



BEYOND 2050

The Economic Imperative of Water Infrastructure Investment

A practical guide for leaders to fund, modernize and secure water systems for the long term



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The observations throughout refer broadly to national water industry trends. Similarly, the cited data and figures presented in this document represent national data as reported, and are not specific to Veolia owned or operated utility systems.



Why Water Is the Essential Engine for Every Community's Prosperity

Water is far more than a *utility*.

It is the essential operating system of every community on the planet — the foundation for public health, economic growth and resilience. And yet water infrastructure continues to be undervalued, underfunded and increasingly at risk.

The hard truth facing too many communities today is that their water systems were engineered for a different century. They're being managed with a "good enough" mindset that is cracking under increasingly hard-to-ignore pressures: aging assets, climate volatility, escalating cyber threats, a shrinking talent pool and limited capital for critical upgrades.



The result is a widening gap between what communities expect and what municipal water systems can deliver. Addressing this disconnect is not optional — and the longer we wait, the more expensive it gets. In infrastructure time, 25 years is a blink of an eye. The choices leaders make today are already defining what water systems will look like in 2050 and beyond.

Thankfully, there are solutions. Technology-enabled operations and next-generation treatment options are delivering measurable gains in performance and efficiency. Innovative reuse methods are turning yesterday's wastewater into tomorrow's supply. New financing and partnership models are helping to spread costs and risks. But to achieve lasting impact at scale, these approaches require strategic vision and bold action from local leaders.

This report lays out that vision. It's a roadmap to a future-ready, resilient municipal water system that goes Beyond 2050 — with practical, actionable strategies every leader needs to consider.

Our report explores:

1

The Challenges facing communities today, and why delays only compound risks.

2

The Innovation Imperative and the emerging solutions already reshaping how water is managed, treated and valued.

3

The Business Case for investment in modern water systems that unlock growth and resilience.

4

The Path Forward, with concrete steps for governance, education, financing and partnerships.

5

Beyond 2050, a look at what a sustainable water future means for communities that act today.

Together, these themes outline a vision for water stewardship that safeguards communities and fuels prosperity — economic, cultural and civic — for generations to come.

Let's take a closer look.



1 | THE CHALLENGES: Why Today's Water Systems Are Falling Behind



Across the United States, municipal water systems are under strain on multiple fronts. Long-deferred infrastructure investment, intensifying climate stress, expanding digital vulnerabilities and persistent workforce shortages have converged into a systemic threat.

And yet, as long as the water runs, the public remains conditioned to believe it will always be there — largely unaware of the increasingly fragile network of pipes, plants and people behind the faucet. Local leaders recognize the risks, but they are also navigating an expanding list of complex challenges, including:



Aging Infrastructure and Deferred Maintenance

Much of North America's water infrastructure was built for a different century, and in many places, those assets are reaching the end of their designed life. Break rates are rising, repairs are reactive and the “kick-the-can” cycle of patchwork fixes leaves communities increasingly vulnerable to disruption.

The hard data: The United States experiences around 240,000 water main breaks every year, and roughly one in five mains is already past its useful life — with replacement costs estimated at \$452 billion.¹

Climate and Environmental Pressures

Drought, flooding and extreme weather now strain both supply and treatment capacity. Many older cities still rely on combined sewer systems that can't manage heavier rainfall, while western and midwestern regions face increasing scarcity. These shifts are eroding reliability and compounding stress on already aging systems.

The hard data: Reservoir storage across the United States is steadily declining, with about 70% of large reservoirs showing measurable reductions in maximum water levels.² Meanwhile, global projections estimate that overall water demand could rise by at least 50% by 2050.³





Technology and Cybersecurity Vulnerabilities

Water is one of the most vulnerable sectors of essential infrastructure. Legacy technology and weak cybersecurity can leave operations exposed. Thousands of small, independent utilities operate on aging control systems with limited visibility across their networks, creating a fragmented landscape that's difficult to defend. Recent ransomware incidents have shown that even smaller systems can become entry points for bad actors.

The hard data: A 2024 review from the U.S. Environmental Protection Agency (EPA) reported that about 30% of large public drinking water systems had some level of cybersecurity risk exposure in 2024 — and 1 in 10 faced critical vulnerabilities.⁴

Talent Gaps

Behind every reliable water system are the dedicated people who operate it. But that trusted workforce is shrinking. Many industry veterans are nearing retirement even as utilities struggle to attract younger, tech-skilled professionals. Tight budgets and limited training pipelines compound the problem, leaving many systems understaffed as complex new demands emerge.

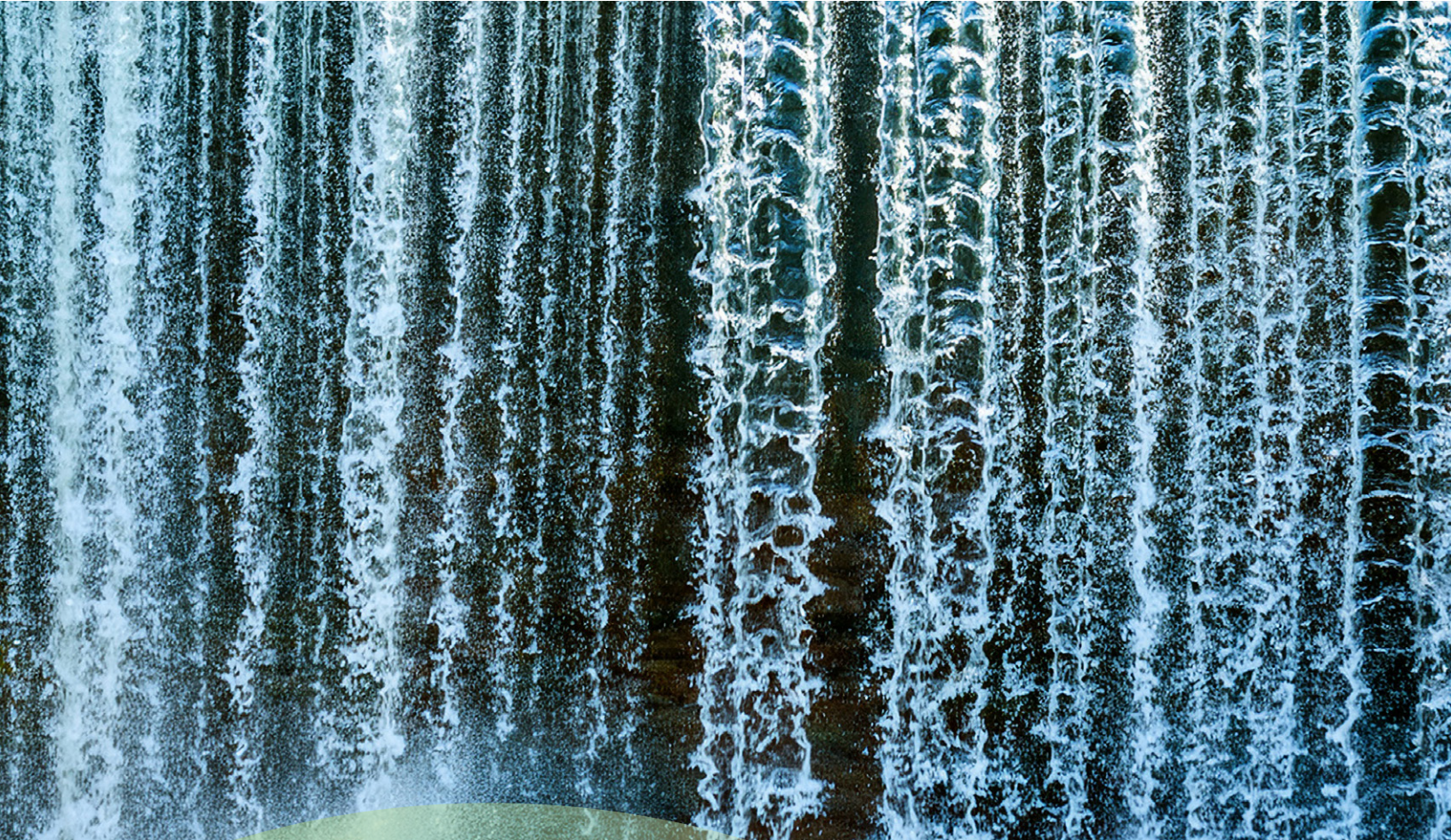
The hard data: Roughly one-third of the U.S. water workforce will be eligible to retire within the next decade, risking one of the largest public sector talent gaps in the country.⁵





2

THE INNOVATION IMPERATIVE: Modern Solutions for a Changing World



The challenges facing municipal water leaders are urgent, but they are not insurmountable. In systems across the country, innovation is already driving progress. Utilities and their partners are testing new approaches, deploying new technologies and building the workforce capabilities that define future-ready systems into 2050 and beyond.

These advances can help systems move from patchwork fixes to continuous improvement — using data, design and human ingenuity to deliver more dynamic and reliable water services for their communities. Three core areas are driving these new opportunities:



1 New Approaches

Innovation often starts with rethinking scale. Many utilities are embracing modular and decentralized designs that can be deployed faster and at lower cost than traditional capital projects. Advanced treatment units expand capacity without massive construction, while reuse systems turn wastewater into new supply. These flexible models show that modernization doesn't always require mega projects — just smarter, scalable design.

Examples in action:

- Utilities are increasingly deploying containerized or skid-mounted treatment units, such as mobile filtration or contaminant-removal systems, for targeted capacity needs.
- Modular storm- and groundwater-capture systems can catch peak flows, reduce local flooding and store water underground for later use, avoiding costly upsizing of pipes and tunnels.



2 New Technologies

AI and automation are transforming how utilities operate. Digital monitoring, task automation and AI-powered analytics give operators unprecedented visibility across networks — helping them anticipate failures, manage use and better enable their teams to improve performance with precision.

Advanced data analysis provides another huge opportunity. For decades, utilities have been awash in data but lacked the tools to use it effectively. Modern platforms now turn that data into action by helping companies streamline data collection, resolve legacy issues, and focus on analysis and insights. This means less time chasing data and more time for teams to prioritize maintenance, fine-tune treatment and make better decisions, faster.

Technologies referenced in this paper are examples of available industry solutions; implementation varies by system, jurisdiction, regulatory approval and cost-benefit analysis.



Examples in action:

- **AI-enhanced operations:** Veolia's Hubgrade platform includes AI tools like Talk to My Plant, which lets operators query facilities in plain language and gather updates that accelerate how teams respond and optimize performance.
- **Smart sewers:** In South Bend, Indiana, a \$7 million project to deploy advanced sensors and analytics over the last decade has cut overflow volumes by more than a billion gallons annually, improving water quality and reducing projected capital costs by almost \$500 million under the city's revised long-term control plan. It's an approach now being replicated in cities across the country.⁶



3 New Skills and Advocacy

Technology only matters when people use it. Building the water systems of 2050 and beyond requires a workforce fluent in both system operations and digital skills. Utilities are training operators to pair process expertise with AI tools, cybersecurity prowess and data analysis. These systems don't replace people, they *elevate* them.

Customer education is part of the equation too. Public outreach and transparent communication help residents understand how innovation investments can safeguard reliability and health — building the trust needed to sustain long-term investment.

Examples in action:

- **Workforce development:** Leading systems are equipping the next generation of operators with treatment expertise and AI and digital literacy through targeted training programs. Veolia, for example, operationalizes this commitment via a network of six dedicated academies to upskill the workforce in both essential trade craft and new digital capabilities.
- **Community education:** Through partnerships with municipalities, Veolia helps cities design public awareness campaigns that link infrastructure investment to community well-being.



THE VEOLIA DIFFERENCE



Leading the Way on AI and Cybersecurity

AI and cybersecurity now define the digital backbone of modern water systems. Every step forward in automation brings greater efficiency — and requires stronger protection.

At Veolia, we treat AI and cybersecurity as core infrastructure. We integrate plant controls with data systems, keep sensitive functions on separate network segments and run continuous monitoring across the whole spectrum.

Drawing on global resources and a dedicated cybersecurity command center, the company operates one of the most advanced monitoring frameworks in the sector — combining local oversight with global expertise.

At the same time, Veolia is pioneering practical AI tools that enhance human judgment, rather than replacing it.

Our AI-enabled Hubgrade platform and related tools convert decades of operational data into actionable insights, helping operators make faster, better-informed decisions while maintaining full control of the required actions.

This dual commitment — responsible AI and embedded cybersecurity — illustrates how innovation and protection can advance together, ensuring digital transformation becomes a secure, scalable foundation for long-term resilience.



3 | MAKING THE BUSINESS CASE: Why Water Investments Pay Dividends for Every Community



At first glance, the business case for water seems fundamentally simple: Without reliable water, commerce stalls, quality of life erodes and public health suffers.

And yet, as every municipal leader knows, advancing the required investments is *anything* but simple. Because water has long been perceived as relatively inexpensive and readily available, its value is often taken for granted — until a failure makes it visible.

But, as decades of research have shown, strategic investment in water systems can deliver economic, operational and social returns that far exceed the costs. Essential infrastructure must be viewed



by the community and its leaders as a platform for prosperity, not an “expense” to contain. The challenge for leaders is to show residents and employers what those returns look like, why timing matters and how costs can be shared equitably. And the business case they make today will deliver results during their tenure and lay the groundwork for reliable, sustainable water operations in their communities Beyond 2050.

In practice, that business case rests on four critical drivers: return on investment (ROI), competitive advantage, the cost of inaction and paying fairly while protecting those at risk. Here’s a closer look at each one.

DRIVER #1 Economic ROI

As numerous studies have shown, investment in water systems has direct ROI for local communities. For example, a major 2024 U.S. industry analysis reports that every dollar invested in water infrastructure generates roughly \$2.50 in economic output.⁷ When accounting for resilience, the return is even higher: Every dollar spent on mitigation saves \$6 in avoided future costs, per a report from the National Institute of Building Sciences.⁸

Jobs are a big part of the ROI. Independent modeling has shown that keeping federal water investment at current levels preserves more than 200,000 jobs.⁹ And a separate national analysis found that fully closing the water investment gap could add roughly \$4.5 trillion to gross domestic product (GDP) over 20 years, deliver more than \$2,000 in savings per household each year and support about 800,000 jobs.¹⁰ These are paychecks that flow to local workers, contractors and suppliers across regional economies.

Federal funding for water infrastructure has increased in recent years due to the 2021 Infrastructure Investment and Jobs Act (IIJA). But future appropriations are uncertain — levels can change with

2.5x
ROI for communities
from investment in
water infrastructure



Economic impact estimates referenced here derive from external industry studies and are not financial projections or guarantees related to any Veolia owned or operated regulated utility subsidiary.



each Congress — so it's prudent to plan for multiple scenarios. One analysis of IJIA's impacts shows that maintaining IJIA-level funding would cut water-related business disruptions nearly in half and deliver almost \$7,000 in household savings over 20 years. It would also avoid shifting roughly \$125 billion in additional capital needs to local rate-payers — a cost communities would otherwise have to absorb.⁹

The reality *is* simple: Strategic water investment delivers economic, operational and social returns for communities that far exceed the costs. But because federal support fluctuates, local leaders must be ready to articulate the value of these projects on their own merits.

Making the case

- Tie projects to the local GDP, jobs and household earnings in your impact memos and public communications.
- Convert avoided emergencies into dollars. For example, compare planned replacements vs. break-and-repair costs, including service disruptions and impacts on local industry.
- Show energy savings from modern pumps, controls and treatment and how lower electric bills strengthen ROI.
- Detail how upgrades can improve bond ratings and borrowing costs so the municipality pays less interest over time.

800,000

jobs from new
investments in
U.S. water systems

DRIVER #2

Water Reliability as a Competitive Advantage

Businesses expand and thrive where water is reliable — full stop. From manufacturing to data centers to food and beverage producers, dependable water supply, treatment capacity and compliant discharge are non-negotiable. A single semiconductor plant can require 10 million gallons of ultrapure water per day,¹¹ and one recent report noted that U.S. data centers churn through 450 million gallons daily.¹² This level of demand makes these companies highly reliant on local water operators and systems that can reliably deliver that volume while maximizing recycling and reuse.

But while chipmakers and data centers grab the water usage headlines, *every* employer has water needs, from hospitals and breweries to warehouses and small manufacturers. Many business site-selection consultants now view water and wastewater readiness as essential, focusing on systems with permitted capacity, proven water quality, redundancy and clear time-to-serve.¹³ Communities that can document capacity, quality and backup plans rise to the top; the rest are screened out early.



Making the case

- Put your compliance record and 24/7 monitoring on one page so employers see you meet industrial water quality specs.
- Quantify recent wins tied to water readiness — jobs, payroll and tax base — and include letters from anchor employers or the local chamber of commerce.
- Be ready to serve: Publish available capacity and redundancy, give a clear time-to-serve, and pre-permit priority water and wastewater projects so construction can start fast.
- Line up delivery partners early. Public-private arrangements can add expertise and speed while protecting affordability.

DRIVER #3 The Cost of Doing Nothing

Deferred maintenance compounds risks and costs. Small leaks become main breaks, emergency work orders multiply and public trust evaporates. Cities like Newark, N.J., and Jackson, Miss., show how prolonged underinvestment can drain budgets and confidence. But those headline cases are just the most visible outcomes. An “it can’t happen here” mindset underestimates how quickly deferred investment can escalate into financial, operational and reputational strain.

To be sure, the gap in funding is stark: The federal share of capital spending for water fell from 63% in 1977 to roughly 9% by 2017 — shifting the burden to states and local ratepayers.¹⁴ But the cost of waiting keeps rising: A 2020 report by the American Society of Civil Engineers noted that annual costs from deteriorating infrastructure, service disruptions and other deferred maintenance would be seven times higher by 2039 — from \$2 billion in 2019 to \$14 billion by 2039 if investment lags.¹⁵ “Wait and see” today means paying more later — financially, socially and politically.

7x

increase in
water service costs
by 2039 without
new funding

Making the case

- Convert outages and boil-water notices into fully loaded costs, such as emergency labor, damage claims, water loss, business interruption and reputational impact.
- Show lifecycle cost comparisons: planned replacement now vs. repeated patch-and-repair over the asset’s remaining life.
- Document regulatory risk and potential penalties tied to missed compliance windows.



DRIVER #4 Paying Fairly, Paying Forward

Rate sensitivity is real — but, here again, so is the cost of inaction. Communities that delay upgrades often see steeper rate shocks later. A 2024 EPA assessment estimates that as many as 19 million U.S. households face water affordability challenges — evidence that investment strategies must be paired with thoughtful implementation.¹⁶ One widely recognized approach is to design funding and delivery models that can help balance cost, timing and customer impact through steps like phased modernization and targeted assistance. In practice, this can include lifeline blocks for essential use, targeted customer assistance for hardship and arrears, and pacing capital work so bills rise predictably, not suddenly.

Making the case

- Model rate paths so people see the difference between step increases and phased adjustments over time.
- Sequence projects into multiyear phases to smooth bill impacts and match benefits to costs.
- Show value and fairness with a plain-English bill-to-benefit map that explains what a rate increase funds, what failures it prevents and simple equity metrics that quantify outcomes.

1 in 7

U.S. households
struggles to afford
water





4 | THE PATH FORWARD: Six Steps Every Community Can Take to Build Water Resilience



The business case is clear. The goal is progress you can measure in 3-, 10- and 25-year increments. Beyond 2050 is a milestone, not a cliff.

Now comes execution. Communities that move fastest do several things at once: modernize operations with digital tools and AI, align partners around measurable outcomes, and finance upgrades in ways that promote growth and protect affordability. The steps below provide a practical guide that any city can apply, scaled to local needs and budgets.



STEP 1: Lead with Technology and Data

Enhanced digital operations turn the system you have into the system you need. Start with real-time monitoring, cybersecurity basics, automated controls and AI decision support so operators can anticipate failures, cut energy use and improve quality. Build on that with reuse optimization and fit-for-purpose treatment. Technology is the multiplier — every dollar invested here makes capital work harder and smarter.



STEP 2: Forge Strong Public-Private Partnerships

Today's partnerships are transparent, performance-based agreements that align municipal oversight with private-sector expertise and capital. They transfer defined risks, guarantee service levels and accelerate modernization without overburdening ratepayers. Done right, they deliver what every community needs: predictable costs, measurable performance and confidence that services will keep pace with growth.

Bonus: Partnerships can also help municipalities quickly access leading-edge technology, AI and cyber expertise at scale.



STEP 3: Engage Industry as a Co-Investor

Co-investment brings large users to the table as customers who can help fund specific solutions — onsite reuse, pretreatment, shared infrastructure or demand-management programs — because reliability is in their direct interest. These arrangements protect business continuity and reduce load on public assets while expanding local capacity for everyone.



STEP 4: Innovate Financing

Traditional rate revenue cannot close the funding gap alone. Green and climate-resilience bonds, state revolving fund loans and blended finance models combine public and private capital to sustain projects over time. Transparent rate design and clear capital improvement plans signal to residents and investors that every dollar supports the public good. Innovation here is less about complexity than continuity — keeping momentum even when budgets tighten.

These conceptual strategies are intended to inform industry dialogue and do not constitute policy commitments or procedural decisions for any Veolia owned or operated regulated operations.



STEP 5: Strengthen Governance and Accountability

Money and technology deliver results only when governance sustains them. Regional authorities, performance-based contracts, independent audits and public dashboards help commitments survive election cycles. Clear roles and measurable targets build trust with ratepayers, regulators and investors — and ensure progress endures.



STEP 6: Educate and Engage the Public

Modernization succeeds when people understand its value. Rate resistance often stems from uncertainty, not opposition. Ongoing communications — briefings, online metrics, visible success stories — turn infrastructure into community pride. When residents see the link between investment, safety and economic strength, they become partners in sustaining it.





5

BEYOND 2050: A Water-Smart Future



By the 2050s, the best water systems will feel almost invisible — quiet, steady and trusted — even as they carry more load than ever. Taps run through heat waves and storms. Treatment plants adjust in real time. Bills are predictable, with protections that keep essential use affordable. What looks effortless on the surface is the product of choices made a generation earlier.

In the water-smart city of the near future, supply is diversified and resilient. Reuse closes the loop so every drop works twice — and sometimes three times — through fit-for-purpose treatment. Networks are mapped and monitored end-to-end; AI helps operators



see around corners, tune processes and cut energy use. Cyber-security is routine — networks segmented, alerts triaged, hygiene embedded in daily work — not an afterthought.

Capacity grows modularly as neighborhoods and employers grow, so expansions are measured in months, not years. The workforce looks different, too, led by operator-analysts who pair process expertise with data fluency, backed by apprenticeships and continuous training. And the public can see what they're paying for on a single page: quality, reliability, projects delivered, dollars saved.

This future isn't speculative. The tools exist today. The economics are sound and the path forward is clear. What separates communities that get there from those that don't is timing and follow-through. Start with one decision that compounds results — one modernization, one partnership, one financing move that keeps momentum when budgets tighten. Do that, repeat it and the benefits stack — fewer emergencies, stronger balance sheets, jobs that stay, neighborhoods that thrive.

Dynamic water services and sustainability Beyond 2050 aren't about distant promises — they're about setting a higher standard now and meeting it, day after day.

**The tools exist,
the economics are
sound and the path
forward is clear.**

**Follow-through is
the only variable.**

This future-state depiction is aspirational and illustrative in nature; outcomes are influenced by numerous regulatory, environmental and economic factors outside of Veolia's control.





About the Authors



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Karine Rougé serves as the Executive Vice President of Strategic Transformations for Veolia in North America and Chairwoman of the Regulated Business Unit. Previously she was Chief Executive Officer of Veolia North America's Municipal Water services.

Karine entered the water industry in 2010 when she joined Suez, first in Paris and shortly thereafter in the United States. For 11 years, Karine worked for Suez and led various strategic and people-led transformations in the digital, municipal and industrial water sectors. She joined Veolia in 2022 to lead the combined municipal water teams, which form today the leading private water player, serving almost 21 million people in the United States with water, wastewater and biosolids management services. Veolia operates both as a regulated water utility in six states and as a contract operator with almost 200 projects in 33 states across the country. Karine also chaired the National Association of Water Companies (NAWC) in 2024 and has been very active as a representative of the industry as a whole, especially on issues touching workforce, and environmental resilience and adaptation. In addition to her Board role at NAWC, she is also a Board member of Sigma, a Wind Point company.

Prior to joining Suez, Karine worked at Goldman Sachs in the investment banking division in London, Paris and Johannesburg. She also spent a year at Igneo Infrastructure as an operating partner prior to joining Veolia. Karine holds an M.S. in management from HEC Paris and an M.S. in economics from the Paris School of Economics.



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Rob is President and CEO of the National Association of Water Companies (NAWC), representing private water providers across the United States. He previously served as a commissioner at the Federal Energy Regulatory Commission and as chairman and commissioner of the Pennsylvania Public Utility Commission. Under Commissioner Powelson's leadership, Pennsylvania customers gained an active voice on issues such as nuclear power production, renewable investment, broadband deployment, infrastructure development, unaccounted-for water and cybersecurity.

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