How to Optimize Your PFAS Compliance Costs

Lessons Learned from the AWWA PFAS Cost Model Project

Black & Veatch team members tour their completed PFAS treatment project at Cape Fear Public Utility Authority's Sweeney Water Treatment Plant

Based on Black & Veatch's PFAS cost model tool originally developed for the American Water Works Association (AWWA), this whitepaper demonstrates how the tool can be used to optimize PFAS compliance investment for your utility and ratepayers.

BLACK & VEATCH

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1.0 Introduction

Black & Veatch helps utilities across the country and around the world address their PFAS challenges, providing end-to-end consulting, engineering, and construction services to meet each community's unique needs.

1.1 About Black & Veatch

Black & Veatch is an employee-owned engineering, procurement, consulting, and construction company with a 100-year legacy of innovations in sustainable infrastructure. For more than a century, Black & Veatch has been developing the water infrastructure that has built communities across the nation and around the world. As your needs evolve and grow, our experienced team is at the cutting edge of innovation, helping clients address the challenges of today, while planning for a more sustainable tomorrow. With a focus on sustainability and resilience that starts with you, we deliver long-term value to water, sanitation and stormwater clients at every stage of the project lifecycle. Learn more at bv.com.

1.2 Black & Veatch's PFAS Expertise

Black & Veatch helps utilities across the country and around the world address their PFAS challenges, providing end-to-end consulting, engineering, and construction services to meet each community's unique needs. From applied research to executed projects, Black & Veatch is at the forefront of innovative and effective PFAS treatment solutions, trusted by key trade and research organizations such as the American Water Works Association, the Water Environment Federation (WEF), and the Society of American Military Engineers to mitigate the impacts of PFAS in our environment, critical infrastructure, and communities. We help clients address the integrated cost, characterization, regulatory and public and policy considerations of PFAS contamination – and the best methods of treatment. Learn more at bv.com/pfas.

2.0 Background

2.1 U.S. EPA's NPDWR

In March of 2023, the U.S. Environmental Protection Agency (EPA) released its first-ever National Proposed Drinking Water Regulation (NPDWR) for per- and polyfluoroalkyl substances (PFAS) with significantly lower Maximum Contaminant Levels (MCLs) than many expected. This newest regulatory activity adds to the mounting pressure from the public, media, and state regulators to address PFAS contamination in our communities. As utilities around the country realize that a PFAS treatment solution is needed, one of the first questions they must face is: *how much will it cost?*

The answer can be found using the PFAS cost model tool originally developed for the American Water Works Association (AWWA) by Black & Veatch. The tool accounts for the unique circumstances of each water utility to produce high-level cost estimates, calculated for each designated best available treatment technology.

2.2 About the AWWA Cost Model Tool

The American Water Works Association (AWWA) contracted Black & Veatch to perform a nationwide analysis of the PFAS NPDWR's financial impact on the water utility industry. The results of the project were cited in AWWA's public response to the new proposed regulations in March 2023:

> "Advanced drinking water treatment systems for PFAS will require communities to make significant investments. A recent study conducted by Black & Veatch on behalf of AWWA estimated the national cost for water systems to install treatment to remove PFOA and PFOS to levels required by EPA's proposal exceeds $3.8 billion annually*. The vast majority of these treatment costs will be borne by communities and ratepayers, who are also facing increased costs to address other needs"
>
> **AMERICAN WATER WORKS ASSOCIATION (AWWA)**
> "AWWA Statement on Proposed Drinking Water Standards"

In addition to helping AWWA advocate for water utilities, this cost model tool can be used to analyze the PFAS cost burden for individual or groups of systems. Black & Veatch has already analyzed the cost burden for several utilities, allowing them to move forward with securing appropriate funding. As community awareness of PFAS grows and regulations evolve, understanding your utility's options will help you move forward quickly and confidently.

* Updated in May to $3.2 billion annually.

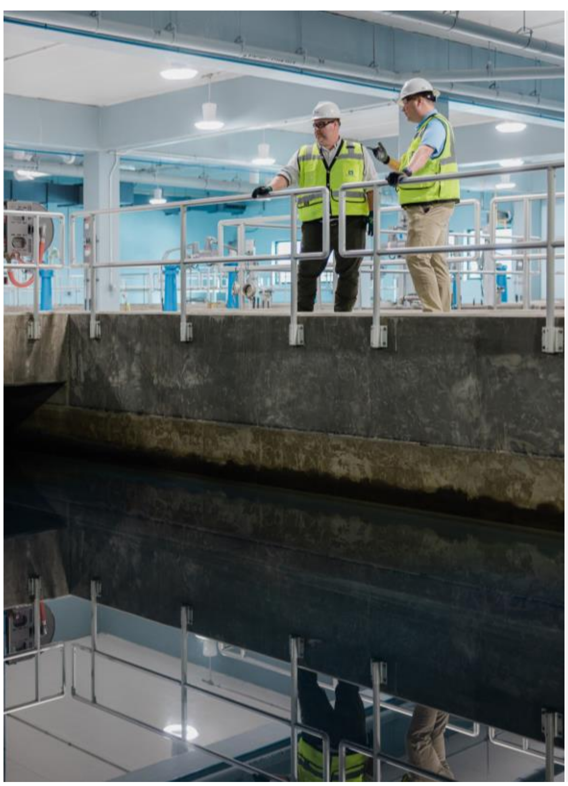
3.0 Identifying Key Cost Variables

At a high level, it is important to first identify which factors affect PFAS treatment costs most significantly. These factors include water quality, treatment goals, and site-specific constraints. Examples will be taken from Black & Veatch's PFAS treatment project for Cape Fear Public Utility Authority, which, although completed prior to the creation of the AWWA cost model, illustrate how each of these variables can impact the final design of a PFAS solution – and therefore its price tag.

3.1 Water Quality Considerations

Each water source contains a unique makeup that impacts the feasibility of different PFAS treatment options. For example, if your utility has significant levels of compounds other than PFAS that will also be targeted by Granulated Activated Carbon (GAC), the media will adsorb those additional compounds and therefore reach capacity faster, meaning higher costs to replace over time. But if you have water quality issues other than PFAS that need to be treated anyway, co-removal of other contaminants can be a benefit.

To test the effectiveness (and therefore feasibility) of different treatment options, demonstration testing (bench-, pilot- or full-scale studies) are used to assess how the unique characteristics of source water impact treatment performance. Testing provided by Black & Veatch analyzes the effectiveness of several selected media. Rigorous, site-specific testing can save you money later by factoring in your system's unique water chemistry. For example, in the absence of testing, most utilities may default to a GAC solution, where another treatment technology such as Ion Exchange (IX) may be more affordable while equally effective.



Client Example:
Pilot Study Helps Utility Move Forward

In response to PFAS contamination concerns along the Cape Fear River, Cape Fear Public Utility Authority (CFPUA) contracted Black & Veatch to help remove PFAS to the satisfaction of all stakeholders. Black & Veatch provided transparent, multi-phased demonstration testing of advanced treatment technologies to remove PFAS contaminants. The pilot study included on-site, real-time testing of both granular activated carbon (GAC) and ion exchange (IX) resins. Data from the study was used to develop performance and cost models that helped refine treatment goals and implementation plans. Regular progress meetings and stakeholder workshops were held with CFPUA during the study to ensure established treatment goals were satisfactory and beneficial. Based on the pilot study, CFPUA selected post-filter deep-bed GAC contactors to remove PFAS at their Sweeney Water Treatment Plant. Read the Full Project Story

3.2 Treatment Goals

Another key factor to consider is how completely your utility aims to remove PFAS. For example, does your utility want to target complete removal? Or aim for compliance? If the latter, utilities may be able to treat a fraction of their supply and blend to meet maximum contaminant levels (MCLs) rather than expend the resources to achieve total removal.

Utilities may also consider which PFAS compounds to target. In other words, does your utility want to limit your treatment to the six PFAS compounds that are currently regulated? Or does your utility want to target non-regulated PFAS compounds as well? Only six PFAS compounds are currently included in the EPA's National Proposed Drinking Water Rule (NPDWR), but thousands of PFAS compounds are still being studied. As scientific research reveals more about these additional PFAS, regulation may change in the future to include some of these additional compounds.

To maximize the long-term value of PFAS treatment infrastructure, we're seeing an increase in the number of utilities that are factoring in future regulatory activity that may occur at the federal, state, and local levels.

3.3 Site-specific Constraints

A utility's most cost-effective PFAS treatment solution will most often depend on their facility's existing infrastructure. For example, if your facility has limited land for additional treatment capacity, only the treatment solutions with the smallest footprint, such as IX, may be considered.

Or, if your facility has an existing brine discharge capacity, Reverse Osmosis (RO) becomes a more favorable option, since developing a new path for RO brine disposal can be very costly and environmentally challenging. Systems in proximity to an existing brine discharge line may have an easier path to permit their discharge than systems attempting to permit a new outfall or injection well, which may take a lengthy process to obtain.

Another factor to consider is gravity – the hydraulics of your facility may allow the insertion of gravity contactor basins without any pumping. If pumping is required to get contactors into your treatment train, pushing source water through pressure vessels may be a superior alternative to gravity basins. In short: the most cost-effective treatment technology will be one that complements your utility's existing infrastructure and operational needs.

Client Example: Flexible Design and Seamless Integration Save Operational Costs

When Black & Veatch first began planning a PFAS treatment solution for Cape Fear Public Utility Authority (CFPUA), there was yet no federal regulatory standard. Therefore, the design of the facility had to provide operational flexibility to meet multiple potential future regulations. Black & Veatch delivered a design that enables CFPUA to operate the facility's contactors in multiple configurations with GAC, ion exchange (IX), or other proven media resins. This flexibility allows CFPUA to adapt to both changing source water conditions and rapidly evolving PFAS regulations, maximizing the long-term value of the facility.

The design also included a seamless integration with the existing filter complex and pipe gallery, influent pump station and gravity bypass structure, and dedicated truck unloading and media conveyance system to ease impacts of media changeout on plant operations, complementing the existing infrastructure and saving on long-term cost.

4.0 Analyzing Cost Per Technology

4.1 Introduction

Once the previous factors have been considered, we can begin to calculate cost scenarios. The total cost of treatment will vary greatly depending on which technology is utilized; therefore, the different cost scenarios are organized by treatment technology.

Each technology has many advantages and limitations that should be considered. For a summary of the pros and cons of known treatment technologies, please refer to the AWWA Cost Model Project's Technical Memorandum prepared by Black & Veatch. Please note that these are costs for an individual system that does not reflect the costs of every utility. Performance characteristics, and therefore cost, are also contingent on demonstration testing to validate. These scenarios will be further evaluated and confirmed through demonstration testing (bench- or pilot-scale) prior to final selection and implementation of a treatment technology.

4.2 Client Profile

The three cost scenarios we review were recently calculated for a large water utility in the eastern U.S. who realized after the EPA's NPDWR that they needed to update their existing Capital Improvement Plan (CIP) to include PFAS treatment. The utility contracted Black & Veatch, who leveraged the AWWA cost model tool, to provide preliminary designs and analysis to help the utility weigh the pros, cons, and costs of each treatment option, together with the impact on ratepayers.

Serving approximately 120,000 accounts, the utility found PFAS concentrations in their raw water ranging from 2.2 parts per trillion (ppt) to 21.5 ppt. Their existing facility has a production capacity of 140 million gallons per day (mgd). The assumed maximum raw water levels to be treated are based on the highest levels of PFAS compounds observed plus a 25% safety factor. The utility decided to target a maximum finished water concentration of 2 ppt of PFOA and PFOS individually.

4.3 Granular Activated Carbon (GAC)

4.3.1 Preliminary Design

It's possible in many cases to retrofit existing filter basins with GAC to achieve PFAS removel. However, for this client specifically and most others with media filtration basins not specifically designed for PFAS, using the existing treatment facility would lead to inefficient use of media because of frequent backwashing and a short replacement frequency stemming from insufficient bed depth. For these reasons, a post-filter contactor is recommended. A GAC post-filter contactor solution for PFAS can come in two different forms: post-filter gravity basin configuration or pressure vessel configuration. Concrete post-filter gravity basins become more affordable per square foot the larger they are built. The same is not true for pressure vessels where increases in size lead to larger forces and thicker steel required to resist the internal pressure and dead loads.

Table 4-1: Preliminary Design Criteria – 140 mgd GAC Contactor Facility

PARAMETER	TYPICAL RANGE	VALUE
Contactor Type	Pressure Vessel or Gravity Basin	Gravity Basin
SLR, gpm/ft^2 (Note 1)	4-10	6.0
EBCT, min (Note 2)	10-20	16
Building Footprint, ft^2	--	42,000
Bed Volumes	--	10,200

Notes:
1. *GPM = Gallons Per Minute*
2. *EBCT = Empty Bed Contact Time*

4.3.2 Project Cost

For the purposes of alternatives analysis and capital improvement plan (CIP) planning, a -30% + 50% ASCE Class 5 estimate for a project cost for a 140 mgd GAC contactor facility was evaluated as follows:

Table 4-2: Project Cost for 140 mgd GAC Contactor Facility Annual Operations and Maintenance (O&M) Cost

DESCRIPTION	PROJECT COST
140 mgd GAC Contactor Facility	$139,940,000

Notes:
1. *Project cost includes process equipment; additional project costs such as site work, yard piping, electrical, I&C; contractor markup costs such as overhead, profit, mobilization/bonds/insurance, general requirements, and contingency/market volatility; and other non-construction costs such as Engineering, Legal, and Administration.*

A summary of the annual O&M costs and 20-year present worth costs is provided in Table 4-3.

Table 4-3: GAC Annual O&M Costs

COST CATEGORY	COST
GAC Replacement (Note 1)	$18,756,000
Power	$547,000
Maintenance	$344,000
Media Incineration (Note 1)	$5,627,000
Labor	$126,000
Total O&M	**$25,400,000**
Present Worth of 20-Years of O&M Costs (Note 2)	**$269,088,000**

Notes:
1. *Media incineration and purchase of virgin media assumed due to unknowns about GAC reactivation with CERCLA regulation.*
2. *Present Worth Costs are calculated using an interest rate of 7%.*

4.4 Ion Exchange (IX)

4.4.1 Preliminary Design

Preliminary design criteria for a 140 mgd ion exchange facility is summarized in Table 4-4. These criteria should be further evaluated and confirmed through a pilot study prior to final selection and implementation of a treatment technology.

Table 4-4: Preliminary Design Criteria - 140 mgd Ion Exchange Facility

PARAMETER	TYPICAL RANGE	VALUE
SLR, gpm/ ft^2	5-12	8.33
EBCT, min	1.5-3.0	2.2
Building Footprint, ft^2	--	52,800
Bed Volumes (BVs)	--	128,000

4.4.2 Project Cost

For the purposes of the alternatives analysis and CIP planning, a project cost for a 140 mgd IX contactor facility was evaluated, as summarized in Table 4-5.

Table 4-5: Project Cost for 140 mgd Ion Exchange Facility

DESCRIPTION	PROJECT COSTS
140 mgd Ion Exchange Facility	$150,500,000

Notes:

1. *Project cost includes process equipment; additional project costs such as site work, yard piping, electrical, I&C; contractor markup costs such as overhead, profit, mobilization/bonds/insurance, general requirements, and contingency/market volatility; and other non-construction costs such as Engineering, Legal, and Administration.*

4.4.3 Annual Operations and Maintenance (O&M) Cost

A summary of the annual O&M costs and 20-year present worth costs is provided in table 4-6.

Table 4-6: Ion Exchange Annual O&M Costs

COST CATEGORY	COST
IX Resin Replacement	$7,935,000
Media Incineration	$780,000
Power	$868,000
Maintenance	$342,000
Labor	$655,000
Total O&M	**$10,580,000**
Present Worth of 20-Years of O&M Costs(Note 1)	**$112,085,000**

Notes:

1. *Present Worth Costs are calculated using an interest rate of 7%.*

Ribbon-cutting ceremony at Cape Fear Public Utility's Sweeney Water Treatment Plant.

4.5 Ion Reverse Osmosis (RO) or Nanofiltration (NF)

4.5.1 Preliminary Design

Preliminary design criteria for a 140 mgd reverse osmosis facility is summarized in Table 4-7. These criteria should be further evaluated and confirmed through a pilot study prior to final selection and implementation of a treatment technology.

Table 4-7: Preliminary Design Criteria for 140 mgd Reverse Osmosis Facility

PARAMETER	TYPICAL RANGE	VALUE
Target Recovery, %	70-85	78
PFAS Rejection, %	95	95
Building Footprint, ft^2	--	127,000

4.5.2 Project Cost

For the purposes of the alternatives analysis and CIP planning, a project cost for a 140 mgd reverse osmosis facility was evaluated, as summarized in Table 4-8.

Table 4-8: Project Cost for 140 mgd Reverse Osmosis Facility

DESCRIPTION	PROJECT COSTS
140 mgd Reverse Osmosis Facility	$434,120,000

Notes:

1. *Project cost includes process equipment; additional project costs such as site work, yard piping, electrical, I&C; contractor markup costs such as overhead, profit, mobilization/bonds/insurance, general requirements, and contingency/market volatility; and other non-construction costs such as Engineering, Legal, and Administration.*

4.5.3 Annual Operations and Maintenance (O&M) Cost

A summary of the annual O&M costs and 20-year present worth costs is provided in table 4-9.

Table 4-9: RO/NF Annual O&M and Lifecycle Costs

COST CATEGORY	COST
Membrane Replacement	$2,306,000
Chemicals	$10,072,037
Power	$7,750,840
Maintenance	$3,376,829
Labor	$673,955
Total O&M	$24,180,000
Present Worth of 20-Years of O&M Costs(Note 1)	$256,164,000

Notes:

1. *Present Worth Costs are calculated using an interest rate of 7%.*

5.0 Comparing Costs Per Technology

5.1 Summary

Now that costs per treatment technology have been evaluated for this client example, we can begin comparing lifecycle costs per technology to help determine the preferred treatment technology. Site-specific demonstration testing is recommended to further evaluate and confirm design criteria for each treatment technology, which will assist in further refining capital costs. The cost of such bench-scale testing is anticipated to be approximately $48,000[1], while a high-level estimate of the cost of pilot testing is $500,000[1]. With cost scenarios in hand, the utility can move forward with exploring the abundant funding opportunities available for PFAS treatment solutions – funding that is often available on a first-come, first-serve basis, putting the utility at an advantage when it comes to competing for funding resources.

5.1 Post-Filter PFAS Removal Lifecycle Cost Comparison

Table 5-1: Post-Filter PFAS Removal Life-Cycle Cost Comparison

	GAC BASINS	IX	RO
Project Cost	$139,940,000	$150,500,000	$434,120,000
Annual Recurring Cost	$25,400,000	$10,580,000	$24,180,000
Lifecycle Cost	**$409,028,000**	**$262,585,000**	**$690,284,000**

5.2 Summary of Potential Post-Filter PFAS Removal Projects

Table 5-2: Summary of Potential Post-Filter PFAS Removal Projects

POTENTIAL IMPROVEMENTS	PROJECT COSTS
Site-Specific PFAS Bench-Scale Testing	$48,000
Site-Specific Post-Filter PFAS Pilot Testing	$500,000
140 mgd GAC Contactor Facility	$139,940,000
140 mgd Ion Exchange Facility	$150,500,000
140 mgd Reverse Osmosis (RO) Facility	$434,120,000

[1] Excluding laboratory analytical costs

6.0 Calculating Cost Per Household

Utilities may calculate cost per household to further compare treatment options.

Utilities analyzing their expected cost burden may also want to consider their expected cost per household to weigh the cost of treatment systems on their customers. Black & Veatch's AWWA Cost Model Project analyzes the annual financial impacts to the utility at a per household level from costs associated with the installation and operation of drinking water treatment facilities for PFAS. The financial impacts to individual households will vary by specific PFAS levels, system size, and other factors. Additionally, the impacts to individual households arising from the NPDWR will differ depending on whether there is an existing state regulation for PFAS in drinking water.

To calculate the annual expected cost per household, use the calculated capital and operating costs (see Table 5-1) to factor in the cost to not only build a treatment solution, but maintain it over an expected lifespan of 20 years with a 3% discount rate, which is the rate the U.S. EPA used in their calculation estimates. This calculation provides you with an estimated annualized cost of $34,807,000. Finally, divide by the number of service connections.

For example: the client has approximately 120,000 accounts, so if you divide the annualized cost by 120,000, you get $290.06 per year per household.

This simple calculation can be another viewpoint through which a utility analyzes the affordability of their treatment options.

7.0 Conclusion

Black & Veatch helps utilities analyze their cost per PFAS treatment technology to optimize their investment and move forward confidently with PFAS mitigation.

Black & Veatch's AWWA cost model tool allows utilities to quickly and confidently calculate their expected PFAS compliance cost burden. With these cost scenarios in hand, utilities can move forward to seek funding, align stakeholders, and maintain public trust as they tackle their PFAS challenges.

Black & Veatch offers experienced partnership for water utilities handling PFAS contamination, from testing and planning to design, construction, and maintenance. For more than a century, we have been developing the water infrastructure that has built communities across the nation and around the world. As your needs evolve and grow, our experienced team is at the cutting edge of innovation, helping clients address the challenges of today, while planning for a more sustainable tomorrow. With a focus on sustainability and resilience that starts with you, we deliver long-term value to water, sanitation and stormwater clients at every stage of the project lifecycle.

For a cost analysis report for your specific utility or to discuss your utility's specific needs, contact our experts at bv.com/contact-us.

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