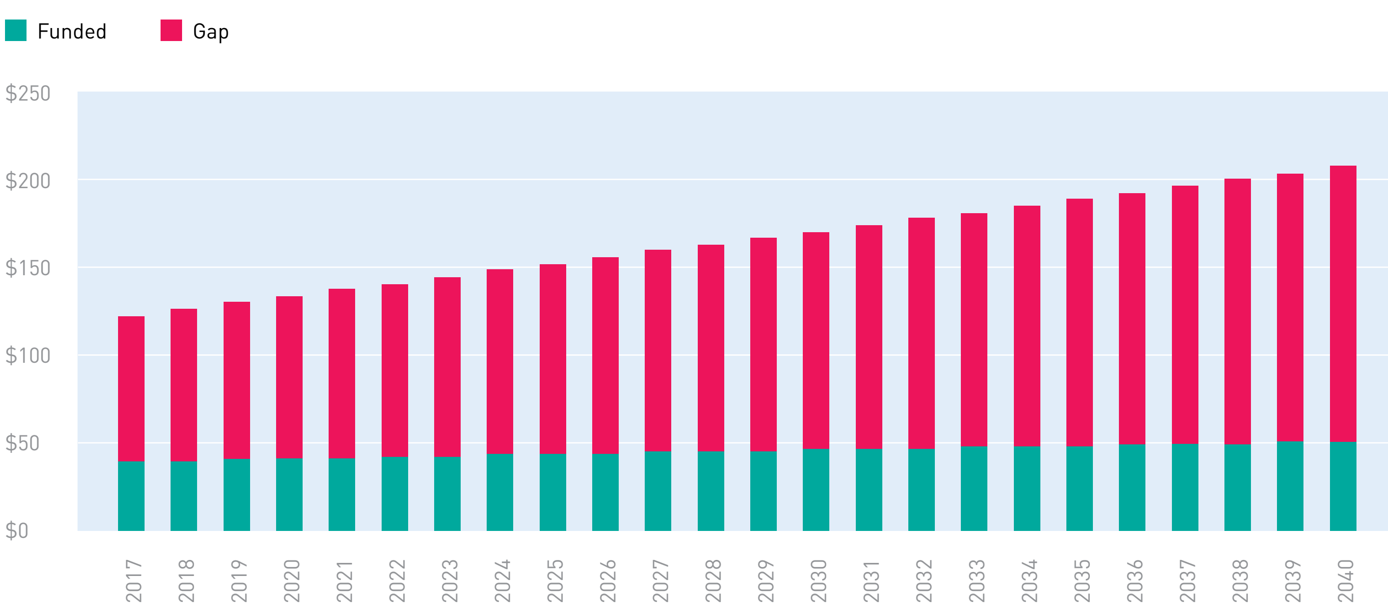
American Society of Civil Engineers. 2016. *Failure to Act: Closing the Infrastructure Investment Gap for America's Economic Future.*

Environmental Protection Agency. 2016. *Clean Watershed Needs Survey 2012. Report to Congress.*

Environmental Protection Agency. 2013. *Drinking Water Infrastructure Needs Survey and Assessment: Fifth Report to Congress.*

Figure 2

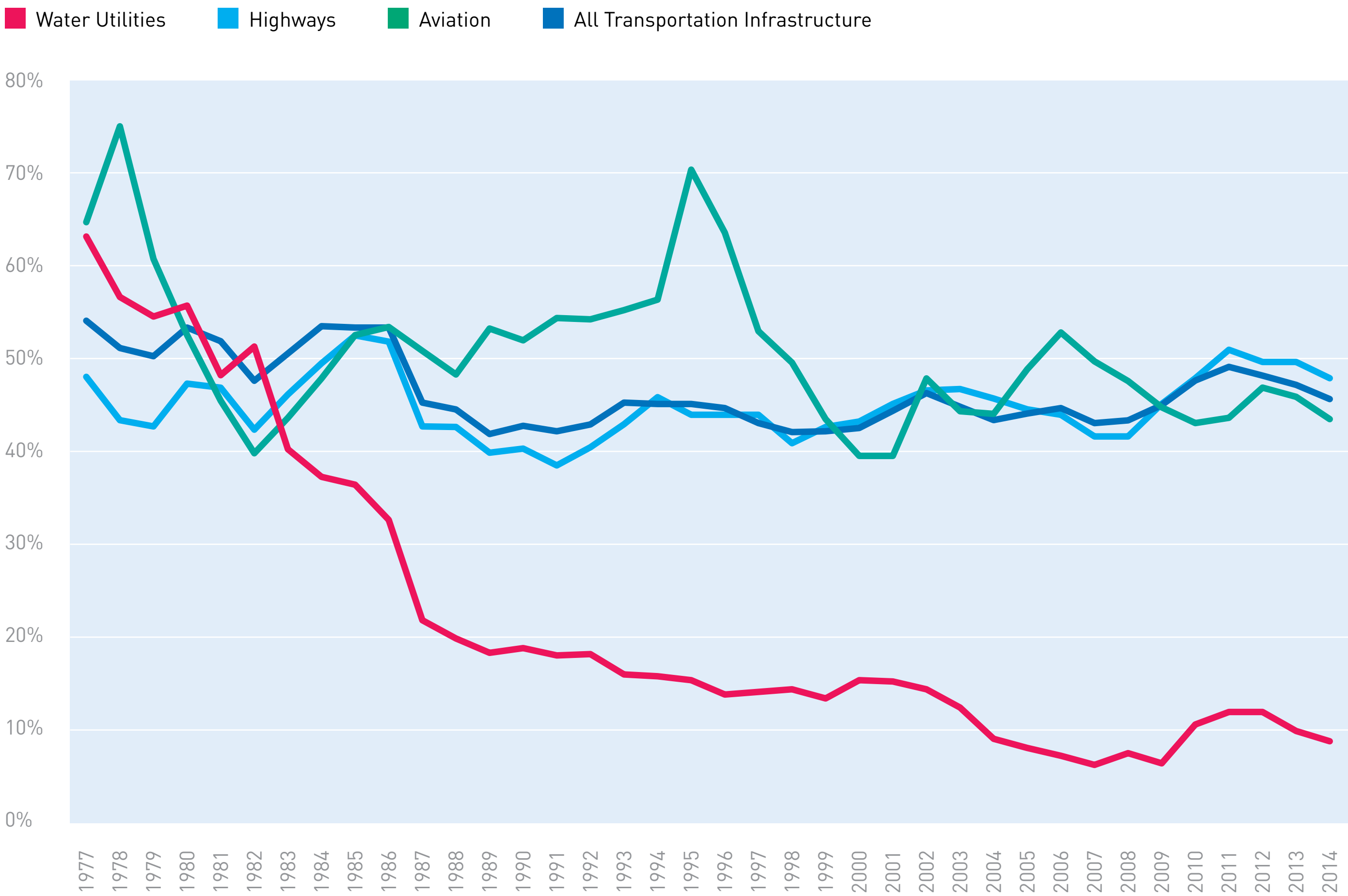
Projected Growth in Water and Wastewater Investment Gap If Current Investment Trends Continue (in $Billions)



Needs expressed in constant 2016 dollars. Source: ASCE 2016, BLS 2016.

Figure 3

Federal Contribution to Total Infrastructure Spending



Source: CBO 2015.

Figure 4

Annual Federal Investment Per Capita

Recipient	Per Capita Federal Investment
IT Infrastructure (Federal Departments)	**$251**
Research & Development—Defense	**$245**
Research & Development—Civilan	**$208**
Higher Education Grants	**$143**
Highways	**$136**
Other Transportation Infrastructure	**$55**
Energy Infrastructure	**$46**
Water Infrastructure	**$11**

Values expressed in 2014 dollars. Source: CBO 2015, CBO 2013, GAO 2016.

The decline in federal investment

Meeting the water infrastructure gap requires greater investment at the local, state, and federal levels. The federal government was instrumental in the development of water infrastructure over the previous century. As the country assesses its 21st century water infrastructure demands, there is a need for meaningful federal investment.

Despite rising capital needs, the federal government's contribution to water infrastructure capital spending has fallen over the past 30 years from 63 percent of total capital spending in 1977 to nine percent of total capital spending in 2014. In terms of per capita spending on water infrastructure, federal spending has fallen from $76 per person in 1977 to $11 per person in 2014 (2014 dollars; CBO 2015). In contrast, over the same time period, the federal government's share of total public spending on transportation infrastructure (including highways, mass transit, and aviation) has stayed constant at approximately half of total capital spending, with the remainder coming from state and local sources (see Figure 3) (CBO 2015).

Today, the federal government dedicates far fewer resources to water infrastructure than it spends on a broad range of priorities, from research and development, to highways, to grants for higher education (see Figure 4). For example, the federal government spends approximately 24 times more upgrading and maintaining the information technology (IT) infrastructure of federal agencies than it does repairing the nation's water systems.

As federal support for water infrastructure has declined, local and state spending has increased to help meet capital needs. Per capita spending by local communities has more than doubled in real terms from $45 in 1977 to upwards of $100 per person in 2014 (2014 dollars). Despite increased contributions from water ratepayers, this report shows that funding for water infrastructure continues to fall far below capital needs. The following sections of this report highlight the economic benefits that can be achieved if all levels of government, along with the private sector, work together to close the funding gap.

Water infrastructure failures across the country—including water main breaks, flooding from overwhelmed stormwater systems, and damaged dam spillways—demonstrate the urgent need to reinvest.

The aggregate economic activity supported by water investments exceeds the **GDP of twenty-six states.**

Employment opportunities in water infrastructure sectors are stable, well-paying positions providing average wages above the national average.

The US economy would stand to gain **over $220 billion in annual economic activity** by meeting its water infrastructure needs.

Aggregate economic impact: $220 billion in annual economic activity and 1.3 million jobs

By closing the annual investment gap in water infrastructure, the national economy would stand to gain over $220 billion in annual economic activity and approximately 1.3 million jobs per year. The aggregate economic impact is comprised of the direct impact on the water infrastructure sector, as well as indirect and induced impacts that are generated by successive rounds of spending on goods and services in other sectors. By meeting the gap, the US economy stands to gain a total of $2.22 trillion in additional economic activity over the next 10 years.

The number of jobs supported annually by funding the water infrastructure gap is greater than the employed workforce in sixteen states including Mississippi (1.22 million), Nebraska (980,000), and New Hampshire (730,000). The aggregate economic activity supported by these investments exceeds the GDP of 26 states including Oregon ($217.6 billion), South Carolina ($201.0 billion), and Alabama ($199.7 billion).

Direct economic and employment impacts

Investment in water infrastructure creates economic opportunities for businesses directly involved in the design, engineering, and construction of water infrastructure. These establishments would directly support $82 billion in annual economic activity and approximately 500,000 jobs (see Figure 5). Employment opportunities in water infrastructure sectors are stable, well-paying positions providing an average wage of $63,000 per year—approximately 20 percent above the national average. Employment gains would be concentrated in construction-related occupations, many of which can be accessed with a high school diploma (IMPLAN 2015; AECOM 2014).

Indirect and induced economic impacts

Investment in water infrastructure generates additional economic benefits through spending by directly impacted firms and their employees. For example, construction businesses play a major role in the repair and replacement of water infrastructure. These businesses purchase machinery and equipment from manufacturers, which in turn demand primary materials from other suppliers. Concurrently, employees of these businesses purchase personal goods and services in retail, medical, and other sectors. In this way, the initial investment in water infrastructure "ripples" throughout the economy due to spending by interrelated industries (the "indirect effect") and employees (the "induced effect"). The indirect and induced effects of closing the water infrastructure gap would add $140 billion to national economic activity, and generate and sustain an additional 760,000 jobs over the ten-year period (see Figure 5).

Economic multiplier of meeting the investment gap

The aggregate employment impact per $1 million investment in water infrastructure is comparable to public investments in energy, health care, and transportation, and is greater than the impact generated by military spending and personal income tax cuts, as estimated by economic impact studies of these sectors. For every $1 million invested in water infrastructure, it is estimated that **upwards of fifteen jobs are generated** throughout the economy. Six direct jobs are generated to support the design and construction of water infrastructure, and nine additional jobs are sustained by the indirect and induced spending triggered by the original investment (see Figure 6 and Figure 7).

Figure 5

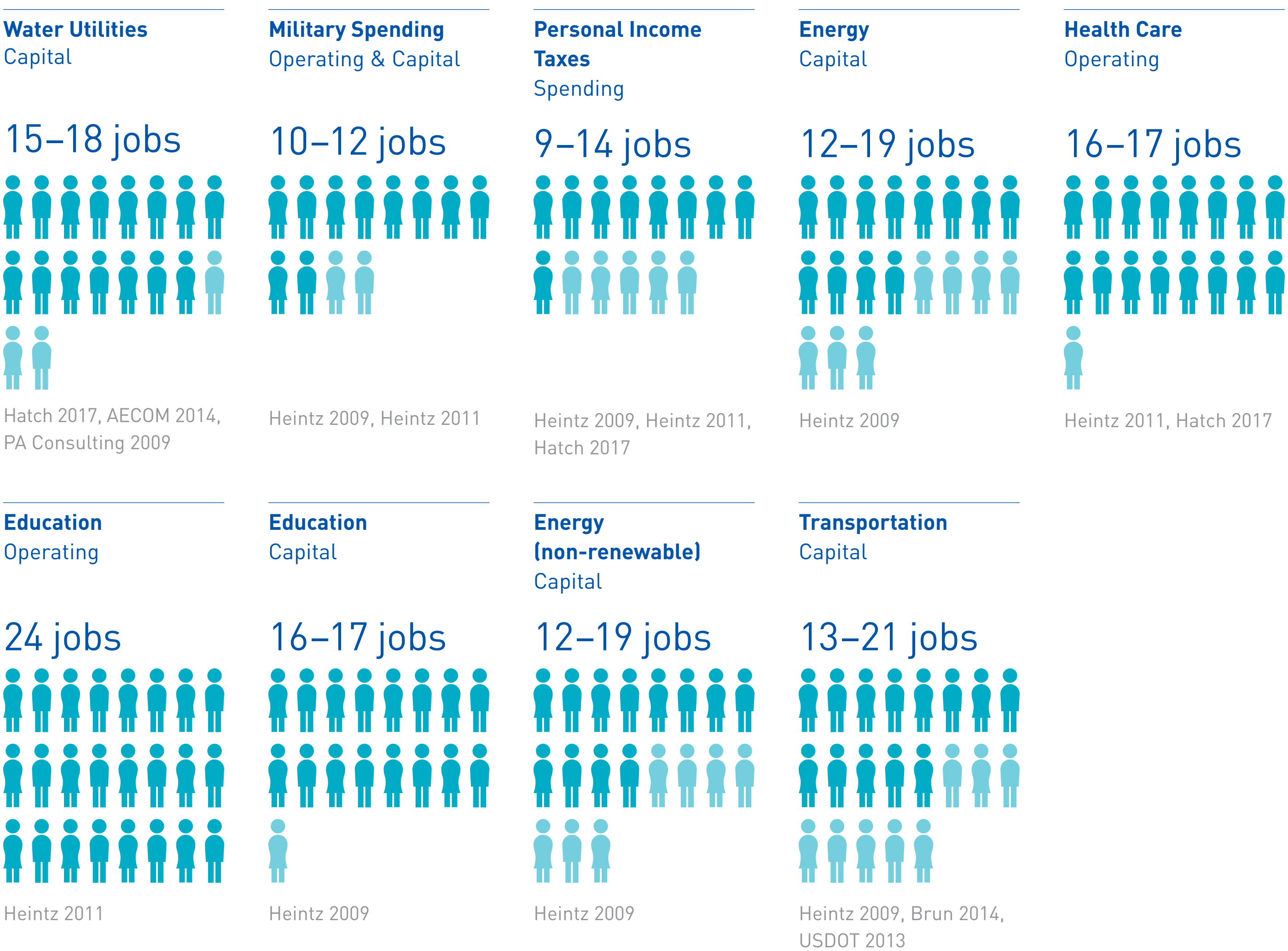
Economic Impact of Funding the Water Infrastructure Gap

	Aggregate Impact	Direct Impact	Indirect & Induced Impact
Annual Impact			
Employment	1.26 million jobs/year	500,000 jobs/year	760,000 jobs/year
Labor Income	$75 billion/year	$32 billion/year	$43 billion/year
Output	$222 billion/year	$82 billion/year	$140 billion/year
Cumulative Impact (10 Years)			
Labor Income	$750 billion	$320 billion	$430 billion
Output	$2,220 billion	$820 billion	$1,400 billion

Impacts expressed in constant 2016 dollars. Source: IMPLAN 2015.

Figure 6

Jobs per $1 Million by Sector and Expenditure Type



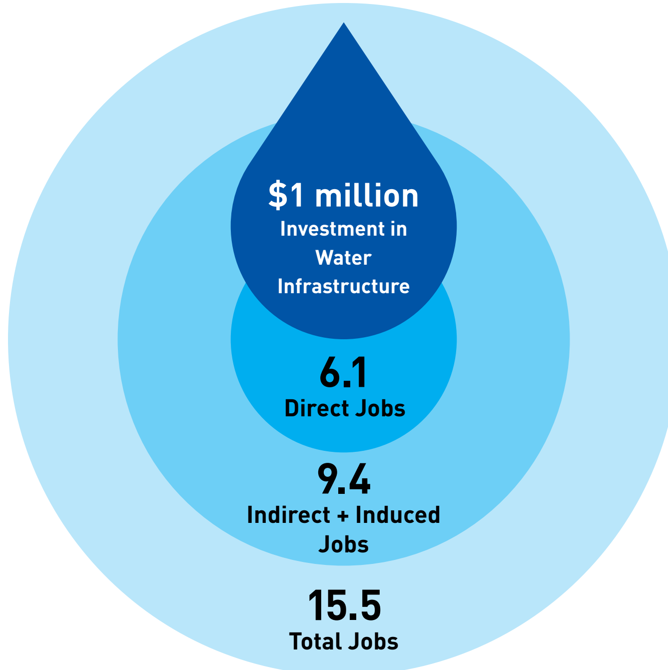
Values expressed in constant 2016 dollars.

Figure 7

Ripple Effect of Water Investment

	Jobs per $1 million
Direct Jobs	6.1
Indirect + Induced Jobs	9.4
Total Jobs	15.5

Impacts expressed in constant 2016 dollars. Source: IMPLAN 2015.



The number of jobs supported annually by funding the water infrastructure gap is greater than the **employed workforce in sixteen states.**

Reverse osmosis membranes at the Carlsbad Desalination Plant, which supported thousands of local jobs and infused $350 million into the local economy during the three-year construction.

Atlanta Department of Watershed Protection estimates creating 5,775 jobs over the course of the $350 million water supply capital program.

A Day Without Water:

Service disruptions put **$43.5 billion** in daily economic activity at risk.

The costs of service disruption

Investment in water infrastructure is necessary to prevent disruptions in water service. Many places across the country—from large metropolitan centers to small town communities—have already begun to experience the consequences of major service disruptions due to aging infrastructure.

Because water is an essential input to industry, even temporary disruptions in service can have major impacts on business sales. Without water, production in many industries virtually grinds to a halt. Empirical investigations have measured the effects of temporary service disruptions on business sales in impacted communities (FEMA 2011, Aubuchon 2012). For every day of water service disruption, the average US business loses $230 in sales *per employee*. In industries most reliant on water, sales drop by up to 75 percent, or up to $5,800 per employee. At a national level, a one-day disruption in water service represents an aggregate daily loss of $43.5 billion in sales and $22.5 billion in GDP. **To put this level of economic activity in context, an eight-day national disruption in water service would amount to a 1 percent loss in annual GDP—putting roughly 1.9 million jobs at risk** (see Figure 8).

Industries that depend most on water infrastructure

Businesses receive reliable, clean, and relatively affordable water and wastewater services. This enables businesses to produce goods and services with water as an essential input. This study identifies commercial and industrial business categories that depend most on water and wastewater utilities, by comparing water use and business sales. These findings show that water-dependent businesses represent a broad range of sectors from universities, to hotels and restaurants, to pharmaceutical manufacturers (see Figure 9).

Put simply, water-dependent businesses are those that rely most on the services of water utilities to grow their business. For example, water utilities deliver an estimated 182 million gallons per day to hotels across the country for laundry, food service, and guest use. For every $1,000 in sales to the hotel industry, water utilities must deliver 4,700 gallons of water. For pharmaceutical manufacturers, water acts a critical raw input and solvent in the production process. For every manufacturing job added by the pharmaceutical industry, water utilities must deliver approximately 473,000 gallons of water. Given that water-dependent businesses such as these exchange goods and services with the larger economy, all sectors ultimately benefit from investments in water system efficiency and reliability.

Without reliable infrastructure to deliver water or remove wastewater, production in many industries would essentially grind to a halt.

At a national level, a one-day disruption in water service represents an aggregate daily loss of **$43.5 billion in sales and $22.5 billion in GDP**.

Figure 8

Economic Benefits of Water and Wastewater Service Reliability

	Savings Per Day of Avoided Service Disruption	
Impacts to Business	**Aggregate National ($BN)**	**Per Employee**
Sales Saved	$43.5 billion per day	$230 per day
GDP Saved	$22.5 billion per day	$120 per day
Days to 1% GDP Savings	8 days; 1.9 million jobs protected	

Values expressed in 2016 dollars. Source: IMPLAN 2015, FEMA 2011, Aubuchon 2012, Chang 2002.

Figure 9

Industries Most Dependent on Water Utilities

Industry	Gallons /$1000 sales	Gallons /Job
Junior colleges, colleges, universities, and professional schools	4,700	563,600
Other basic organic chemical manufacturing	1,100	2,116,500
Dry-cleaning and laundry services	700	48,300
Car washes	600	33,700
Wineries	400	141,600
Hotels and motels, including casino hotels	400	48,300
Paper mills	300	284,200
Breweries	300	328,000
All other food manufacturing	300	111,300
Plastics material and resin manufacturing	300	505,300
Full-service restaurants	300	14,100
Other aircraft parts and auxiliary equipment manufacturing	300	90,200
Metal coating and nonprecious engraving	300	71,100
Other concrete product manufacturing	300	59,900
Pharmaceutical preparation manufacturing	300	473,200

Source: IMPLAN 2015, USGS 2014.

Keeping water infrastructure in a good state of repair supports **$94 billion in annual productivity savings**.

The value of water service to business productivity

While water infrastructure provides broad economic benefits realized simply through the opportunities created by major capital investments, this does not account for the significant benefits to the customers of water systems and utilities—specifically, business productivity.

A centralized water delivery and treatment service allows businesses to connect to the system rather than building the infrastructure themselves. Without economies of scale, each business and household would have to independently source, clean, and treat their individual water use. These drinking water and wastewater services can be easily scaled as local household and business demand changes, rather than each individual attempting to scale their water and wastewater needs independently. The efficiency realized from a utility-scale drinking water and wastewater systems creates more productive local economies.

Productivity saved by closing the water infrastructure gap: $94 billion per year

If the water infrastructure gap is not addressed, industries and households are projected to experience higher costs to procure water and wastewater services. Costs may take the form of higher water rates, costs of self-supply, or costs of relocating to better-served areas. Meeting the funding gap would have a positive impact on the overall economy by avoiding these costs, allowing businesses to control their production costs and households to retain their spending power. Due to these effects on productivity and consumer demand, funding the water infrastructure gap would preserve $94 billion per year in business sales and 505,000 jobs over the next ten years (see Figure 10). The estimated productivity savings to businesses, and their associated economic impact, are based on the analysis prepared by ASCE in "Failure to Act: Closing the Infrastructure Investment Gap" (2016).

Additional economic benefits not quantified in this study

This study focuses on water infrastructure's contributions to the economy through construction spending and the provision of reliable water service to businesses. There are many other ways that water infrastructure benefits our society that have not been quantified in this analysis. By preventing contamination of natural water bodies, water infrastructure provides a valuable service to recreational industries that depend on our nation's waterways. The recreational boating and fishing industry alone is responsible for upwards of $70 billion in spending per year and employs over 150,000 people (EPA 2012). Water infrastructure has played an instrumental role in reducing the incidence of water-borne illness in the US. It has been estimated that the cost of a single disease outbreak associated with inadequately treated water exceeds $100 million in medical costs (Corso 2003).

If the water infrastructure gap is not addressed, costs to industries would total approximately **$28 billion per year**.

Figure 10

Annual Productivity Savings by Closing Water Infrastructure Gap

Business Sales Saved

	Annual Impacts*
2017–2026	**$94 billion/year**
2027–2040	**$402 billion/year**

Source: ASCE 2016. ASCE figures adjusted for inflation and to reflect 2017–2040 time period.

Jobs Saved

	Annual Impacts*
2017–2026	**505,000 jobs** (2026)
2027–2040	**956,000 jobs** (2040)

*Business sales reflect annual averages. Jobs reflect jobs preserved by 2026 and 2040 respectively.

Renewed investment in water infrastructure at the local, state, and federal level will foster a stronger economy, create jobs, and ensure economic competitiveness.

Renewed investment in water infrastructure from the local, state, and federal level fosters a stronger economy, creates jobs, and ensures American competitiveness—now, and for the future.

Conclusion

Water infrastructure is fundamental to our nation's economic health. By keeping water infrastructure in a state of good repair, we strengthen our economy. As this study shows, investments in water infrastructure generate high-quality jobs, increase the competitiveness of American businesses, and lead to a significant injection of economic activity throughout the nation. Over the long term, all sectors stand to benefit from improvements to the reliability and efficiency of water systems. By meeting the gap, the US economy stands to gain a total of $2,220 billion in additional economic activity over the next 10 years.

Investments in water systems during the prior century helped to drive economic growth, improve public health, and protect the nation's waterways. As infrastructure ages and capital needs escalate, we must uphold our commitment to the nation's water infrastructure. Meeting the investment need requires collaboration across public and private sectors, including strong partners at the local, state, and federal level. The funding gap is significant, but the benefits of filling the gap are far greater.

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This report, along with the technical appendix, can be found at TheValueofWater.org/resources

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