MOTT MACDONALD

Purifying an essential resource

Innovative solutions for drinking water treatment

A partnership for clean water

Managing a community's water supply is a serious responsibility — whether that community is large or small. Few things are more important for the health and well-being of a society than a reliable supply of clean, safe drinking water.

When you choose Mott MacDonald, we share that responsibility with you every step of the way. Our water professionals are experienced with every type of water treatment infrastructure and every step of the water treatment process.

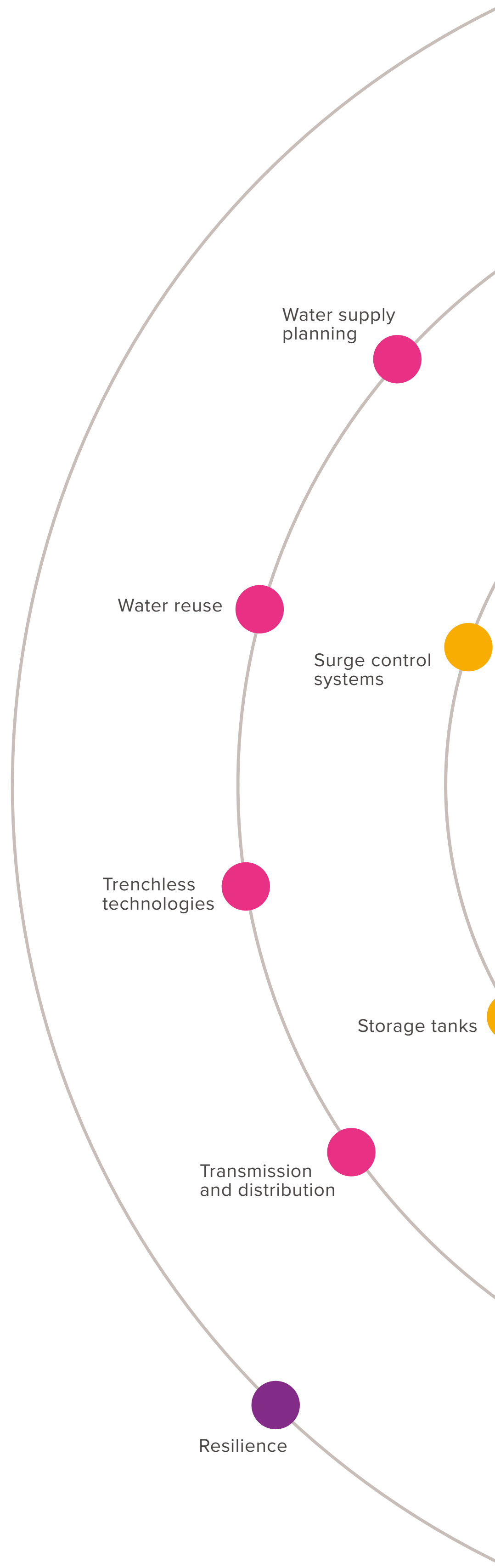
We understand the need to serve customers while reducing the life-cycle cost of water treatment. We know the importance of ensuring that the treatment system is delivered on time and on budget, and meets the unique local project objectives. And we appreciate that treatment facilities should be designed to provide operational flexibility and minimize maintenance requirements.

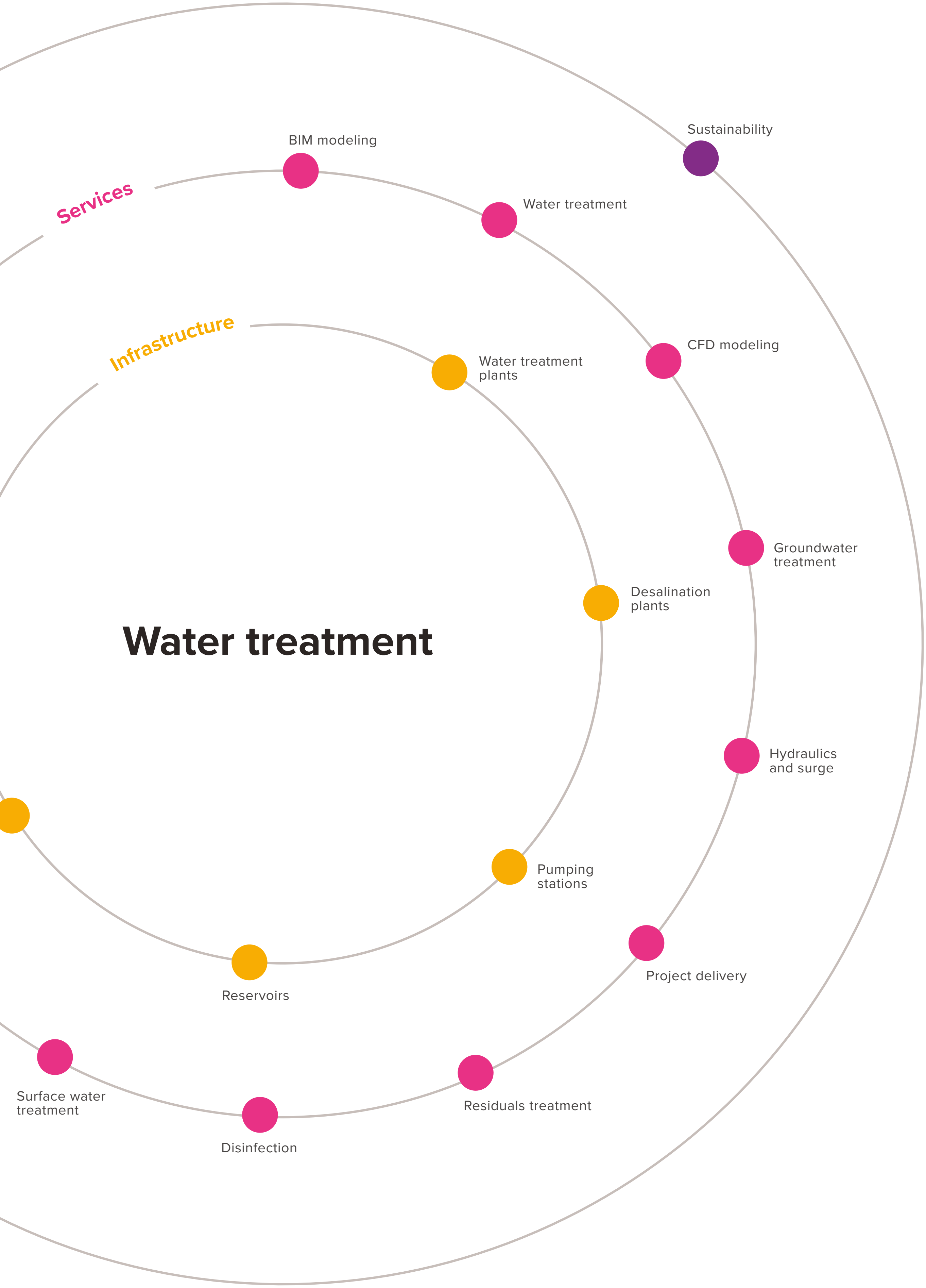
Cover: In Sterling, Colorado, USA, an award-winning reverse osmosis plant serves 14,000 residents.

Tested solutions

Our experience adds value to the design of new or upgraded facilities. It ensures you have sufficient flexibility to address growth in demand, degradation in source water quality, and potential changes to drinking water regulations while providing resilience to climate change and optimizing capital investment and operational costs.

With Mott MacDonald, you can expect tested solutions and proven innovation that ensure regulatory deadlines are achieved, investment is within budget, and environmental impact is minimized.





Water treatment
Services
Infrastructure
BIM modeling
Sustainability
Water treatment
CFD modeling
Water treatment plants
Groundwater treatment
Desalination plants
Hydraulics and surge
Pumping stations
Project delivery
Reservoirs
Surface water treatment
Residuals treatment
Disinfection

Improve your system's performance

Modeling is one of the most powerful tools for optimizing the performance of a water network. When used at various stages of the asset cycle, it offers water utilities the information they need to make key business decisions.

As a planning tool, modeling is the basis for master plans, strategic planning, and feasibility studies. We use modeling as a design tool to size pipeline networks and locate reservoirs and pump stations. As an operational tool, our treatment process models can identify constraints in treatment plant performance or operational productivity — even in real time.

Working closely with our clients, we develop detailed water network models to improve plant reliability, process mass balance performance, maintain distribution system quality, and manage water networks. Our experience spans the range from planning and design to addressing operational constraints, using a wide range of software tools including H2KnowHow, our proprietary analysis and management platform.

Reduce costs

Looking at the whole water system sometimes uncovers surprising opportunities to cut costs. Through modeling and analysis, we have significantly saved whole life capital and operational costs.

By designing energy-efficient, low-carbon projects, we've helped our clients qualify for grants and low-interest loans. Our emphasis on maintenance and rehabilitation has helped clients avoid the cost of responding to service interruptions on an emergency basis.

Maintain water distribution system water quality

New water treatment processes are often selected to address issues such as specific contaminants, space limitations, or cost. However, water quality will continue to change throughout the distribution system as it reacts with piping materials and contaminants in the bulk water. For example, converting to chloramination to reduce disinfection byproducts can increase the biological activity of the water, impacting corrosion and the stability of the chlorine residual.

We provide a comprehensive evaluation of water quality from source to tap: critical to minimizing issues with distribution system water quality.

Use data and testing to stay informed

When evaluating potential treatment options, water quality data provides the foundation for the analysis. Insufficient data and the inability to see a complete picture can result in a treatment system that cannot respond to changes in water quality. At the outset of every project, we evaluate existing data and prepare a "gap analysis" to identify the data that is needed to properly evaluate the treatment systems.

Testing, which can range from initial bench testing to pilot or demonstration testing, is another important component of evaluation. We test and evaluate the unique conditions of a particular water source or distribution system.

10 ways our expertise can help you

1

Work with a team that's committed to your project

Our project managers and technical experts approach the challenges of water treatment as a dedicated partner with our clients. We can meet the full range of project needs, from initial planning, investigations, and studies, through design and construction, to facility commissioning, training, and continuing advisory services.

2

Benefit from surface water and groundwater expertise

Our surface water experience includes conventional and high-rate treatment processes. Our groundwater experience includes removal of iron, manganese, volatile organic compounds, arsenic, and radionuclides along with emerging contaminants such as perfluorinated compounds and pesticides.

3

Invest in a proven solution

We provide comprehensive evaluations for a range of solutions, so you can make the best choice for your budget, schedule, and specific challenge. Before investing in a new or upgraded treatment process, bench or pilot testing is often used to verify the technology and optimize the treatment process.

4

See what you're getting

Our advanced visualization tools help you see where your water treatment project is going before you get there. These tools are employed at the early stages of a project, and provide greater definition at the planning stage. Higher project definition enhances collaboration by all team members, including operations, maintenance, engineering, and management.

5

Meet your deadlines

Our disciplined and collaborative approach ensures that we meet project and regulatory requirements on time, and help you cope effectively with unexpected issues.

6

Stay on budget

Transparency is the key to avoiding unexpected cost overruns. With our cost estimating and project management expertise, we communicate at every step with your management, engineering, and operations staff to help you understand the impacts of design decisions and to control costs.

7

Ensure water quality all the way to the tap

Water quality doesn't stop with the water treatment plant. Our holistic approach helps ensure the quality of drinking water from the reservoir through the treatment process and into the distribution system to the customer tap.

8

Minimize environmental impact

Mott MacDonald is a leader in sustainability. Your water treatment solution will include energy efficiency, appropriate use of treatment chemicals, management of carbon, and the responsible treatment and disposal of residuals.

9

Anticipate regulations — don't just respond

We're not just familiar with current laws and regulations. We track advancements in water treatment research and which contaminants may become regulated in the future. This leads to a deeper understanding of how solutions implemented to meet today's regulations can be adapted to address future needs.

10

Design for the future

A facility may have enough capacity today — but what about tomorrow? Our flexible design approach helps you accommodate the addition of more process units to enhance treatment and provide additional capacity when necessary.

A sterling solution in Colorado

Project
Reverse osmosis water treatment plant

Client
City of Sterling

Location
Sterling, Colorado, USA

Expertise
Planning, pilot testing, design, permitting assistance, services during bidding, services during construction

Engineering Excellence Award
American Council of Engineering Companies of Colorado

The award-winning reverse osmosis treatment plant uses deep injection wells to safely dispose of uranium-contaminated brine.

Opportunity

The City of Sterling faced multiple EPA violations of the national primary drinking water standards, including uranium and trihalomethanes, a byproduct of chlorine disinfection. Sterling's raw water source also contained high levels of sulfates, total dissolved solids, and hardness.

The City wanted to install a new reverse osmosis water treatment plant, but brine from the treatment process would contain uranium, creating disposal challenges.

Solution

Based on an extensive cost-benefit analysis, we determined that the most viable solution was a 9.6 million gallon per day (MGD) (36.3 million liters per day or MLD) reverse osmosis treatment plant, coupled with deep injection wells — typically used in the oil and gas industry — to dispose of uranium-contaminated brine.

Due to stringent environmental regulation and wide stakeholder engagement, the permitting process for the Class 1 deep injection wells took more than a year.

Outcome

Our out-of-the-box thinking enabled the City to meet its water quality goals, provide 14,000 residents with safe, clean, and aesthetically pleasing drinking water, and protect waterways, groundwater, farmland, and the natural environment from contamination.

Sterling's Utilities Superintendent Jeff Reeves wrote that because of our expertise, "the City now benefits from the effectiveness of RO without incurring the high costs and safety risks associated with the disposal of uranium contaminated waste."

The rooftop viewing platform of the Taupo plant has become a popular meeting place.

Project
Taupo water supply upgrade

Client
CH2M Beca, Taupo District Council

Location
Taupo, New Zealand

Expertise
Strategic planning, options assessment, concept design, preliminary and detailed design, construction supervision, commissioning management, project management

Cost-effective treatment plus an attractive public space

Opportunity

New Zealand's largest lake, Lake Taupo, is both a national treasure and the source of much of the area's drinking water. Geothermal activity in the area is a source of arsenic.

Updated drinking water standards, increased demand due to population growth, and aging infrastructure prompted the Taupo District Council to upgrade its urban water treatment plants and improve the storage and distribution network.

Solution

We investigated multiple options and proposed the development of a new coagulation/microfiltration membrane plant at the site of the existing Lake Terrace treatment plant.

Dedicated water mains connect the new plant to the two main supply zone reservoirs, creating a gravity-fed system. This addressed the problem of low reservoir turnover and prevented surge pressures from affecting the network. Our staged construction solution, incorporating temporary facilities, enabled an uninterrupted supply of safe drinking water during construction.

Outcome

The new water treatment plant is efficient, cost-effective, reduces arsenic levels to below required levels, and provides a barrier to protozoa. The plant supplies approximately 11,000 properties in Taupo with safe drinking water. It can meet the current peak demand of up to 6.6 MGD (25 MLD), upgradable to 9.2 MGD (35 MLD) by supplementing the existing treatment process with additional membranes and treated water pumps.

The project was a finalist in the competitions for three New Zealand engineering awards.

A high-tech approach to better-tasting water

Opportunity

The Neshaminy Water Treatment Plant draws its source water from Neshaminy Creek. Periodic blooms of algae in the creek can add unwanted tastes and odors. Due to the age of the pretreatment system, the facility was scheduled for major upgrades, including new pretreatment and mechanical dewatering facilities.

The plant historically used a powdered activated carbon (PAC) system to address the problem, but it could not effectively remove enough of the taste and odor causing compounds. Increasing the amount of carbon led to increased costs and more waste sludge. The plan to replace the existing clarification system with a new high-rate system would further impact the effectiveness of PAC.

Solution

We used building information modeling (BIM) to engineer more efficient pretreatment and residuals treatment for this 15 MGD (56.8 MLD) facility. The upgrade included advanced oxidation using ultraviolet (UV) light and hydrogen peroxide.

BIM enabled Aqua Pennsylvania to visualize every aspect of the water treatment process and to lay out complex systems of piping and equipment. This was especially important given the extremely limited space for construction of the new pretreatment facility.

To address the taste and odor issues, an advanced oxidation process (UV-AOP) used ultraviolet light and potassium permanganate.

Outcome

“Working from a detail-rich, 3D model made it easy for our operational staff to visualize and enhance the design,” said Marc Lucca, President of Aqua Pennsylvania. “For instance, our operational staff spotted a number of opportunities to suggest enhancements that would make maintenance easier for them. Being able to collaborate in real time was empowering.”

The UV-AOP process was more effective than the use of PAC and resulted in a significant reduction in residuals production. The new UV-AOP system also had a smaller carbon footprint than the PAC system.

The use of BIM enabled the client to visualize every aspect of the water process.

Project
Neshaminy Water Treatment Plant improvements

Location
Middletown Township, Pennsylvania, USA

Client
Aqua Pennsylvania

Expertise
Condition assessment, hydraulic analysis, treatment evaluation, alternatives evaluation, cost estimation, detailed design plans and specifications, permitting, procurement support, construction administration

Merging old and new approaches to treat PFOA

The Ranney Station Water Treatment Plant uses GAC to treat PFOA cost-effectively.

Opportunity

To help ensure safe drinking water for its customers, New Jersey American Water implemented a design-build project to create a new Ranney Station Water Treatment Plant with a capacity of 2.2 MGD (8.3 MLD).

Challenges included the need to address elevated levels of iron, manganese, and perfluorooctanoic acid (PFOA), a chemical used to manufacture stain-resistant fabrics and nonstick cookware. Maintaining the existing groundwater source was important to ensure a sustainable balance between the use of groundwater and surface water.

Solution

We recognized that granular activated carbon (GAC), used for years in conventional water treatment, would also be effective in removing PFOA. We assisted in conducting Rapid Small Scale Column Carbon Tests to evaluate alternate carbon configurations and to simulate the effect of a year or more of treatment in a matter of weeks.

Cutting-edge BIM techniques were used to design the facility. Using Autodesk's Revit software, we integrated all disciplines into a coordinated 3D model which was utilized during design workshops with the Contractor and Owner to achieve full engagement from all project stakeholders.

Outcome

The upgrade met the goals of managing PFOA cost-effectively while balancing the use of groundwater and surface water as sources. By implementing a design-build project delivery method, New Jersey American Water completed the project $1 million under budget.

Project
Ranney Station Water Treatment Plant

Location
Carneys Point, New Jersey, USA

Client
New Jersey American Water

Expertise
Design, BIM, hydraulics analysis, preliminary and detailed design, permitting, field observation, construction administration

Drawing water safely and sustainably from the River Trent

Opportunity
Forecasts of water shortages in the Lincoln area prompted a need for increased supplies of potable water. The River Trent was an obvious potential source, but the cost of treatment had to be considered. For part of the year, the river water has high levels of iron, manganese, and turbidity.

Solution
We provided detailed feasibility studies, detailed design, and construction management as part of a design-build alliance for a new 5.3 MGD (20 MLD) treatment plant, including a river intake, supply pipelines, and storage and service reservoirs.

Building Information Modeling (BIM) 3D models were used to design the plant. To reduce capital and operational costs, submerged membranes and a build-offsite approach with precast concrete elements were adopted. The treatment process was designed to minimize the use of chemicals.

Outcome
The design of the plant and treatment process reduced capital expenditure by 23% against the initial budget and reduced carbon by 63% (embodied carbon and operational carbon).

Project
Lincoln Water Treatment Works

Location
Newton on Trent, Lincolnshire, UK

Client
Anglian Water

Expertise
Design, geotechnics, construction support

Fast track testing and treatment for 1,4-dioxane

Opportunity

Artesian Water Company in Delaware is the largest investor-owned public water utility in the Delmarva Peninsula, which Delaware shares with Maryland and Virginia. Ten percent of Artesian Water's supply comes from its Llangollen Wellfield, which began operation in the 1950s.

In 2000, bis(2-chloroethyl) ether (BCEE) was found in the wellfield, which is now removed using a GAC treatment system. Further contamination by 1,4-dioxane was recorded in 2013, and a fast-track solution was needed to reliably deliver high-quality drinking water.

Solution

Our specialist water treatment process engineering team addressed the removal of 1,4-dioxane from the groundwater supply. This included a treatability study, analysis of technology options, a bench testing program, design of a new system, and required regulatory permitting.

We proposed treating the well water by adding hydrogen peroxide and treating with low-pressure high-output UV light, a method used in only a handful of US treatment plants. We also designed an innovative and cost-effective bench test procedure to prove the effectiveness of the proposed treatment process. With a capacity of 2.2 MGD (8.3 MLD), the facility was designed, permitted, and constructed in less than 18 months.

Outcome

After the first year of the new system's operation, neither BCEE nor 1,4-dioxane was detected in the treated water. The life of the GAC media was significantly extended and resulted in greatly reduced carbon replacement costs. According to Artesian Water, "Your collaboration with Artesian was critical to the success of the project."

Project
Llangollen Wellfield treatment system

Location
New Castle County, Delaware, USA

Client
Artesian Water

Expertise
Treatability study, bench testing, design, permitting

After a fast-track upgrade, neither BCEE nor 1,4-dioxane was detected in the water following treatment.

Meeting water demand with desalination

Project
Barka desalination plant upgrade

Location
Barka, Oman

Client
Oman Power and Water Procurement Company

Expertise
Design review, witnessing of testing and commissioning

Opportunity

In Oman, increasing population and limited rainfall contribute to chronic water shortages. Long-term depletion of groundwater has increased the salinity of soil in coastal plains.

In 2003, the first of three power and desalination plants was constructed at Barka to supply drinking water to the area. To meet increasing demand, the Oman Power and Water Procurement Company negotiated an expansion of Barka 1 with the developer, ACWA Power.

Solution

The expansion of the plant was carried out in two phases. Both the phases required reverse osmosis units, with pretreatment using ultrafiltration membrane technology. Water was sourced from the heat reject section of the existing thermal desalination plant. Following post-treatment, drinking water was delivered to a reservoir adjacent to the site.

Mott MacDonald acted as technical advisor to the Oman Power and Water Procurement Company from initial conception to commercial operation. Early in the project, we carried out a high-level design review to confirm compliance with the minimum functional specification. A multidisciplinary team of engineers was on site during testing and commissioning to ensure operability and reliability. We helped the client monitor the site acceptance tests, trial runs, reliability run, and initial performance test.

Outcome

The capacity of Barka 1 Expansion Phase 1 has been increased by 12 MGD (45 MLD) and the capacity of Phase 2 by 15 MGD (57 MLD), providing a reliable supply of high-quality drinking water.

An expandable approach to surface water treatment

A hollow fiber membrane system helped increased the capacity of New Brunswick's plant.

Opportunity

The City of New Brunswick provides drinking water to approximately 60,000 residents, and delivers water on a wholesale basis to two adjoining municipalities. The City's treatment plant is a conventional surface water treatment facility. Its pressure filters, installed in the 1930s, were considered obsolete for treating surface water and required replacement.

Solution

Mott MacDonald recommended a hollow fiber membrane filtration system that could replace the pressure filters and allow an increase in the plant's capacity. After pilot testing of alternative membrane systems, an immersed membrane system was chosen.

The project design included a new building to house the membrane system and associated pumps, chemical feed systems, backwash facilities and residuals handling facilities. The membrane filtration system was designed to work in parallel with the existing gravity filters, which could be converted in the future to GAC "polishing" filters.

Outcome

The four membrane trains in our design provided an initial capacity of 10.7 MGD (40.5 MLD), expandable to 12 MGD (45.4 MLD) by adding membrane modules to the tanks. Two more trains can be added for an ultimate capacity of 18 MGD (68.1 MLD). The existing pressure filter building was renovated to house a new pumping station, plus new electrical and distribution equipment to replace 50-year-old equipment.

Mott MacDonald prepared all the planning and design documents to support a successful loan application to the New Jersey Drinking Water State Revolving Fund program.

Project
Membrane filtration plant

Location
New Brunswick, New Jersey, USA

Client
City of New Brunswick

Expertise
Treatment evaluation, pilot study, design plans and specifications, permitting, construction administration, resident engineering, facility commissioning, funding assistance

Optimizing water production in the Thames Valley

Opportunity

Thames Water operates over 100 water treatment plants serving London and the Thames Valley. Many are very old and are experiencing deteriorating performance and variable raw water quality.

With increased demand for water production, higher operational costs, and regulatory pressure, Thames Water is seeking to optimize water delivery through more efficient operations.

Solution

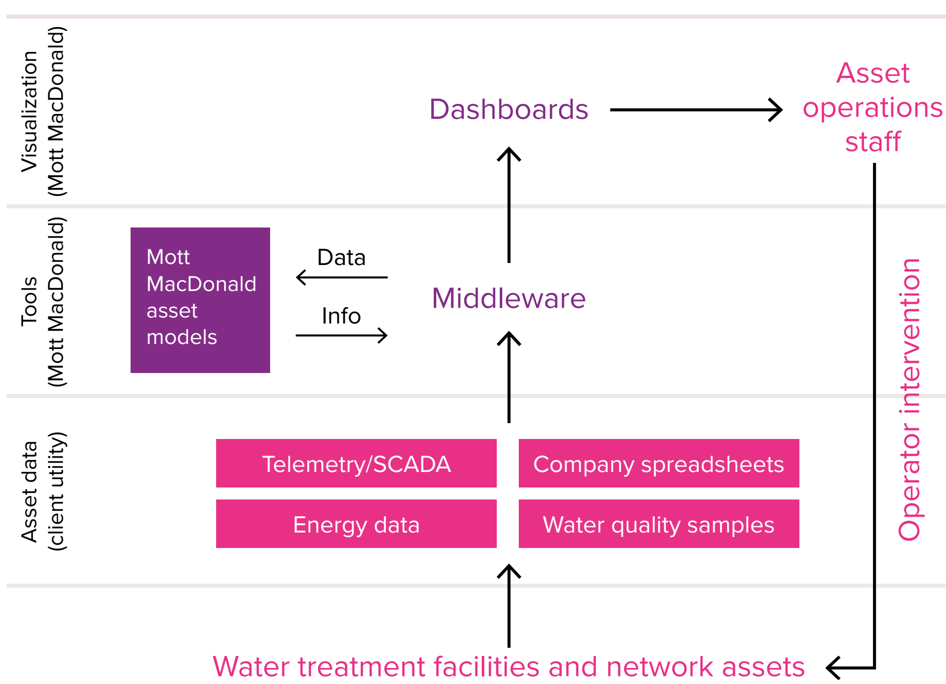
We created a mass balance process model that simulates the operational capability and capacity of each treatment plant under multiple scenarios. Data from Thames Water's telemetry and water sampling systems allows asset availability and performance to be modeled and run against historic performance.

We also created a risk model that assesses the risk of every asset at the site, based on the cost and consequence of asset failure. The model compares a default risk (what the risk should be) to the current risk, based on observed failure rates and asset availability.

In addition, we collated data relating to key performance indicators to provide operators and site managers with a dashboard to monitor performance and flag issues for attention more easily.

Outcome

The project aims to increase the capacity and efficiency of sites by making information readily available to operators. This will optimize water production, reduce the need for new water resources, reduce service downtime by making risks visible, and reduce the overall cost to operate the business.



Project
Water treatment plant criticality assessment

Location
London, UK

Client
Thames Water

Expertise
Data analytics, asset management, process design

Utilities collect data in many separate systems. Our tools process this data and link it to assets to produce meaningful information such as forecasts and risk assessments. Outputs are tailored to different stakeholders, allowing our clients to make better decisions, reduce risk, and improve efficiency.

An effective low-tech solution for a rural community

Opportunity

Maletsunyane Falls, located in central Lesotho, is a horsetail waterfall 630 feet (192 meters) high. The waterfall draws tourists to the village of Semonkong, meaning “site of smoke,” which is named for the vapor driven up by the plunging water.

The 8,000 residents of Semonkong relied on unsanitary well points for their drinking water, along with water collected by bucket from the river.

Solution

Mott MacDonald was retained to design a water treatment facility that would provide potable water and would be appropriate for a remote rural area with few skilled maintenance staff. The design was based on a slow sand filter that included a low-rate backwash facility.

Outcome

The new water treatment facility provides water to local house connections and several water kiosks centrally located around the village. The cleaning process is considerably less labor-intensive than for other systems.

No filter sand is lost during the cleaning process and backwash water wastage is less than that experienced in conventional rapid sand filter backwash systems. The schmutzdecke layer (the purifying biofilm found in slow sand filters) provides additional protection, ideal in the long term for rural areas where skilled labor and maintenance are scarce.

Project
Slow sand water treatment plant

Location
Semonkong, Lesotho

Client
Water and Sanitation Company (WASCO)

Expertise
Site assessment, design

The Semonkong water treatment plant requires little maintenance.

Balancing water treatment and wastewater treatment

A dewatering facility allows residuals to be disposed of in a way that doesn't burden the wastewater treatment system.

Project
Mechanical residuals dewatering facility

Location
Trenton, New Jersey, USA

Client
Trenton Water Works

Expertise
Design report, plans and specifications, permitting, construction services, inspection, training

Opportunity

Providing water service to approximately 225,000 people, Trenton Water Works draws water from the Delaware River and treats it at a filtration plant with a peak capacity of approximately 45 MGD (170 MLD).

To avoid discharging settled residuals from the treatment process back into the Delaware River, Trenton Water Works considered a design that would discharge them into the sanitary sewer system, with ultimate disposal at Trenton's wastewater treatment plant.

Solution

Mott MacDonald was retained by Trenton Water Works to determine whether the proposed design was feasible. We found that residuals would significantly overload the wastewater plant and inhibit the operations of the regional processing facility for wastewater sludge.

After investigating options including belt filter presses, plate and frame presses, and centrifuges, we recommended the construction of a mechanical dewatering facility using belt filter presses, and prepared plans and specifications. The plant includes six backwash holding tanks, two mixing and equalization basins, two gravity thickeners, two thickened sludge mixing and equalization basins, and four belt filter presses.

Outcome

The facility collects all filter backwash water, returning the decant supernatant to the head of the plant for reuse, and collects all residuals from the Superpulsator clarification units. Residuals are thickened and dewatered for off-site disposal, leading to environmental improvement by avoiding discharge to the river or the wastewater system.

Improving desalination in Tampa Bay

Opportunity

Faced with the need to reduce the use of groundwater that was significantly lowering the groundwater table, resulting in saltwater intrusion concerns, Tampa Bay Water constructed a 25 MGD (95 MLD) seawater desalination plant. The plant used continuously backwashing prefiltration, reverse osmosis (RO), and various forms of chemical treatment to supply water that was subsequently blended with other source water to serve the Tampa Bay Water service area.

The plant suffered from membrane fouling as a result of inadequate pretreatment. The backwashing filters were continuously operated and stressed due to very high loading rates, which resulted in inconsistent and poor water quality for the membrane filters. The plant also experienced trouble processing residuals due to the lack of a settling/thickening process.

Solution

As part of a subsequent design-build team, we assisted with the design of modifications to the plant, including new pretreatment facilities, upgrades to the sand filters, new membranes, new residuals treatment facilities, and upgrades to lime and CO_2 treatment systems.

Mott MacDonald served as engineer of record for the project and was responsible for structural, architectural, mechanical, and site-related design of the planned modifications. We reviewed the pilot testing and process design, provided engineering oversight during construction, and prepared Florida Department of Environmental Protection permit applications.

Project
Upgrade to desalination plant

Location
Apollo Beach, Florida, USA

Client
American Water and Acciona Agua/Tampa Bay Water

Expertise
Design, permit review, construction oversight, record drawing

Tampa Bay's upgraded desalination plant provides about 10% of the drinking water for 2.5 million people.

Outcome

When the upgrade was completed, the plant passed two performance tests, proving its ability to consistently produce up to 25 MGD (95 MLD) of drinking water. With an expected lifespan of 30 to 50 years, the plant supplies about 10% of the drinking water for more than 2.5 million people in the Tampa Bay area.

Need help with a water treatment project?

For more information:
watertreatment@mottmac.com

Opening opportunities
with connected thinking.

For more information, write to americas@mottmac.com or call 800.832.3272.

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