



OFFICIAL NOTICE AND AGENDA
of a meeting of a City Board, Commission, Department
Committee, Agency, Corporation, Quasi-Municipal
Corporation, or Sub-unit thereof.

A Meeting of Wausau Water Works Commission will be held in the
Council Chambers, 1st Floor City Hall, Wausau, WI 54403 at 6 : 15 p.m. on
Wednesday, April 6th, 2022.

Members: Katie Rosenberg (President), Dawn Herbst, Jim Force, Joe Gehin, John Robinson

AGENDA

1. Approve Minutes of March 1st & March 8th 2022 Meeting.
2. Director's Report on Utility Operations
 - DWTF Update
 - Corrosion Control Treatment
 - Lead Service Line Replacement Plan
 - Pilot Study
 - Solar Project
 - CW3 Status and Moving Forward
 - Update on Water Pitchers and Bottled Water
 - 3 Positions Vacant for Water: 2 Water Distribution Maintainers, 1 Water Operations Technician
 - Wastewater Treatment Plant is On Track to Meet Permit Limits
 - 3 Positions Remain Vacant for Wastewater: 1 Wastewater Plant Operation, 2 Collection Systems Technician (Sewer Maintainers)- The New Employee Passed Class A Driving Test and Will Start On-call Duties
 - Collection Systems Technician (Sewer Maintainer)- Yielded 2 Applicants but did not Meet Qualifications
 - Wastewater Plant Operation Technician Job Description Submitted to HR for Review/Approval
 - No Applicants Received for Summer Aide Position Posted at Wastewater.
 - Industrial Park Force Main Scheduled for Cleaning
 - Wastewater Plant Construction Progresses Daily
3. Presentations from Engineering/Consulting Firms Regarding Expertise Related PFAS Treatment and Removal from Drinking Water Systems.
 - a. CDM Smith
 - b. Wood Environment & Infrastructure Solutions Inc.
 - c. Shannon & Wilson
 - d. Tetra Tech
 - e. Geosyntec Solutions
 - f. AECOM
4. CLOSED SESSION Pursuant to Section 19.85(1)(e), Wisconsin Statutes, for the Purpose of Deliberating or Negotiating the Purchasing of Public Properties, the Investing of Public Funds, or Conducting Other Specified Public Business, Whenever Competitive or Bargaining Reasons Require A Closed Session, Regarding Consideration of Responses to the City's Request for Qualifications for Professional Experience Related to PFAS Treatment & Removal from Drinking Water.
5. RECONVENE Meeting into Open Session for the Purpose of Acting Upon Closed Session Item if Necessary.
6. Discussion and Possible Action on Supplementing the Sale of Rain Barrels in 2022 and Establishing a Memorandum of Understanding (MOU) Again with Rain Water Solutions, Inc.

7. Discussion and Possible Action on Increasing the Funding Amount for Lead Line Services on the Homeowner's Side.
8. Discussion and Possible Action on Future Bottling of Northwoods Mist.
9. Discussion and Possible Action on Sole Source Purchase of Polymer for the Gravity Belt Thickener and Belt Filter Press.
10. Discussion and Possible Action on Sole Source Purchase of an Emergency Bypass Pump System.
11. Discussion and Possible Action on Consent to Termination of the Redevelopment Agreement by and Between the Redevelopment Authority of The City of Wausau, Wisconsin and Wausau Joint Venture.
12. Discussion on Future Meetings Dates/Times for Regular Scheduled Meetings.

Adjourn.

**Next meeting scheduled for May 3rd 2022 (no selected time)*

Signed by: /s/ Katie Rosenberg, Mayor
Presiding Officer or Designee

It is possible and likely that members of, and possibly a quorum of the Council and/or members of other Committees of the Common Council of the City of Wausau may be in attendance at the above-mentioned meeting to gather information. **No Action will be taken by any such groups at the above-mentioned meeting other than the Committee specifically referred to in this notice.**

THIS NOTICE POSTED AT CITY HALL AND EMAILED TO CITY PAGES AND DAILY HERALD: April 4th 2022 at 2:30 p.m.

This meeting is being held in person and via teleconference by calling 1-408-418-9388. The WebEx Access Code is 2493 270 9055 and the password is WausauH2O.

All public participants' phones will be muted during the meeting. Members of the public who do not wish to appear in person may view the meeting live over the internet on the City's YouTube Channel <http://tinyurl.com/WAAMedia>, live by cable TV, Channel 981, and a video is available in its entirety and can be accessed at <https://tinyurl.com/wausaucitycouncil>. Any person wishing to offer public comment who does not appear in person may e-mail gina.vang@ci.wausau.wi.us with "Water Commission Public Comment" in the subject line prior to the meeting start. All public comment, either by email or in person, will be limited to items on the agenda at this time. The messages related to agenda items received prior to the start of the meeting will be provided to the Chair.

In accordance with the requirements of Title II of the Americans with Disabilities Act of 1990 (ADA), the City of Wausau will not discriminate against qualified individuals with disabilities on the basis of disability in its services, programs or activities. If you need assistance or reasonable accommodations in participating in this meeting or event due to a disability as defined under the ADA, please call the ADA Coordinator at (715) 261-6590 or ADAServices@ci.wausau.wi.us to discuss your accessibility needs. We ask your request be provided a minimum of 72 hours before the scheduled event or meeting. If a request is made less than 72 hours before the event the City of Wausau will make a good faith effort to accommodate your request.



Minutes of March 1, 2022

A meeting of the Wausau Water Works Commission was called to order at 6:00 p.m. in City Hall on Tuesday, March 1st, 2022. In compliance with Wisconsin Statutes, this meeting was posted and receipted for by the Wausau Daily Herald on February 25, 2022.

Members Present: President Rosenberg, Commissioners Herbst, Gehin, Force, Robinson
Others Present: Eric Lindman, Scott Boers, Ben Brooks, Valerie Swanborg, Debra Ryan, Tom Kilian, Anne Jacobson, Stephen Opatik/ Becher-Hoppe, Susan Wojtkiewicz/ Donohue, Andrew Dow/ Donohue, Mike Gerbitz/ Donohue Via WebEx: Dan Bauman, Lou Larson, MaryAnne Groat

1) Approve Minutes of January 4th & February 15th 2022 Meeting.

Herbst moved to approve the minutes of the January 4th and February 15th 2022 meeting.
Seconded by Gehin.

Motion carried 4-0.

2) Director's Report on Utility Operations.

Force questioned personnel shortages and if there were possibilities of advertising or recruitment of more staff through local institutions or through apprenticeship.

Gehin questioned employee that resigned in wastewater if he moved to a different community or if it was a salary issue.

Brooks stated he moved to another community.

Lindman replied something did go to HR Committee city wide about an apprenticeship program that passed unanimously. At this time the utility does not have an established apprenticeship program in place.

Director's Report placed on file.

3) Presentation on Temporary and Permanent Perfluoroalkyl and Polyfluoroalkyl (PFAS) Removal Options and Discussion on a Path Forward (Donohue & Associates and Becher Hoppe).

Gerbitz, Wojtkiewicz and Dow from Donohue presented with removal options. See attached PowerPoint in the packet starting at page 17 or view [online](#).

Wojtkiewicz pointed out they have had a joint agency meeting with Wisconsin Department of Natural Resources (DNR) and Public Service Commission (PSC), DNR requires plan approval for any modification/improvements to water system that would affect quality/quantity of water delivered, including water treatment facilities, engineering reports, pilot study results, DNR worksheets, and plans and specs. Along with the need to secure a water utility certificate from the PSC if the costs for construction, purchasing, installing, modifying, or replacing exceeds \$432,000.

Dow presented 3 major responses 1) Rapid Response- which we could do right away 2)

Interim- what would work until the new drinking water treatment plant is up and running/temporary solution 3) Permanent- what may potentially be for many generations to come. He also presented with 4 mature technologies that could be utilized 1) Powdered Activated Carbon (PAC) 2) Nanofiltration/Reverse Osmosis (NF/RO) 3) Granular Activated Carbon (GAC) and 4) Ion Exchange (IX).

Herbst questioned if filtered systems were the best way to go and if so, who would install/maintain them, would residents know for sure it would reduce PFAS amount to under 20 parts per trillion (ppt), requested the service life of a filter and if there would be a removal process.

Dow replied stating just like a Brita water filter, the homeowner would be responsible for maintaining it but in answering the rest of the questions, the DNR/DHS has a website for approved/certified PFAS removal filters.

Robinson questioned if the state would consider funding engineering and approve in bringing someone in with PFAS removal experience or with innovative approaches or models.

Bauman replied that the idea makes a lot of sense but availability of funding is more of a question for DNR funding program but it doesn't mean we can't take it to the secretary's office or through state legislators' and governors as well as department to see if we can meet somewhere in the middle.

Force questioned the disposal of spent granular activated carbon (GAC).

Dow replied with the reactivation process, the high temperature thermal is more commonly used vs. incinerating.

Kilian questioned if we could indicate proximity of the source and long-term plan source identification or consider a new well. He spoke with a product manager regarding a filter and with Duke study that shown reductions, and the highest was 3ppt with filter life of 6 months.

Gerbitz replied that they design drinking water and wastewater systems and do not get involved in contaminant fate and transport but are open to supplement and work with others with this type of expertise.

Wojtkiewicz stated we could investigate digging of a new well but how far we need to move to get away from impacted groundwater, not knowing if the other side of Wisconsin River is impacted and supporting costs of wells could be significant because the further it is, there is more cost of water mains and infrastructure.

Opatik replied with additional well investigations a while back, East side was looked at, water quality there was higher in Manganese than other areas we've worked with. Treatability was challenging.

Ryan brought forth the importance of lead in our piping as ongoing issues with the importance of PFAS now too. She requested that both lead and PFAS require the need for action and to filter water before drinking.

Rosenberg commented that PFAS were everywhere, found in the firefighter foam and even in her ice cream cup.

No Action Taken.

4) Discussion and Possible Action to Approve Funding for a Pilot Study and Scope of Services for PFAS Removal at the new Drinking Water Treatment Facility with Donohue & Associates & Becher Hoppe.

Gehin excused himself from the meeting for this Agenda Item.

Force moved to approve funding for pilot study with Donohue not to exceed \$155 thousand with the task order of \$30,000. Seconded by Herbst.

Robinson questioned the expertise of PFAS removal.

Force reiterated there would be opportunity after the pilot study to include that but we

needed to take the first steps/action.

Rosenberg reiterated the motion to approve funding for pilot study and scope of services for PFAS removal at the new drinking water treatment facility with Donohue & Associates & Becher Hoppe including finding consultants/engineers with expertise of PFAS removal.

Seconded by Force.

Motion carried 4-0.

Gehin returned to the meeting after the motion made.

5) Discussion and Possible Action on Interim PFAS Remedial Options Including Funding Recommendations until the new Drinking Water Treatment Facility is Operational.

Robinson stated he would like to direct staff to prepare an RFQ.

Jacobson questioned if the motion on the floor felt germane to the body in order to take action on this item.

Rosenberg stated she finds it germane in her point of view because it's the same pilot project. She stated we could direct this to Council and wants to follow parliamentary sway unless she gets overridden.

Robinson moved to direct staff to provide qualifications for services to help evaluate pilot processes/options following engineering.

Robinson questioned timeline/outline of when alternatives would be.

Lindman replied Donohue is presenting to Council next week Tuesday.

Robinson questioned if this needed to be ran through Water Commission or would it be a joint meeting.

Lindman replied that a joint meeting could be set up but Council can make those decision and that's why they wanted those options put before them. An item they wanted was to take action on possible expenditure of funds. We could discuss possible dates/times.

Rosenberg stated Council can approve alternate funding sources that are not ratepayers or kick it back to this Commission. She stated there's a Finance Committee meeting ahead of Council Meeting and a County Human Resources Committee Meeting so it may make sense to have the joint committee meeting. The Finance Committee is at 5:15pm. Then the Council meeting follows at 6:30pm.

Rosenberg stated she would explore the joint meetings with the chair of the Finance Committee.

Robinson moved to direct staff to prepare an RFQ and advance rapid response short-term and interim basis. Seconded by Force.

Motion carried 4-1.

6) Discussion and Possible Action on Approving terms of Settlement Agreement between Wisconsin Department of Natural Resources (WDNR) and the City of Wausau, providing for dismissal of both Contested Case and Petition for Judicial Review (Marathon County Case No. 19CV32).

Lindman stated when the first permit came out there was no total maximum daily load (tmdl), we had a low phosphorous limit, so we contested the permit.

Jacobson stated we've been at this since 2019, challenging the discharge permit agency level before the DNR and at circuit court level. Nothing has happened at the circuit court level. We've petitioned for contested case hearing at DNR and they've accepted it and we kept negotiating on terms of permit and accepted staff's request for construction deadline to remain 6/30/2023 with the compliance date 6 months thereafter to 12/30/2023. There is a public comment/hearing of 70 days but as long as we don't have a third-party challenge, then the contested claim would be dismissed.

Gehin motioned to approve terms of settlement agreement between WDNR and City of Wausau, providing for dismissal of both contested case and petition for judicial review. Seconded by Herbst.

Motion carried 5-0.

7) Discussion and Possible Action on a Budget Modification for the Burek Ave/ Campus Drive Water Main Project.

Lindman stated the diameter of water main increased from 14” to 18” along with increased material costs put us over budget by \$400,000 and are looking for budget modification approval for this project in 2022.

Gehin moved to approve budget modification. Seconded by Herbst.

Motion carried 5-0.

8) Discussion and Possible Action on Utility Policy Addressing PFAS Issues in Water and Wastewater Treatment Systems.

Robinson proposed that we look at the health advisory levels and what other states were doing. We need to begin to monitor both influent and effluent at the Wastewater Treatment Plant to minimize exposure. Where are we in terms of sampling biosolids at the Wastewater Plant and looking holistically at the effects of PFAS in our utility system.

Lindman replied that we have not sampled any biosolids at the plant.

Force stated we have talked about it in our past minutes and questioned if Robinson’s holistic approach included source identification or source investigation.

Robinson replied there would be two sources, looking at the source of groundwater contamination/drinking water wells and the other is the source of potential dischargers into the systems. He stated he would move that we embrace health standards to address quality issue in drinking water and expand knowledge through influent/effluent biosolid testing. Seconded by Force.

Gehin wanted to bring to light that we have no approved methodology for the Wastewater; Biosolids testing yet so we need to be careful because we don’t want to go out on a limb and find out that we came out with bad information and committed to serious investments that our taxpayers would not appreciate.

Robinson questioned if there really were no approved methods to test biosolids.

Brooks stated there are costly methods.

Lindman replied there are no standardized testing methods yet for biosolids and would not recommend moving forward with testing. DNR established guidelines for some PFAS levels in biosolids but these are not enforceable standards only guidelines, these were presented at a previous meeting and we can bring them back for your review.

Rosenberg stated it is worth it to investigate because what goes in does come out.

Robinson requested a three-part motion, 1) adopt department of health recommendation for 20 ppt for water 2) evaluate wastewater influent/effluent biosolids 3) look for source identification for PFAS in both groundwater and effluent if we had any.

Rosenberg reiterated we have motion to adopt the department of health recommendation for 20 ppt in drinking, evaluate wastewater influent/effluent, and investigate source of PFAS.

Motion carried 5-0.

9) Discussion on Possible Steps Moving Forward on PFAS Removal in Water and Wastewater Treatment Systems.

Robinson stated we can go with the sampling and get out the timelines and expectations to everyone out there that are waiting.

Lindman replied we can do that on the website.

Force reiterated that we can be as transparent to the Public so they understand the issue and what we are doing about it.

Rosenberg stated she is working with a firm to communicate this out and in plain English.

No Action Taken.

10) Discussion on Future Meeting Dates and Times for Wausau Water Works Commission.

Robinson requested that the joint meeting mentioned be no earlier than 530pm.

Rosenberg stated she will send out a note to request that and stated we can align with evening times for future meeting times.

No Action Taken.

11) Adjourn.

There being no further business to discuss, motion to adjourn by Gehin. Seconded by Herbst.

Link to view meeting in its entirety: <https://tinyurl.com/wausaucitycouncil>

Gina Vang, Recording Secretary

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Minutes of March 8, 2022

A meeting of the Joint Wausau Water Works Commission & Finance Committee was called to order at 5:46 p.m. in City Hall on Tuesday, March 8th, 2022. In compliance with Wisconsin Statutes, this meeting was posted and receipted for by the Wausau Daily Herald on March 4th, 2022.

Members Present: President Rosenberg, Commissioners Herbst, Gehin, Force, Robinson
Finance Committee Members: Lisa Rasmussen, Michael Martens, Dawn Herbst, Sarah Watson via WebEx: Deb Ryan

Others Present: Eric Lindman, Scott Boers, Ben Brooks, Valerie Swanborg, Maryanne Groat, Toni Vanderbom, Tom Kilian, Becky McElhaney, Stephen Opatik/ Becher-Hoppe, Susan Wojtkiewicz/ Donohue, Mike Gerbitz/ Donohue

1) Discussion and Possible Action on Options for Potential Rapid Response Solutions and Long-Term Strategies to Address Perfluoroalkyl and Polyfluoroalkyl (PFAS) compounds in Wausau's Drinking Water and Funding for Same.

Rasmussen began that the Committee and Commission working together on issues of mutual interest is good because the Finance Committee has flexibility and latitude with certain fund sources to approve things faster than what the Commission can do using utility and rate payer revenue so we can work through some action plans and have the right combination for filter/treatment process of PFAS at the new plant when it opens. Both Water and Finance Committee support a pilot study research which is going to the Council tonight. We do need to look at something interim that they can employ separate from bottled water to reduce the level of PFAS. At the faucet level we are about a 30 ppt. The Department of Natural Resources (DNR) board adopted 70 ppt with the Environmental Protection Agency (EPA) but there is an expectation that the EPA may reduce the level but the further we are ahead of that requirement, the better position the utility will be to meet requirements.

Lindman started that staff has been asked to prepare potential scenarios for immediate/interim response to PFAS results in the drinking water: 1) Pilot Study 2) Purchasing/make available bottled water & filter pitchers for in-home use 3) Establish reverse osmosis filling stations around the city 4) Set up/deploy a large filtration system for all distributed water at the existing treatment facility but the cost and timing may present challenges.

Rasmussen stated that the Committee of the Whole had some interest in option 4 in attaching mobile units to the existing plant but the cost would be somewhere around \$2,000,000. We have to look at the cost to benefit analysis and where are we at as far as the logistics for this solution.

Lindman replied the biggest hurdles would be the timelines for approvals by the DNR and Public Service Commission (PSC) because those take about 3-4 months plus the timing for set ups. Donohue is here for specific questions. Approvals take a lot of time because when we start

touching the drinking water system, we start changing the water chemistry and we could have other problems potentially downstream like compromising the corrosion control, disinfection and other things that could cause an actual health risk to the public.

Rosenberg stated the importance of the downstream effects but in speaking with DNR, they have advised they could expedite the approval through the PSC and DNR on these rapid response strategies if needed but she didn't know exact timelines but anticipates that it would not be as long as 2 months.

Watson questioned if option 4 could be accelerated and what the timeline looked like with the estimation of 6 weeks for approval from the DNR.

Gerbitz replied that the ranges in the Memo from Donohue on Page 3 showed from 16-23 weeks which entailed authorization to commissioning. This was assuming best case scenarios with DNR/PSC process we have to work through. The blue bar is the procurement timeline from getting materials from the shop, piping and then installing. It doesn't mean that it would be 14 weeks but could be in the range of 16-23 weeks assuming the DNR/PSC doesn't slow it down.

Watson stated she is concerned about the chemistry testing because if we inject something into the drinking water that impacts corrosion control but brings up higher lead levels, then there's a bigger problem. She questioned if the 16-23 weeks or 4-6 months have a chem testing included or if it was just for approvals.

Gerbitz stated it was independent of the approvals. The blue bars are independent of any testing, it's the amount of time with the supply shortage. The 16 weeks estimates getting the material in contractors' hands and fabrication then it goes out in field to get it installed.

Rasmussen stated it was the most expensive option, people want a reasonable solution and much quicker option than that time frame.

Watson questioned if this would be for all the wells and if we need all the wells to run to feed all the utility customers?

Gerbitz replied it would be one system that goes into the front yard of the existing water treatment facility before it goes out into the water distribution system. It would be like a supplemental treatment before it goes out into the system.

Robinson questioned if the granular activated carbon (GAC) vessels were looked at and if this was for the vessels or media and why would it take 3-5 weeks.

Gerbitz stated we didn't look at the universe of strategies we are showing the ion exchange because the six vessels are sitting at the warehouse ready to go right now. If you decide tonight it would be 3-5 weeks largely for the piping. One contractor said they can get stainless steel piping in 8 weeks and a couple of weeks to fabricate it, another contractor said nickel went up 250% and there's a huge shortage, another contractor stated if you are in a hurry, rather than use stainless steel you could use carbon steel and coat the interior to satisfy the drinking water requirement. We weren't able to find any GAC in short order that was in stock ready to go.

Gehin wanted a description of how it would be connected at the plant, would we have enough flow or do we do bypass in the event of an emergency. Do we have to do any additional pilot?

Gerbitz replied the 3rd figure shows where it comes up and goes through the building. We do have 60 year old pipes, but the information suggests that those pumps would get the flow through these vessels in series because there would be less pressure loss. If the City moved forward with this, we suggest field testing of those pumps to look for the amp draws and performance at different back pressures. The probability looks good from a flow capacity standpoint. The maximum flow would be 6.8 million gallons a day.

Wojtkiewicz replied to Gehin's question and stated they've been working with the DNR and in an emergency they would approve ion exchange or GAC technology without pilot

testing.

Gerbitz clarified this was not the universe of temporary solutions but the thing driving the schedule is all the interconnections/piping and not the regulatory process. The construction is what's taking the time. The effort was to give you a realistic understanding and quickly procure for a 5-7 million gallon a day system. The cost given defines the brackets from ceiling to the floor but the cost could fall somewhere in between there.

Rosenberg stated if we could use the mobile GAC that stated they could roll in a week?

Gerbitz stated we could talk with them to see how they were going to connect it. We are working with Evoqua and 2 large contractors who gave us the 16-week timeframe.

Force questioned the status of the pilot study approved a week ago and if we did any tests at various taps regarding the 30 ppt? Do we know the PFAS levels coming out of our homes and business?

Gerbitz stated we were waiting on council approval but materials have been ordered. The folks providing the equipment are looking forward to providing material once we submit a Purchase Order (PO).

Wojtkiewicz added they have already submitted the pilot test protocol to DNR who provided review questions that her colleague was working on the answers this evening and should be expecting DNR approval this week. Will be getting initial results within a month of beginning the pilot, not final answer but will have information.

Lindman replied testing was done at the points where the finished water enters the distribution system after the treatment facility. We do not know the level of PFAS in homes/business but we are not losing PFAS out in the system anywhere.

Rasmussen stated if it leaves the plant at 30 then there's a reasonable assumption that it arrives at the house at 30. We could look at option 3- multiple reverse osmosis filling station around the city.

McElhaney stated the urgency to do something now, she's hearing from her residences that they don't believe the water is safe. Since the Water Advisory, she's gotten calls from residents she's never heard from. The landlord at the Job Center turned off all the water, how many businesses have turned off water and people are trying to find bottled water to take in for work. Someone went into a restaurant and was asked if they wanted poison water or soda. This is what's happening around the City. With the portable system we talked about a month ago, I didn't understand that, you did or didn't look at it?

Rasmussen stated that was what we were just talking about, the mobile filtration system that attaches to the existing water plant but that was the 16 weeks. It sounds like the residents are not willing to wait 4 months. They love that it's an equitable solution, but is there an array of options that we could put out more sooner?

Force stated it would be option 1- bottled water. His research was that other people had volunteers help load the water into the cars and had multiple pick up locations. If we are talking about spending \$1.5- \$2 million to wait 16 weeks to hook up, are we not better off expanding the bottled water effort and spending the money there?

Rasmussen stated that would be the question we are discussing but option 2- bottled water and filter pitcher on the memo would be an option and option 1 was for the pilot study in which we already approved but if the council approves that then its already in progress. If we want to skip to item 2 we could.

Waston wanted to hear option 3- multiple reverse osmosis filling stations within the city.

Lindman stated this is another option, we would be serving more than 25 individuals so we would need approval with DNR maybe not the PSC but challenges would be disinfection with these units, the reverse osmosis removes the disinfection from the water in the storage unit. The taps can also get infected as well, we also have installation time at various locations along

with ordering them and their availability.

Boers replied cost would be \$25-\$35 thousand per unit and would be between 30-60 days depending on what company and what they have available at the time of order.

Ryan stated she has been using the Berkey filter system. PFAS is priority but we still have a lot of Lead. She questioned if we have a definitive filter that is best to buy in bulk and give options to neighbors instead of lugging water around?

Rasmussen stated that Boers did some research but there are a lot of filtration devices. The question is if these filtration devices work because some that we see sold in the stores were more about the water tasting and not water quality, some filter certain substances but they don't all filter PFAS. This is the fastest option, but if there is a pitcher that works, is it something we could source? Starting with a smaller quantity and see the demand. Is there an item we could get 1500 and distribute those items, then place another order once we run low.

Boers replied he contacted 3 companies and proposed 1,000 per unit. 1) Berkey- which has a travel size of 1.5 gallon, for \$241/unit and could ship 250 units every 6-8 weeks. 2) Hydroviv- goes under the sink filter but only lasts 6 months, online price is a little over \$200, they would knock it down to \$105/unit for a 1,000 order and could deliver us 1000 in 30 days. 3) Aquasana- is a countertop unit which is good for 450 gallons and could sell us 1,000 for \$61/unit and could be delivered in 90 days.

Rosenberg stated she didn't like the idea of waiting 18-22 weeks to fix something and doesn't love the idea of people installing something in their home but questioned what are the needs, what do we want to spend and how quickly could we fix this?

Force stated he agreed we needed to move quickly and couldn't sit around. He advocated that bottled water be made available and in more places.

Watson stated she was disappointed of the 3 months wait time but would also like it to be more user friendly.

Rasmussen questioned if the Berkey really filtered both PFOA and PFOS?

Boers replied they sent certification for both PFOA and PFOS.

Rasmussen stated if we estimate 90 days with Aquasana, and under counter systems may be cumbersome for people to install, we are looking at \$105 thousand dollars approximately.

Robinson requested that we look at bottled water for an interim solution but asked if we could look at emergency management to see if there was a way we could access piping and vessels quicker for emergency situation where they may have the ability to accelerate the delivery of vessels and/or piping? He was concerned about in-home solutions because there are about 17 thousand housing units. If it were something under sink, would landlords let you in, would they have plumbers who know how to do it, let's see if emergency management could get us some assistance.

Kilian agreed that more bottled water is useful. There's a Drinking Water Advisory from the State, how many people would want bottled water. Regulators were able to intervene because there was no middle organization at those private wells but in this case it is the Commission so in action is not an option anymore, bottled water doesn't seem to work out mathematically but a portfolio with a mix and match may bring up some solutions of scale.

Rasmussen questioned if the Aquasana was a pitcher or a countertop unit?

Rosenberg replied countertop and it attaches through the sink.

Rasmussen questioned the concern last time was because it may not fit everyone's faucet properly. It seems to be a practical solution for those who are concerned. It would be easier if we had supply of filters that people could come down to City Hall to obtain. All of these units, have a slow delivery. We approved a purchase of bottled water up to \$13,200 from a water source that could get us pure water the fastest. This buys us about 2 months but it wouldn't give us enough time to roll out the Aquasana system. If you purchased 1000 Aquasanas that's

\$61,000, that's a reasonable price vs \$100-\$250 thousand. The plant is on schedule to open late Summer, if we have the right mix, we really have about a 5 month problem.

Watson questioned if GAC filters were investigated for their small sized pitchers.

Boers stated we didn't look at the single or short term use pitchers because there didn't seem to be much interest in those at the Committee of the Whole, typically pricing ranges around \$40-\$60 per unit.

Rasmussen stated stores in this area were out but she researched and discovered that most of the big store filters off the shelves don't filter PFAS. They are readily available at Steven's Point but not in Wausau. That weekend, she went to Sam's Club and every other cart had bottled water so there is a widespread concern. We need to address those concerns with an interim palatable solution. We don't have 4-6 months to do it and if we could do it for less than \$2 million all the better. She'd like to see an interim solution but not take 4-6 months to roll out and if there's an item we could distribute whether it be a countertop or a pitcher that would allay some of these fears between now and the opening date. The advisory is about consumption, it's not about laundry or showering, it's about drinking water. We want a practical solution that could come a little quicker.

Watson stated most of the options she sees are interim but not really rapid because rapid would be within 1-2 weeks. Maybe the rapid solution would be to have these filters for pick up or bottled water distribution. She questioned what could we do now?

Rasmussen replied stating the Finance Committee has money to spend but we need some type of movement on what people want to buy. If we are going to fund it with the rescue plan funding we have, we could approve that right now if somebody makes a motion to order 1,000 of something. Are we going to sit for 2 more weeks and wait? Indecision is where most of the frustration with the public is coming from and we know we can get the right mixture of filter media and strategy for the new plant but what we do in the meantime because people feel like we are doing a lot of talking and not a lot of acting.

Force questioned the funding for the bottled water because it seemed to come out from the contingency funding. Is that a fund within the City?

Rasmussen replied it was an Emergency Funding but we are talking about the American Rescue Plan Act (ARPA) Funding which is about \$15 million.

Force stated bottled water is super expensive but for the time being bottled water would make more sense if you wanted to do something within a few days but the Neighbor's place is only open 4 days a week.

Rasmussen stated we approved that order and could look at other avenues for distribution as well.

Force questioned what the budget was or the cost.

Rasmussen stated one of the American Rescue Plan approved uses is clean water projects and whether or not it includes emergency measures, we'd have to ask the Finance Director. Do we want to devote a substantial amount to this project not based on amount we received but if the solutions are between \$61,000-\$250,000, we have that kind of money, we don't want to cheap out on a solution, but we want one that is effective and reasonable that wouldn't break the bank and take long to implement?

Watson requested for more numbers and stated we couldn't keep kicking the can but we don't have enough information either. We could make a decision on spending \$2.5 million on it at the source but it wouldn't be done for another 4 months. Should we schedule another joint meeting for more clear-cut information being timeframe and money.

Rasmussen replied so option 3 of reverse osmosis, we are looking at \$35,000 per unit sold be deployed 30-60 days and how many units?

Lindman stated around 6 units. 3 on each side of river but people would have to bring their

own bottles to fill up.

Gehin questioned those reverse osmosis because we would need someone to man those due to cross contamination.

Lindman replied that the quick response would be the bottled water and then on the interim combining a couple different filters that remove PFAS and ordering from different companies but they would have to be on order, most of the companies are at least 30-60 days out before they are delivered.

Rasmussen stated that Finance is managing the cost of the solution but not designing the solution. As a Committee should we earmark a sum of money to be used on a combination of bottled water and filter solutions to get some of this off the ground.

Rosenberg replied that's a start.

Martens motioned to earmark \$60,000 to be used in any way for immediate mitigation of the PFAS via bottled water or Pitcher. Seconded by Watson.

Rasmussen summarized the motion to earmark/allocate \$60,000 from the ARPA funding to a combination of bottled water and filter devices and the mixture of which to be determined by the professional team.

Watson questioned if we could have a discussion monthly to revisit this because she'd actually like to up the amount.

Lindman requested if we could up the amount to \$150,000, he stated he was not sure what we could find and the availability for purchases but will try to keep it down as much as we could or we could bring an update back if you wanted.

Martens motioned to up the amount from \$60,000 to \$150,000. Seconded by Watson.

Herbst stated she got a chance to do research and found some pitchers with NSF53 filters and there were some really good ones. If we were going to do some combination that would be something to check into but stated she wasn't sure of the time frame for delivery either.

Rasmussen stated the sooner they can place the order and have the funds, the better.

Watson questioned if this could be placed on tonight's City Council Agenda.

Rosenberg stated we could have a special session to act on this.

Groat stated that the resolution for the bottled water for \$13,200 could be amended to change the financing source to ARPA and the dollar amount to \$150,000 to include not just bottled water but a mixture of filters too that could be accomplished tonight.

Rasmussen recapped the motion already seconded on the floor to allocate \$150,000 from the ARPA funding to a combination of solutions outlined in the memo of item 2 which includes in-home filter devices and bottled water. Finance Committee Passed with Motion 5-0.

Rasmussen questioned if the Water Committee needed to act since Finance is doing the funding.

Rosenberg stated if it's the ARPA Funding, we do not have jurisdiction over that.

Rasmussen stated now the money is there, we just need to figure out the ordering and the logistics.

Motion for Finance Committee to adjourn by Watson. Seconded by Herbst.

Motion for Wausau Water Works Committee to adjourn by Gehin. Seconded by Robinson.

Link to view meeting in its entirety: <https://tinyurl.com/wausaucitycouncil>

Gina Vang, Recording Secretary

S:\WaterWorks\Common\WaterCommission\2022\April\WWWC_20220308_Minutes.doc.



MEMORANDUM

TO: President Rosenberg
Commissioner Herbst
Commissioner Force
Commissioner Gehin
Commissioner Robinson

FROM: Eric Lindman, P.E.
Director of Public Works & Utilities

SUBJECT: Director's Report – March 2022

WATER DIVISION

1. Drinking Water Treatment Facility Update: See attached.
2. The scope of work for the Corrosion Control Treatment (CCT) Optimization Study has been submitted to the DNR for their review and approval. Approval is expected within the next week or so. The study is to be completed March 2023, a short timeline for completing this work.
3. The Lead Service Line Replacement Plan (LSLP) is currently in progress with the consultant reviewing the city's existing inventory and preparing concepts for improving inventory and methods for tracking LSL's as well as verifying LSL's. We are also working on a communication plan related to LSL's and are hoping to roll this out starting in early summer. Staff is also working with the attorney's office to bring forward a mandatory LSL replacement ordinance this summer for the commission to review and consider. The City did receive about \$577,000 in 2022 for LSL replacement funds.
4. Pilot Study – The pilot study was set up and initiated mid-March. The study is testing removal of PFAS from our existing water treatment facility and is also testing removal from water that is expected to be from the new treatment facility. Staff is working with our hired communication consultant to help prepare communications to the public regarding the pilot and other PFAS related matters/information. Attached is an update from our engineer consultant related to work that has been initiated since early February.

5. Solar Project – Clark Dietz has been working on landscape renderings and working to schedule additional Geotech work on property to the north. This geotech work will be test pits dug to determine types of buried debris and the potential depth of the debris. This information will need to be determined to estimate costs and determine feasibility of establishing an adequate foundation for the solar panels. Staff will also be meeting with the neighborhood group over the next couple of months to discuss the proposed solar array, options and possible landscape renderings. The neighborhood group has not been meeting in person and is expected to begin in-person meetings this spring.
6. The utility was on track to disconnect CW3 from the drinking water treatment facility and had an approved plan to discharge the water to the river through the city's storm sewer system. With the proposed PFAS rules this will no longer be an option and CW3 will need to continue to be run through the treatment facility. This is unfortunate because the utility will now need to keep the old concrete water line in place and operational under the river to transport water pumped from CW3 to the new treatment facility. We have also been deferring maintenance on this well and pumphouse anticipating taking it offline for potable water use. The strategy now is to work with GHD and the EPA to hopefully be able to shut this well down and no longer use it for the superfund site. As we move through this process and communicate with the EPA we will continue to update the Commission.
7. The City has received 1500 pitchers with distribution scheduled to start April 4th. 2700 more have been ordered and should be on their way. March 28th and 29th 23 pallets of water were distributed, totaling 1326 cases. More bottles of water are anticipated to arrive April 4th as well. Distribution information will be released once we have it.
8. A Water Distribution Maintainer recently turned in a 2 weeks' notice and we will now be down 2 Water Distribution Maintainers and 1 Water Operation Technician.

WASTEWATER DIVISION

1. The Wastewater Treatment Plant is on track to meet new permit limits.
2. One position remains vacant for the Wastewater Plant Operations Technician, and two positions vacant for the Collection Systems Technician, Sewer Maintainer. With snow removal yet taking precedence, the shortage of employees and everyday demands of the wastewater project have made maintenance on the collection system and wastewater plant slow down. With having only two CDL drivers on the collection system side it has made employee on call rotation difficult as well as completing day to day job task. Both Wastewater and Collection Systems are falling farther behind with daily scheduled maintenance. The Collection System Crew has been understaffed for the past two years, making it hard for current staff to keep up with daily task. The Wastewater crew is falling behind on their daily task due to the new systems being place in service and maintaining them. Due to the lack of knowledge of the equipment and the industry as a whole, it is taking much longer to train new hires and the quantity and quality of work suffers.

New Collection System employee Matt Stockman recently has passed his Class A driving test and will be starting on-call duties.

3. Collection System Technician (Sewer Maintainer): first round of advertising yielded only two applicants which neither met job description qualifications. Second round of advertising was recently extended and ends April 5, 2022. Staff are hopeful to receive qualified applicants.
4. Wastewater Plant Operations Technician requisition form and job description have been submitted to HR for review and final approval. Awaiting response from HR to proceed with advertising.
5. Summer Aide positions have been advertised for over a month now with no applicants received to date.
6. Industrial Park force main is scheduled to be cleaned on April 4, 2022.
7. Plant construction continues to progress day by day with new equipment start-ups occurring weekly.

Wausau Drinking Water Treatment Facility - Project Status

April 6, 2022

Drinking Water Treatment Facility

All major equipment and piping have been installed. Plumbing and chemical feed piping have been coated and are being insulated. Nearly all electrical wiring is installed, and the electrical contractor is working on pulling control wire, installing monitoring equipment and working with the system integrator to prepare for installation of their computer/control equipment.

Contractors are taking advantage of the snowmelt and have installed the outfall piping for the storm detention area.

The general contractor and mechanical subcontractor have been working for several months with suppliers, manufacturers, engineering team to address an issue with coating adhesion on the ductile iron pipe fittings. A remediation procedure has been developed where the contractors are removing the coating from each fitting while it remains in-place. The removal process consists of using a low-dust blast material (Sponge-Jet) to remove all coating. All equipment in the area is protected against dust and over blast. The work area is sealed off and under negative pressure. The contractor estimates blasting and re-coating should be complete in May. They have assured us the treatment facility will remain on schedule for an August substantial completion.

Administration Building and Garage

The administration building and garage are on schedule for mid-summer completion. Floor tile and ceiling tile are being installed, all the walls are painted, and contractors are working on completion of wiring, electrical and HVAC.

Well House Improvements

Improvements continue at several of the Well Houses. In addition to the required electrical and piping improvements, the City is taking advantage of the down time to have a contractor remove the well pumps at several locations and rehabilitate them.

Offsite Utility Modifications

Contractors are working on pipe connection work required to route the wells to the new facilities. This requires several street and intersection closures. We are working with contractors to notify affected residents and provide detour routing.

The project team (owner / engineers / contractor) continue to meet weekly to plan for equipment demonstration and coordinate with system integrators and computer-control programmers.

Laboratory in new water treatment facility



Treatment Facility – Anion Exchange tanks



Treatment Facility – ductile iron pipe fittings with coating removed



Treatment Facility – Fittings with new prime coat



Treatment Facility – piping and fittings in process of final coating



Stormwater detention area outfall piping



Well 10 bypass piping



Admin. Bldg. – waiting area tile flooring



Admin. Bldg. – Ceiling tile



City of Wausau Wausau Water Works

Professional Engineering Related to
PFAS Treatment and Removal from
Drinking Water



Qualifications

March 2022

**CDM
Smith**



330 East Kilbourn Avenue, Suite 1149
Milwaukee, WI 53202
Tel: 414-291-5100
Fax: 414-278-1251
cdmsmith.com

March 29, 2022

Mr. Eric Lindman, PE
Director of Public Works & Utilities
City of Wausau - Engineering
City Hall
407 Grant Street
Wausau, WI 54403

Subject: **Request for Engineering Professional Qualifications & Scope of Services - Professional Engineering Related to PFAS Treatment and Removal from Drinking Water**

Dear Mr. Lindman:

In 2020, Wausau Water Works (WWW) began construction of a new Drinking Water Treatment Facility that is expected to achieve substantial completion in August 2022, but that will mark the conclusion of just one phase of the work. That's because the facility's design did not take into account potential future regulatory requirements for PFAS. In January 2022, a voluntary test of drinking water by the City of Wausau revealed PFAS levels below the USEPA Advisory Level of 70 parts per trillion (ppt) but above the Wisconsin Department of Natural Resources/Department of Health Services (WDNR/DHS) recommended standard level of 20 ppt. While the WDNR Natural Resources Board has approved setting a Wisconsin drinking water standard to match the USEPA advisory level of 70 ppt at this time, the USEPA has indicated their intention of publishing a proposed PFAS drinking water standard this fall that is expected to have PFAS limits that are much lower than the current advisory level. In response, WWW now seeks to determine the best way to treat its water supply for PFAS. WWW has enlisted the same engineering firm that designed the new facility to conduct a proof-of-concept pilot study to assess PFAS removal/treatment strategies, but the utility seeks additional support from a consultant who can advise the engineering team and WWW on the best PFAS removal/treatment options moving forward provide guidance on additional testing and exploration of options that might be needed.

WWW needs the services of a consultant that has proven experience performing bench- and pilot-scale testing of a variety of PFAS treatment options; designing PFAS treatment systems involving a variety of proven treatment methods; and a demonstrated track record of successfully placing PFAS treatment systems into service. CDM Smith meets all of those requirements, and we stand at the ready to be your trusted partner in pursuit of a solution to remove the PFAS from your drinking water. We offer WWW the following benefits that we believe make us the right choice for this project:

Deep Understanding of PFAS Treatment Methods from Industry-Leading Researchers: CDM Smith has been on the front lines of PFAS research and treatment since 2007 when we began supporting European clients with groundwater projects. Today, our PFAS research continues led by our scientists in our Bellevue (WA) Research & Testing Laboratory where we've conducted dozens of PFAS treatability studies, including for some of our projects included in Section 2 of this Statement of Qualifications. Bench- and pilot-scale testing of various treatment methods is a key component of many of our PFAS projects, and we've helped several clients just like WWW identify the right solution for their unique needs. Much of that work has been led by **Dr. Charles Schaefer Jr.** and **Dung "Zoom" Nguyen**, who will support WWW's project.

Leadership You Know and Trust: Clear, open communication is critical to the success of any project, and that is especially true when it involves determining the right solution for drinking water contaminants. Your project will be guided by a leadership team of CDM Smith professionals who you know well from their ongoing work on the Lead Service Line Replacement Program and the Corrosion Control Treatment Study. **Matt Bednarski, PE, ENV SP; Amrou Atassi, PE, PMP,**





BCEE; and **Mark White, PE**, BCEE are involved in both of those projects. They have established relationships with your staff, know your systems, and understand your high expectations, and they will guide this project to a successful outcome.

A Proven Team will Develop and Implement WWW's PFAS Solution: While few firms nationwide have designed and implemented solutions for PFAS, CDM Smith has several successful projects on its resume. We will make sure WWW benefits from the proven practices and lessons learned from these projects by assigning our most experienced PFAS designers to your project. Project Technical Lead **Al LeBlanc, PE, BCEE**, has worked on more than 20 PFAS projects ranging in scope from studies and testing through design and construction; many of those projects have been done in collaboration with Project Engineer **Jihyon Im, PE**. Among their successes, they led the design effort for the 4-mgd Owen District Road PFAS treatment plant in Westfield, MA, which has been in service since August 2020 and treated more than 400 million gallons of water to date. They also played key roles in the design of two 2-mgd PFAS treatment facilities in Ayer, MA, one currently in operation and the other nearing completion of construction. Charles Schaefer and Zoom Nguyen performed the laboratory testing for all three of those facilities; Technical Advisor **Michael Zafer, PE**, provided technical review of the treatability study results and design documents; and Operations & Maintenance Specialist **Jason Maskaly** assisted in scheduling, startup, and equipment testing of the facilities.

CDM Smith is pleased to include the services of Clark Dietz to provide local resources and knowledge of Wausau's water system. With staff in downtown Wausau, just a few blocks from City Hall, they will provide local resources and boots on the ground to support this project. Our team also includes experienced PFAS researchers from the University of Wisconsin-Milwaukee in an advisory role. These researchers will provide insight into the state of emerging technologies related to PFAS treatment and destruction allowing the City and CDM Smith to stay abreast of the latest developments.

If you have any questions regarding this submittal or require more information, please don't hesitate to contact me at (414) 203-4004 or BednarskiMJ@cdmsmith.com. We look forward to the opportunity to work with you.

Very truly yours,

A handwritten signature in blue ink, appearing to read "Matthew J. Bednarski", with a stylized flourish at the end.

Matthew J. Bednarski, PE, ENV SP
Client Service Leader
CDM Smith Inc.



SECTION 1:

Firm Qualifications and Experience

The design of the new Drinking Water Treatment Facility for the Wausau Water Works (WWW) did not address potential coming regulatory requirements for control of per- and polyfluoroalkyl substances (PFAS). As construction of the new facility nears completion, WWW seeks to determine the best way to address the control of PFAS after a voluntary test of drinking water by the City of Wausau revealed PFAS levels below the USEPA Advisory Level of 70 parts per trillion (ppt) but above the Wisconsin Department of Natural Resources/ Department of Health Services (WDNR/DHS) recommended level of 20 ppt. WWW has enlisted the same engineering team that designed the new facility to conduct a proof-of-concept pilot study to assess PFAS removal/treatment strategies, but the utility seeks additional guidance.

Now, WWW wants to hire a consultant to advise that engineering team and WWW on the best PFAS removal/treatment options moving forward and provide guidance on additional testing and exploration of options that might be needed. There is no firm more qualified and capable than CDM Smith to assist WWW in achieving your PFAS study, design, and implementation needs. We've been on the front lines of PFAS research and treatment since 2007. **From sampling and bench- and pilot-scale evaluations, to the design, construction, and start-up of proven PFAS treatment solutions, CDM Smith is the industry leader in PFAS treatment. We have unmatched experience in applying all the technologies available today, and we're leading the way in developing the next generation of treatment and PFAS destruction. Our capabilities align perfectly with WWW's needs today and in the years ahead. We're ready to go to work for you.**

CDM Smith: Bringing Local Service and National Expertise to Wausau

CDM Smith is a leading provider of services related to water and wastewater, biosolids, environment, transportation, energy, and facilities, with a history of serving both large and small municipalities and utilities in Wisconsin, throughout the upper Midwest, and across the United States. At CDM Smith, we are committed to building strong and lasting relationships with our clients and each other. We work together—in teams and in partnerships with our clients—to solve complex environmental and infrastructure challenges. Together, we provide smart, integrated solutions and are committed to doing what is right for our clients, our communities, each other, and the future. We remain fully committed to our corporate philosophy to **listen. think. deliver.**—and to provide exceptional client service, quality results, and enduring value for each client on every project. Founded in 1947, CDM Smith is an employee-owned global consulting, engineering, construction, and operations firm with annual revenues of more than \$1.8 billion. We currently employ more than 5,000 specialized personnel in more than 125 offices in the United States and abroad. This includes more than 150 professionals in our nearby Milwaukee, Chicago, and St. Paul, MN, offices that provide local service to Wausau. Such robust



resources allow CDM Smith to respond decisively and effectively to our clients, and to take on a wide range of projects. While our services have diversified since our founding 75 years ago, we began as a water and wastewater engineering services firm and those remain at the core of our business today.

Unparalleled Upper Midwest Water Experience

CDM Smith has helped 44 clients in the upper Midwest create and enhance high-quality, reliable water supplies that last for decades, cementing our understanding of water conditions throughout the region. WWW's PFAS project requires an understanding of the challenges and characteristics of the water source, and a team with particular expertise in the treatment, transmission, and supply of local water sources is critical. CDM Smith has extensive water system experience throughout the upper Midwest. This unique expertise and familiarity was gained by performing nearly 100 planning and design projects.

Long-Standing Relationship with Wisconsin Department of Natural Resources (WDNR) and other Regulators

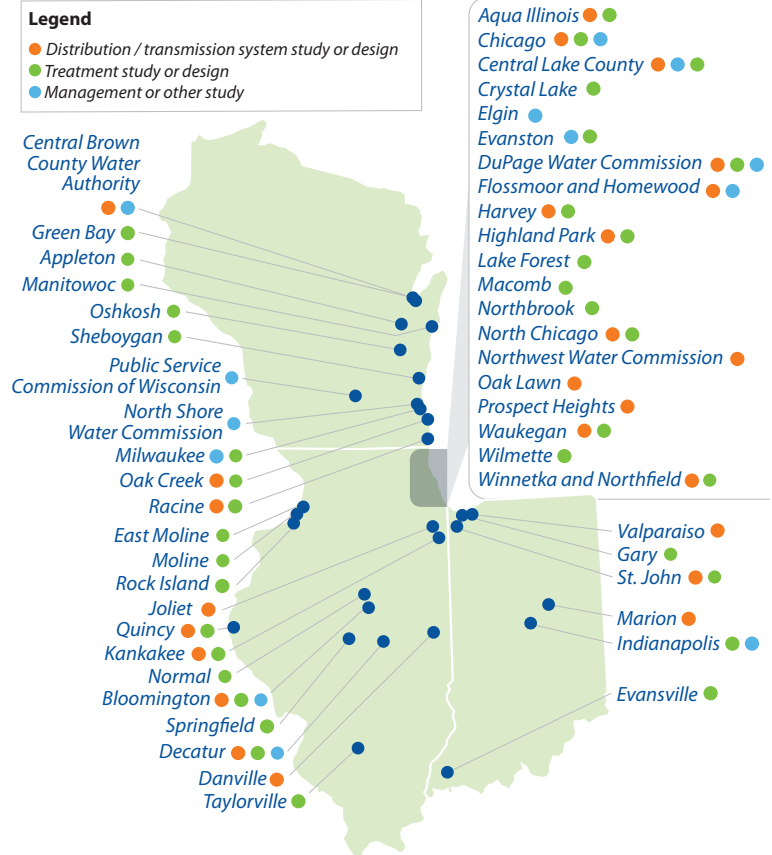
We have a long-standing relationship with WDNR through numerous Wisconsin water plant projects over the past 20 years, including Sheboygan, Racine, Oshkosh, Green Bay, Oak Creek, and others. CDM Smith saves time and minimizes extra and unforeseen costs by collaborating with WDNR to gain support and approval at the outset of any project. Early communication with WDNR has proven essential to various innovative, trend-setting Wisconsin projects. Our designated project task leads have developed working relationships with WDNR staff by initiating discussions early on in the project schedule for WDNR engagement, inclusion during technical review committees, and ultimately project buy-in. Our experience with state regulators like WDNR, as well as federal regulators including USEPA, is a key component of nearly every water and wastewater treatment facility improvements project we perform. Our close, long-standing relationships with these regulators have allowed us to successfully design and implement numerous treatment facilities statewide.

CDM Smith: Leading the Way on PFAS Treatment

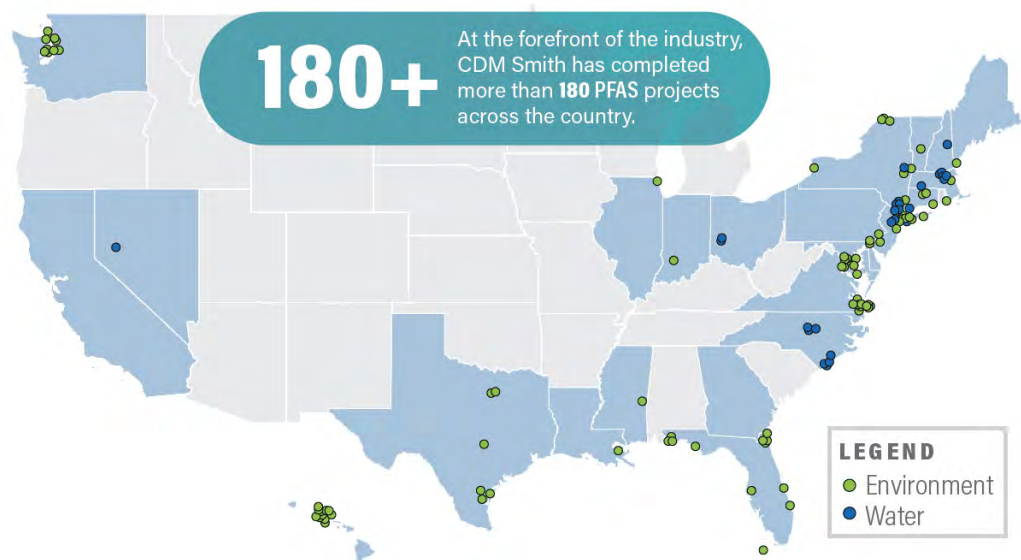
When it comes to innovative treatment of emerging contaminants—and PFAS in particular—CDM Smith is the industry leader and stands at the forefront of the issue. **CDM Smith has been on the front lines of researching and treating PFAS since 2007, when we began supporting European clients with PFAS contaminated groundwater projects. Since then, we have matured our practice and have completed hundreds of PFAS projects around the globe.** We provide the full spectrum of services related to PFAS work, including sampling and analysis, bench- and pilot-scale testing, full-scale design and construction, exposure pathway assessments, risk communications, and education.

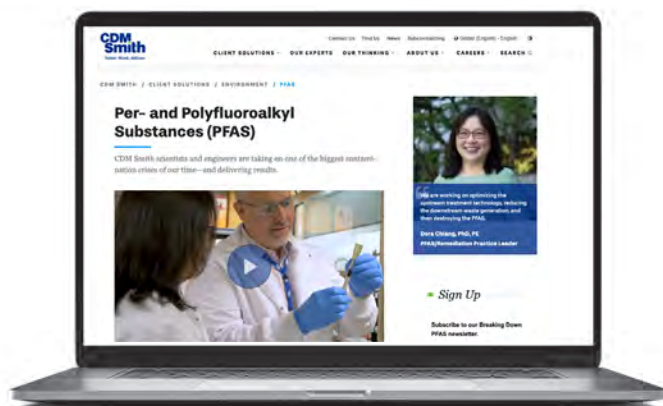
From Filtration to PFAS: An Innovative Water Treatment Solutions Firm

The design and engineering of water treatment plants and the improvement of drinking water quality has been the cornerstone of CDM Smith's practice since the firm's founding in 1947. For more than seven decades, CDM Smith has designed new water treatment plants (WTPs) and facility improvements to municipal and private clients throughout the United States and worldwide.



In fact, our firm's roots are in drinking water solutions, and we've built our reputation as drinking water treatment innovators. From the pioneering of technologies such as dual-media filters and direct filtration, to the design and construction oversight of the first major municipal dissolved air flotation (DAF) installation in New England followed by the largest municipal installation in New Jersey, to the study, design, and implementation of treatment solutions for PFAS, we continue to innovate, evolve, and deliver solutions that help our clients meet the needs of the communities they serve.





Troubled Waters: The Fight Against PFAS

CDM Smith has been on the front lines of researching and treating PFAS since 2007, when we began supporting European clients with groundwater projects. Since then, we've matured our practice and have completed hundreds of PFAS projects around the globe. We provide the full spectrum of services related to PFAS work, including sampling and analysis, exposure pathway assessments, risk communications and education, bench/pilot-scale testing, full-scale design and construction.

<https://www.cdmsmith.com/en/Video/PFAS-Documentary>

PFAS Bench- and Pilot-Scale Evaluations

At CDM Smith, we understand the challenges of managing PFAS issues for state, federal, municipal, and private industrial clients. While uncertainties associated with toxicity, treatment technologies, and risk communications exist, CDM Smith is at the forefront of this emerging issue.

Clients have access to CDM Smith's three internal laboratory facilities with the necessary equipment and experienced staff to complete treatability studies and advanced Research and Development (R&D) activities, including evaluating and developing PFAS treatment technologies. We can build pilot treatment plants to meet your exact needs at our fabrication facility or through our trusted network of subcontractors.

Our Bellevue (WA) Research and Testing Laboratory is a 2,500-square-foot facility that is fully equipped to customize PFAS treatability studies, jar testing, and R&D for various technologies. The laboratory is actively leading numerous state-of-the-art research and pre-design studies for PFAS. It is uniquely managed by water treatment process and environmental remediation experts. The synergy of crossing water and environmental practices allows us to identify treatment options and expand our understanding of this complex group of chemicals. This facility is complemented by our laboratories in Denver, CO, and Chelmsford, MA.

We are currently evaluating the performance of commercially available PFAS treatment technologies and/or testing the

potential full-scale applicability of developing technologies to tailor a treatment program to a client's needs. This includes more than 30 projects related to characterizing and treating PFAS in groundwater and more than a half-dozen related to treating PFAS in drinking water. Notably, our laboratory has learned that rapid small-scale column test (RSSCT) studies are effective for determining PFAS treatability and breakthroughs using AIX resin and GAC, and we've deployed RSSCT studies to determine PFAS treatability on more than 35 projects for municipal clients.



These studies can provide significant value to projects, including assessing the efficacy of commercially available PFAS treatment technologies; independently evaluating vendor claims or comparing competing vendor processes; demonstrating the applicability and efficacy of treating PFAS to levels below specific treatment level goals; evaluating the impacts of site-specific water composition on PFAS removal efficacy; and assisting with cost/benefit analysis, technology selection, and determination of design parameters. A significant benefit of the laboratory PFAS treatability studies is the rapid results that can be cost-effectively obtained, compared to utilizing only pilot-scale tests, which can take a year or longer to obtain useful data.

Additionally, 18 Department of Defense (DoD) Strategic Environmental Research and Development Program (SERDP) projects evaluating PFAS environmental fate and transport or treatment have been executed in our laboratory or by our laboratory leadership in the past 5 years. Two Water Research Foundation projects on PFAS in drinking water (WRF 4913: Investigation of Treatment Alternatives for Short-Chain Poly and Perfluoroalkyl Substances) and wastewater (WRF 5042: Assessing Poly- and Perfluoroalkyl Substance Release from Finished Biosolids) are running bench experiments executed in our laboratory.

Water Treatment Process and Engineering Design

For 75 years, clients have relied on CDM Smith to deliver water treatment engineering and construction services, drawing upon our experience, knowledge and capacity for conceptual and detailed design through construction, from small pilot-scale systems to large water treatment facilities. With comprehensive multidisciplinary design expertise in architectural, civil,

structural, geotechnical, environmental, electrical/mechanical engineering, and chemical/treatment processes, we provide clients a sole point of responsibility for design, construction, and project risk management. Our team has designed and implemented new and/or upgraded facilities employing all treatment methods, including for the removal of PFAS from drinking water.

In 2018, we designed the new 4-mgd Owen District Road WTP, in Westfield, MA, a groundwater treatment plant that contains a granular activated carbon (GAC) system to treat PFAS. Construction of that facility is complete, and the facility is now fully operational. Since then, we've completed or are currently designing multiple other PFAS treatment systems. We completed the final design of an anion exchange (AIX) treatment addition to the 2-mgd Grove Pond WTP in Ayer, MA; construction of the \$3.1 million project concluded, and the facility was placed online in fall 2020. Our team also performed bench-scale testing and then developed the detailed, final design of a GAC treatment upgrade at Ayer's second 2-mgd facility, the Spectacle Pond WTP. Construction of this \$5.1 million project is ongoing. Additionally, we recently completed the design and bidding of the Northwest WTP Expansion and Upgrades project in Brunswick County, NC, which will expand the facility to 48 mgd and provide advanced treatment for removal of many contaminants, including PFAS, via low-pressure reverse osmosis (LPRO). Construction of the project will complete in 2023, at which time the facility will be the third-largest RO system in the US. We are also currently in the design phase of the design-build of ion exchange (IX) PFAS treatment facilities at nine groundwater sites with a total of 14 wells for Anaheim (CA) Public Utilities.

Experience with Proven Technologies and Emerging Technologies for PFAS Treatment/Removal

Like any other emerging contaminants, uncertainties exist associated with analysis, fate and transport, and treatment technologies. The lack of science-based knowledge is one major barrier to communicating the risks to the public, yet proper communication is the key to addressing PFAS-related issues.

CDM Smith is at the forefront of these emerging issues, and we have been actively participating in more than 20

cross-agency funded critical research projects on PFAS.

Our thought leadership has overarching goals to address the challenges of PFAS, including developing high-quality communications, and providing technical solutions that are highly efficient, sustain-able and accountable for characterizing and treating PFAS. Our work also includes in-depth research, testing, and implementation of several PFAS removal technologies, including GAC and AIX.

Technology Summary and CDM Smith's Cost Comparison Model

A summary of the three most common alternatives for PFAS removal and their strengths and weaknesses is provided in the table below.

PFAS Removal in Wastewater and Biosolids (Class A or Class B)

In recent years, biosolids management has become increasingly challenging due to more stringent regulatory requirements, increased public concern regarding biosolids management practices, reduced regional outlets available for disposal or biosolids reuse, and the required capital investment to replace solids processing facilities. The increased scrutiny of contaminants of emerging concern, such as PFAS, further amplifies the challenging task of biosolids beneficial reuse and management.

Our team provides WWW with an unmatched understanding of these critical market issues, the history and capabilities of the existing WWW solids management systems as well as the potential technologies and approaches available to overcome these challenges. CDM Smith's industry-leading residuals experts have a proven record of foresight and successful implementation of proactive approaches to shaping reliable, sustainable, and cost-effective solids management approaches for our clients.

We have decades of experience working on multiple major biosolid projects, many of which have helped utilities move from sludge landfill and disposal methods to various forms of biosolids treatment and beneficial use, and transformed the view of sludge as a waste product sent to disposal to a biosolids end product with commercial and ecological value. This first-hand experience and appreciation of how the sludge/

Characteristic	GAC	IX	Nanofiltration / Reverse Osmosis
Effectiveness in removing long-chain PFAS	Highly effective	Highly effective	Highly effective
Effectiveness in removing short-chain PFAS and GenX	Mixed information	Mixed information / Possibly better than GAC	Highly effective
Commonly used for PFAS removal	Highest	High	Low
Capital Cost	\$\$	\$\$	\$\$\$
Building size required	Large	Medium	Small
Operating Cost	\$\$	\$\$	\$\$\$
Disposal liquid needs	Only with new carbon	Only with new resin	Consistent brine waste stream
Disposal media waste	Yes	Yes	No

Assessing PFAS Release from Finished Biosolids (WRF #5042)

Public and regulatory scrutiny into the emission of PFAS into the environment continues to increase, and it is clear that there is a critical need to quantify the PFAS associated with the land application of biosolids as well as characterize release and transformation mechanisms in the interest of optimized solids management at WRRFs. This project, which took place from 2019-2021, endeavored to reconcile this research gap through quantification of PFAS release and transformation from batch desorption tests as well as mesocosm leaching experiments with biosolids sourced from seven WRRFs with variable solids management strategies. The guidance provided in the WRF #5042 Draft Final Report, drafted by CDM Smith in conjunction with Purdue University and the North East Biosolids and Residuals Association, underscores the importance of quantification of precursors in biosolids and their role in continued PFAA release.

To elucidate mechanisms and quantify release of PFAS from biosolids originating from WRRFs, batch laboratory desorption tests were coupled with mesocosm soil leaching experiments conducted outdoors under natural weathering conditions. The batch desorption experiments assessed the relationship between PFAS concentrations in the biosolids and the extent of PFAS release as well as any potential impacts of organic colloids on the PFAS apparent aqueous solubility and release. The mesocosm leaching experiments assessed the impacts of natural aging/weathering on biosolids breakdown, precursor transformation, and PFAS sequestration over a period of six months. Collation of these datasets were used to develop guidance for utilities on the role of biosolids processing on PFAS release, how precursor transformation impacts long-term PFAA leaching, and the extent to which PFAS release from biosolids can be expected to be sustained at detectable levels.

The study's results demonstrated that PFAS were present in all biosolids samples tested. The important role of precursor compounds and their contribution to sustained PFAS release, even after PFAAs detected in the original biosolids samples had eluted, is of key importance in understanding the long-term leaching behavior from biosolids. This current research increases understanding of trends and mechanisms for PFAS release from biosolids and biosolids-sand mixtures. The results of this research provide values that serve as inputs into established fate and transport models that can be used to understand and enumerate any potential risks to groundwater from PFAS applied to soils in biosolids.

biosolids market has changed over the past 25 years provides both knowledge and perspective as we help clients consider the potential near-term and long-term impacts of new PFAS regulations on biosolids management practices. Our hands-on work in this area includes a groundbreaking collaboration with the North East Biosolids & Residuals Association (NEBRA), the Water Environment Federation (WEF), and the National Association of Clean Water Agencies (NACWA) to conduct a cost analysis of the impacts of PFAS policies and regulations on municipal utilities and biosolids management entities. The end goal of the work was to produce informative materials to share with federal, state, and local legislators, regulators, government officials, and the public to inform PFAS policy decisions and identify unintended consequences.

Experience in the Field of Fate and Transport of PFAS

Fingerprinting is one of the most important tools of any good forensic scientist, but only with enough data. When it comes to PFAS, uncertainties abound, complicating this delicate detective work. The explosion of PFAS testing and sampling in the past several years has led to increased urgency around source identification. Our technical teams have been fielding more questions around this topic than ever before, with some common themes emerging:

- Where do PFAS come from?
- Can they come from multiple sources?
- Who should be responsible for removing them?
- How long have PFAS existed in our community?

- I don't live near any factories; why are the PFAS levels in my community so high?

Borrowing from the field of forensics, environmental scientists have the ability to identify contamination events and determine their origins. It is useful in both remediation and litigation and involves all aspects of site characterization. Not surprisingly, fingerprinting, one of the most widely known tools in a forensics toolkit, has become increasingly relevant to the study of PFAS.

There are more than 4,000 PFAS globally, a seemingly insurmountable data set for any detective following contamination trails. To make matters worse, by the time communities report a positive identification of PFAS in mixed-use plumes, separation and identification becomes time consuming and potentially cost-prohibitive. Fortunately, sophisticated techniques like machine-learning and ever-expanding libraries of data have enabled environmental scientists to trace contaminants like never before.

As with any valid fingerprinting approach, there must be a comparison or suite of chemicals to evaluate against. When fingerprinting petroleum or petrochemicals, which are the most documented, petroleum sources, formulation, refining, alterations and degradations each play a key role in selecting a reliable forensic strategy that reflects complexities in the field. In the world of PFAS, however, simply identifying the best comparison suite can be a significant endeavor on its own.

Large, publicly available datasets, like California's GeoTracker, can help isolate relevant comparison groups. Geotracker is the

Occurrence of PFAS Compounds in US WWTPs Study (WRF #5031)

CDM Smith is leading this important research effort into the formation and treatment of PFAS to acquire comprehensive quantitative data that may help utilities to manage the compounds and their surrounding regulatory climate. Release of PFAS to the environment from water resource recovery facilities (WRRFs) is poorly understood and potentially significant. Existing studies are limited in scope. Our team is developing a dataset which will provide the scientific justification to develop appropriate regulations, benchmarks for typical PFAS mass flows from WRRFs, sampling procedures, analytical methods, and potential mitigation strategies specific to WWTP unit processes.

PFAS are ubiquitously present in wastewater due to some combination of industrial input, leaching from household products, or occurrence in human waste, but our understanding of their behavior in WRRFs is limited. The most commonly studied and regulated PFASs are perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), which have been linked to several health problems. There are thousands of other PFAS compounds, but very little is known about their toxicity. There is insufficient data on the mechanism by which polyfluorinated compounds (PFAA precursors) transform into perfluoroalkyl acids (PFAAs), which are generally recalcitrant in the environment. The fate of PFASs after sorption to biosolids is also not fully understood. This critical study aims to fill these and other knowledge gaps.

Project work has been divided into tasks:

Tasks 1 and 2: Assessing the occurrence of a wide range of PFAS (32 target analytes and 325 precursors) and their fate in solid and liquid streams by conducting a literature review and a survey of PFAS occurrence in US WRRFs

Task 3: Applying statistical tools to identify potential geographical or seasonal variables that impact wastewater treatment plant (WWTP) susceptibility to PFAS

Task 4: Determining the impacts of various treatment processes, including advanced treatment processes, on PFAS fate and partitioning, particularly PFAA precursor transformation

Task 5: Identifying key elements or data gaps in PFAS occurrence in fate in WWTPs to develop guidelines and mitigation / management strategies for PFAS

Through this process, CDM Smith and our many co-collaborators on this project hope to characterize the formation, transport, treatment, and fate of PFAS and PFAA precursors so that any hazards to human health and the environment may be identified and addressed.

state's data management system for sites that impact groundwater or have the potential to impact groundwater. At CDM Smith, our scientists and engineers have been working behind the scenes to build a robust and accurate PFAS metadata library by combining tools like GeoTracker with machine learning. Machine learning is a subcategory of artificial intelligence that enables computers to "learn" from large datasets and improve from experience without having to be specifically programmed. The models and tools developed using this approach can provide predictive analytics and support decision-making for site management of mixed contaminants.

In addition to active research initiatives conducted at CDM Smith laboratories, we have a number of ongoing projects in the field focused on the intersection of PFAS and AI.

Water Distribution System Water Quality and Corrosion Control Optimization

CDM Smith's expertise in distribution system water quality issues, allow water utilities to measure, predict, and model water quality—all with the goal of providing water of consistently high quality to customers. The firm is a recognized leader in the full range of distribution system water quality issues, including simultaneous compliance, corrosion control, control of disinfectants and disinfection byproducts, microbiological quality, other inorganics, synthetic organics, and aesthetic parameters, as well as on-line monitoring, distribution system security, and cross connection control. CDM Smith can compare current distribution system operation and maintenance (O&M) practices against best practices employed around the country, as well as emerging research, to develop and/or revise standard operating procedures (SOPs) for improved control of distribution system water quality. For example:

CDM Smith has assisted dozens of clients in regulatory compliance under the lead and copper rule (LCR), the total coliform rule (TCR), and disinfection byproduct rules, including assisting utilities plan for the Initial Distribution System Evaluation (IDSE) requirement of the Stage II DBP Rule. CDM Smith's compliance assistance to clients has entailed both treatment and distribution operations strategies.

CDM Smith was selected by the American Water Works Association (AWWA) to assist in technical support efforts to provide input into the United States Environmental Protection Agency's (USEPA) revisions to the TCR and in development of a future Distribution System Rule.

We are providing technical support to Water Research Foundation (WRF) projects related to distribution system contamination and distribution system monitoring.

We have actively participated in AWWA's national Distribution System Water Quality Committee for many years, advocating increased attention to special water quality considerations of consecutive systems.

Leadership in Corrosion Control

CDM Smith is a leader in conducting corrosion control studies and making recommendations to optimize corrosion control programs, while maintaining compliance with all other drinking water standards.

We also have expertise in wastewater nutrient removal, which will help us understand the ramifications of potential changes in alkalinity and corrosion control chemicals. We have completed corrosion control studies, as well as varied water quality system evaluations for some of the largest utilities across the nation.

Developing Corrosion Control Solutions

CDM Smith has led multiple research projects under the WRF with Technical Advisor Amrou Atassi serving as co-principal investigator and co-author. Amrou's research includes bench-scale testing, pipe loop installation for multiple water utilities, and harvested pipe analyses.

WRF 4317: Non-Intrusive Methodology for Assessing Lead and Copper Corrosion

This project developed and tested a portable corrosion monitoring rig that aimed to produce more consistent results compared to household sampling for lead and copper corrosion from lead, copper, leaded solder, and leaded brass.

This was the first project that tested pipe loops at various points in the distribution to evaluate water quality changes in the system. CDM Smith partnered with five utilities, including Racine (WI) Water Utility; Indianapolis, IN; Cincinnati, OH; Providence, RI; and Northern Kentucky Water District, KY; on this project.

WRF 4103: Comparison of Zinc Versus Non-Zinc Corrosion Control for Lead and Copper

This project used bench-scale tests with metal coupons to measure the impact of pH, orthophosphate dose and chloride to sulfate mass ratio on lead and copper release. The second stage installed pipe loops in five water utilities to compare the effectiveness of a constant dosage of orthophosphate with varying levels of zinc.

WRF 4033: Impact of Phosphate Corrosion Inhibitors on Cement-Based Pipes and Linings

This project used bench-scale tests, harvested pipe scale analysis, and detailed surveys of utilities' water chemistries and pipe failures in order to determine how water quality impacted cement-based pipes and linings. Both phosphate and silicate corrosion inhibitors were included in the study.

Experience Using Chloramines to Disinfect Drinking Water, and Other Disinfection Methods

CDM Smith has designed and provided other engineering services for chloramination all across the United States. CDM Smith has designed dozens of chloramination systems for water treatment facilities including numerous systems with each of the two primary applications – liquid storage as Aqua ammonia, and gas storage as Anhydrous ammonia. Chloramine has numerous advantages, such as minimal additional formation of disinfection by-products after the chloramines are formed, but chloramines also have numerous

disadvantages, such as being a weaker disinfectant with potential for nitrification. We typically list nine advantages and 12 disadvantages in a study for any utility considering the major change of chloramination. We have assisted many utilities with the public notification that is required prior to chloramination due primarily to impacts to fish and dialysis patients. CDM Smith professionals have authored related papers for State and National AWWA conferences such as "UV and Chloramination Design" and "Chloramination – Rules and Guidance – Variations from State to State." These papers explain the detailed design issues, operations issues, and also the regulatory issues of chloramination.

Beyond chloramines, CDM Smith is experienced in all forms of disinfection treatment design. From conventional treatment methods, to ultraviolet, ozone, chlorine dioxide and beyond, CDM Smith's engineers cover the full spectrum of disinfection treatment technologies. We help our clients determine which disinfection methods will work best to meet their needs, and design solutions that are cost-effective and implementable.

The Current State of Practice: PFAS Waste Management

For PFAS systems that utilize GAC, once breakthrough occurs after the GAC's PFAS adsorption capacity is exhausted, GAC is removed, taken off site, and either thermally destroyed or reactivated. Therefore, overall GAC is advantageous in its low waste production compared to other PFAS treatment strategies. CDM Smith has worked with clients to procure the removal, transport, thermal destruction, and reactivation of granular activated carbon.

The fate of the spent resin IX is more unclear than spent GAC as resin manufacturers do not provide off-site regeneration for reuse or disposal, which puts the disposal responsibility on the owner. Single-use anion exchange resin for PFAS removal cannot be re-used, and to date regenerable anion exchange resins for PFAS removal rely upon regenerants (such as methanol) which are not suitable for use in a potable water application. CDM Smith is actively working with clients to make arrangements for the removal, disposal, and replacement of spent anion exchange resin.

Membrane separation technologies such as nanofiltration (NF) and reverse osmosis (RO) generate a continuous waste stream containing high concentrations of reject contaminants, and the management and treatment of the waste stream must be addressed in design. This inevitably involves permitting the discharge to a nearby receiving water, to a publicly owned treatment works (POTW), or directing the concentrated flow to on-site GAC treatment, with the GAC ultimately requiring destruction or reactivation. CDM Smith has successfully permitted RO concentrate discharge at a 41-mgd water treatment plant in North Carolina and has worked with clients elsewhere to treat or properly dispose of RO concentrate.

Developing the Future of PFAS Management: Concentration and Destruction

CDM Smith is actively researching and developing the next generation of PFAS management technologies and practices. The end goal is a more sustainable future, wherein PFAS is captured, concentrated, and destroyed at the water treatment plant. This future vision is the focus of our efforts for the good of the industry. The goal is that these types of forward-looking R&D efforts, both at CDM Smith and at the University of Wisconsin-Milwaukee, will one day be applied at drinking water treatment plants as the new standard of practice.

Only the most aggressive and energy-intensive technologies are capable of breaking down PFAS. Therefore, cost-efficient treatment options for large volumes of contaminated water rely on coupling technologies that first separate and concentrate PFAS to reduce the volumes and make destructive treatment technologies viable.

Today, destruction technologies like electrochemical oxidation (ECO) and plasma have demonstrated abilities to breakdown the stubborn carbon-fluorine bonds, the strongest in chemistry, at the heart of all PFAS. Recirculating PFAS in the environment from one media to another draws significant concern worldwide, as we risk re-releasing it back into our environment.

Therefore, destruction is a critical step in solving the global PFAS crisis. To make destruction feasible, though, the entire treatment train must be optimized for maximum efficiency.

Separate and Concentrate

In addition to conventional methods like GAC and AIX to reverse osmosis and beyond, our researchers have been rigorously testing new ways to separate and concentrate PFAS molecules, exploiting their affinity for air-water interfaces. One of these technologies relies on using air bubbles to “strip” PFAS out of water and into foams, which are condensed to generate hyper-concentrated PFAS solutions.

Concentration is a critical step in the destruction treatment train because it drastically reduces the volume of PFAS-laden effluent on its way to destruction. Together with EPOC Enviro, CDM Smith has been rigorously testing surface-active foam fractionation (SAFF®), which has been demonstrated to concentrate PFAS molecules up to 42,000 times with ongoing development to achieve concentration factors closer to one million times.

Destroy

There are numerous PFAS destruction technologies under development. Promising ex-situ destruction technologies that have progressed from bench- to pilot-scale include

Over the last five years alone, CDM Smith has been actively participating in nearly fifty critical research projects on PFAS in the water and environment sectors. Our thought leadership has overarching goals to help address the challenges of PFAS for our clients and our communities, including developing high-quality communications, and providing technical solution that are efficient, sustainable, and accountable for characterizing, treating, and destroying PFAS. Our first-hand knowledge, project experience and exceptional staff will help you understand the complex PFAS issues in biosolids and lead you to appropriate decisions. Recent projects particularly applicable to the SESD Facilities Planning Project include:

- WRF-5031: Occurrence of PFAS in US Wastewater Treatment Plants (ongoing).
- WRF-5042: Assessing Per and Polyfluoroalkyl Substance Release from Finished Biosolids (October 2021).
- WRF-5082: Investigation of Alternative Management Strategies to prevent PFAS from Entering Drinking Water Supplies and Wastewater Influent (ongoing)
- NEBRA/WEF/NACWA: Cost Analysis of the Impacts on Municipal Utilities and Biosolids Management to Address PFAS Contamination (October 2020).
- Nantucket, MA: Island-Wide PFAS Assessment, WW Sampling program, and Sludge Technology evaluation. (ongoing).
- California Association of Sanitations Agencies (CASA) PFAS data evaluation for wastewater utilities across the state (ongoing).



Lysimeter testing PFAS Leachability from soil to groundwater.



Precursor transformation study.

electrochemical oxidation, plasma and UV reductive, hydrothermal, and supercritical water oxidation. These approaches have successfully degraded an array of high-concentration PFAS at the laboratory scale. However, not all are sufficiently mature yet to assess PFAS treatment costs and overall effectiveness with confidence at the field scale.

Because they are energy intensive, it is important to selectively employ currently available destruction technologies on highly-concentrated, low-volume targets.

Electrochemical Oxidation (ECO)

Our researchers have proven electrochemical oxidation (ECO) to reduce high-concentration PFAS effectively, typically achieving reductions of 90-99.999% in laboratory studies.

ECO uses an electrochemical cell to generate an electric current between a reactive anode and cathode (the electrodes). The process degrades PFAS through two mechanisms:

- Anodic oxidation (direct electrolysis) – PFAS adsorb onto an anode surface and are destroyed directly at the electrode by a direct electron transfer reaction.
- Indirect oxidation – Strong oxidizing and nonselective radicals (such as hydroxyl, oxygen, sulfate and carbonate) are generated in-situ that react with, and break down, PFAS in the bulk liquid reactions.

The ECO process breaks down PFAS, transforming it from a hazardous material into carbon dioxide, water and fluoride. In general, the direct electron transfer pathway is considered critical for oxidation of PFAAs, such as PFOA, PFOS, and perfluorobutane sulfonic acid (PFBS), while hydroxyl radical oxidation can break down AFFF and PFAS precursors.

Choosing a Destruction Approach

Because of the emerging market for destructive PFAS technologies, they are often promoted hastily without demonstrating complete defluorination and without confidence the technology can meet stringent effluent discharge requirements. The feasibility of these technologies must be carefully considered for each new application. To effectively develop a treatment train approach, technology compatibility, engineering constraints, and operations and maintenance requirements must be considered. A thoughtful approach will ensure the system can meet required treatment volumes, rates, and discharge criteria.

CDM Smith's approach to assessing PFAS destructive technologies at a site includes treatability testing at the bench-, pilot-, and full-scale levels, using three lines of evidence to confirm complete PFAS destruction. Our collaboration with universities and research foundations allows us to explore the latest analytical methods for understanding the destructive mechanisms, kinetics, toxic intermediates, and end products formation. The collaboration helps bring the most effective means and methods to our projects. We are working on advancing the science and engineering into comprehensive treatment systems (e.g., treatment trains) to achieve a complete solution for PFAS-impacted waters.

SECTION 2:

Representative Examples of PFAS Treatment/Removal Projects

CDM Smith has a robust portfolio of PFAS project experience covering the spectrum from bench- and pilot-scale studies, to preliminary and final design, all the way through construction. We've done everything from assisting municipalities with identifying the right PFAS treatment method for their unique water conditions to placing PFAS treatment facilities online. The following pages highlight a representative sample of this project experience, and each of these projects involved multiple members of the team that will serve Wausau.

Owen District Road Water Treatment Plant Westfield, Massachusetts

CDM Smith provided conceptual design, bench-scale testing, final design engineering, construction, commissioning, and Operations & Maintenance (O&M) services for perfluorinated compounds removal at the City's 2,700-gallon-per-minute (nearly 4-mgd) Well 7 and Well 8 groundwater treatment facility.

CDM Smith designed the brand new Owen District Road Water Treatment Plant (WTP) which houses a public drinking water treatment system supplied by groundwater Well Nos. 7 and 8. The project includes construction



of the new WTP building (approximately 76-foot by 54-foot), a natural gas-fired generator, lead shot removal and construction of a septic system in the area of a former gun-firing range, well redevelopment, and associated site work on a City-owned parcel of land. The new WTP includes a granular activated carbon (GAC) treatment system, a sodium hypochlorite storage and feed system, a phosphate storage and feed system, an office area with cubicle and limited sampling and testing provisions, and a lavatory. A new natural gas line, electrical power, and fiber optics were installed on Owen District Road from Mountain Road to the proposed plant site.

The proposed WTP was needed since the perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) concentrations in groundwater supply Well Nos. 7 and 8 exceeded the EPA Health Advisory level of 70 parts per trillion. After the project's inception, MassDEP established a PFAS health advisory covering multiple PFAS compounds and decreased the threshold to 20 parts per trillion.

At the project's inception in late 2016, GAC was MassDEP's preferred treatment technology for PFAS removal. In parallel with the design work, CDM Smith completed a bench-scale test to compare two types of GAC for PFAS removal effectiveness and compatibility with the groundwater matrix. After water

Client: City of Westfield, Massachusetts

Project Dates:

- December 2016 – September 2020
- Design complete: 2018
- Construction complete: 2020

Client Reference:

Mr. Francis Cain, City of Westfield
59 Court Street, Westfield, MA 01085
F.Cain@cityofwestfield.org, Tel. (413) 642-9324

Project Team:

- | | |
|--------------------|----------------------|
| ■ Al LeBlanc | ■ Dung Nguyen |
| ■ Jihyon Im | ■ Michael Zafer |
| ■ Jason Maskaly | ■ Melissa Harclerode |
| ■ Charles Schaefer | |

collection on site in Westfield, the bench-scale testing was carried out by CDM Smith in its laboratory in Bellevue, WA, with additional analytical work performed by the Colorado School of Mines. As part of the final design-phase services, CDM Smith assisted the City in obtaining a Federal Aviation Administration (FAA) permit from the adjacent airport, local Conservation Commission and Planning Board approval, associated environmental permit approvals, and MassDEP approval of the treatment process design.

CDM Smith provided resident construction services during construction and authored an Operations and Maintenance manual for the new plant. The \$5.6 million WTP construction project was placed into service in August 2020, with more than 400,000,000 gallons of water treated to date, wherein regulated PFAS in the source water in the hundreds of parts per trillion have been reduced to "non-detect" since plant startup.



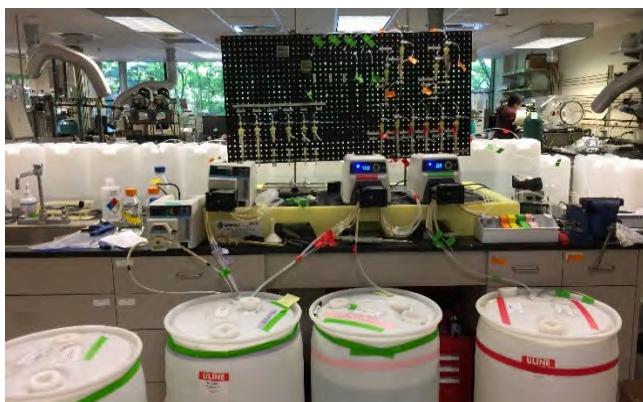
Grove Pond WTP PFAS Removal Evaluation, Testing, Design, Construction, Startup and Commissioning Ayer, Massachusetts

The Town of Ayer, MA, owns and operates the 2-million-gallon-per-day (MGD) Grove Pond Water Treatment Plant (WTP), which uses greensand filtration to treat its drinking water.



In September 2016, the U.S. Army Corps of Engineers (USACE) sampled the supply wells at Grove Pond for unregulated per- and polyfluoroalkyl substances (PFAS) contaminants and discovered the levels detected exceeded the Environmental Protection Agency's health advisory level of 70 parts per trillion (PPT). To address this issue, the Town turned to CDM Smith to develop a Preliminary Treatment Study to identify potential solutions to the PFAS contamination. CDM Smith collaborated with the Town to establish treatment goals, and then analyzed water quality data and assessed technologies for future implementation.

CDM Smith conducted bench-scale testing in its Bellevue, WA, Environmental Research and Testing Laboratory, investigating two types of granular activated carbon (GAC), two types of



Bench-scale testing took place in CDM Smith's Environmental Research and Testing Laboratory in Bellevue, WA.



anion exchange (AIX) resin, and combinations of GAC and AIX. Further, innovative demonstrations were conducted to demonstrate the efficacy of grinding AIX resin for rapid examination at the bench scale, in lieu of underground pilot testing of resin which can take substantially longer to examine.

At the conclusion of the bench-scale testing phase, CDM Smith presented the results to the Town and the Massachusetts Department of Environmental Protection (MassDEP). Given the robust study program and strong output data, the Town and MassDEP collaboratively agreed that one of the AIX resins outperformed the other resin and both GAC products.

CDM Smith conducted detailed, final design of Massachusetts' first AIX drinking water facility designed specifically to remove PFAS. Contractor bids were received on budget. The \$3.1 million project construction reached substantial completion and was placed online in fall 2020. Since the plant's startup, source water with regulated PFAS in the hundreds of parts per trillion has been treated to non-detect levels. Although Massachusetts' PFAS regulations became appreciably more stringent during the life of the project, CDM Smith's testing, planning, and robust treatment approach enable the Town to consistently achieve compliance with all PFAS regulations since startup.

Client: Town of Ayer, MA

Client Reference:

Mark Wetzel, Superintendent, Department of Public Works
978-772-8220 MWetzel@ayer.ma.us

Project Dates:

2018 – 2020

Project Staff:

- | | |
|--------------------|-----------------|
| ■ Al LeBlanc | ■ Jason Maskaly |
| ■ Jihyon Im | ■ Amrou Atassi |
| ■ Charles Schaefer | ■ Michael Zafer |
| ■ Dung Nguyen | |

Spectacle Pond WTP PFAS Removal Evaluation, Testing, and Design

Ayer, Massachusetts

The Town of Ayer, MA, owns and operates the 2-million-gallon-per-day (MGD) Spectacle Pond Water Treatment Plant (WTP), which uses greensand filtration to treat its drinking water.

After sampling the supply wells at Spectacle Pond for PFAS contaminants, the Town discovered the levels detected did not exceed the Environmental Protection Agency's health advisory level of 70 parts per trillion (ppt). However, in preparation for Massachusetts Department of Environmental Protection's (MassDEP's) adoption of a more stringent formal maximum contaminant level (MCL) the Town secured the help of CDM Smith. The anticipated MCL, which was formally adopted in 2020 encompassed six PFAS compounds not to exceed 20 ppt, known as PFAS6. The team set out to develop a Preliminary Design Report with the goal of identifying potential solutions to the PFAS contamination. CDM Smith collaborated with the Town to establish treatment goals, and then analyzed water quality data to assess the feasibility of these technologies for future implementation.

CDM Smith conducted bench-scale testing in its Bellevue, WA, Environmental Research and Testing Laboratory, investigating two types of granular activated carbon (GAC), and three types of anion



Rendering of Proposed PFAS Treatment Building, South-West Elevation

exchange (AIX) resin for PFAS removal. Further, innovative demonstrations were conducted to demonstrate the efficacy of grinding AIX resin for rapid examination at the bench scale, in lieu of underground pilot testing of resin which can take substantially longer to examine.

Client: Town of Ayer, MA

Client Reference:

Mark Wetzel, Superintendent, Department of Public Works
978-772-8220 MWetzel@ayer.ma.us

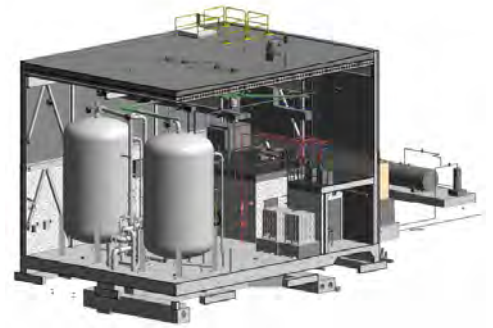
Project Dates:

2019-ongoing

Project Staff:

- | | |
|--------------------|-----------------|
| ■ Al LeBlanc | ■ Dung Nguyen |
| ■ Jihyon Im | ■ Jason Maskaly |
| ■ Charles Schaefer | ■ Michael Zafer |

At the conclusion of the bench-scale testing phase, CDM Smith presented the results to the Town and MassDEP. All three anion exchange resins exhibited fouling and loss of hydraulic throughput on this site's water and as a result, resin was



Interior of Proposed PFAS Treatment Building showing GAC vessels

ruled out for full-scale implementation. Given the robust study program and strong results indicated for the GAC products, the team collaboratively agreed that GAC clearly outperformed resin. In comparing the results of the three GAC products, one in particular outperformed the others, forming the basis of design.

CDM Smith completed a detailed final design in 2020. In addition to the PFAS treatment process addition, a new standby generator, re-roofing of the existing treatment building, SCADA modernization, yard piping modifications, and re-work of finished water chemical injection, among other improvements were included in the design. Contractor bids were received in fall 2020 with a low bid of \$5.1 million. Construction is expected to complete in the spring of 2022.

Spectacle Pond WTP PFAS Removal Evaluation, Blending, Testing, and Design Criteria Development

Littleton, Massachusetts

The Littleton Water Department (LWD), owns and operates the 1.5-mgd Spectacle Pond Water Treatment Plant (WTP), which uses ozone and ultrafiltration to treat its drinking water primarily for iron and manganese removal.

After sampling the supply well at Spectacle Pond for PFAS contaminants, LWD discovered the levels detected did not comply with the Massachusetts Department of Environmental Protection (MassDEP) maximum contaminant level (MCL) of 20 parts per trillion (ppt) for the sum of six PFAS compounds. LWD turned to CDM Smith to develop a Preliminary Treatment Study to identify potential solutions to the PFAS contamination.



Stakeholder workshop, October 2019

CDM Smith led a stakeholder information session, then collaborated with LWD to establish treatment goals, and analyzed water quality data and assessed technologies for future implementation.

To accelerate compliance with MassDEP's guidelines, at the time the strictest in the United States, CDM Smith advanced a design to incorporate blending of the Spectacle Pond WTP water (with PFAS in the 28 ppt range) with the water from the Beaver Brook WTP, also owned and operated by LWD (with PFAS in the 6 ppt range). The blending design features a temporary pipeline and has delivered water with PFAS less than 20 ppt since May 2020.



To assist LWD in establishing PFAS design criteria for the future Whitcomb Avenue WTP, CDM Smith performed a bench-scale study, which began with collecting water at the LWD site. CDM Smith first shipped water to and then conducted bench-scale testing in its Bellevue, WA, Environmental Research and Testing Laboratory, to investigate the best performing media for Littleton's specific water quality, testing two types of GAC, and two types of AIX resin. CDM Smith tracked the testing progress, updated the client and at the conclusion of the bench-scale testing phase, summarized bench-scale results in a memorandum and presented the results to LWD and MassDEP.

With the above-described work completed, CDM Smith provided design criteria for LWD and its plant designer to advance an iron, manganese and PFAS removal facility design.

Through its partnership with Texas Tech University, CDM Smith also conducted a PFAS fingerprinting exercise to help LWD determine what type of PFAS contamination may be present in the Spectacle Pond water supply well. CDM Smith collected samples for analysis of target (24 compound) PFAS, non-target PFAS and PFAS isomer analysis. The results of the fingerprinting effort were presented to both LWD and MassDEP.

CDM Smith collected water from LWD's biological iron and manganese removal pilot testing system and shipped several drums to CDM Smith's Bellevue, WA laboratory for independent testing of LWD's water on multiple GAC and AIX resin products.

Client: Littleton Water Department, MA

Client Reference:

Corey Godfrey, Water & Sewer Superintendent
978-540-2222, cgodfrey@lelwd.com

Project Dates: 2019 – 2020

Project Staff:

- Alan LeBlanc
- Charles Schaefer
- Jihyon Im
- Dung Nguyen

PFAS Treatment System Evaluations Orange, California

The East Orange County Water District (EOCWD) retained CDM Smith to assist during evaluations of a treatment system for the removal of PFAS from groundwater. EOCWD's groundwater has unique challenges including entrained air that could potentially disrupt the ion exchange (IX) resin beds efficiency and life expectancy. EOCWD took this unique opportunity to test and pilot different air entrained removal technologies to bring its wells that were shut down due to presence of PFAS beyond the notification levels online as soon as possible. CDM Smith performed the following services under this contract:

- Water quality evaluation and treatability assessment,
- Different technologies evaluation in term of life cycle cost and efficiency for PFAS removal including Ion Exchange, GAC, and Nanofiltration system
- Evaluation and recommendation for potential piloting technologies for entrained air removal
- Developing of entrained air Piloting plan and protocol
- Hydraulic review including booster pumping needs and surge mitigation
- DDW permitting assistance for the new PFAS removal system, 4-log virus inactivation following the groundwater rules, and secondary disinfection system conversion from chlorination to chloramination system

Client: East Orange County Water District, CA

Project Dates: March-September 2020

Team Members:

- Al LeBlanc
- Michael Zafer

Northwest WTP Expansion and Upgrades Brunswick County, NC

CDM Smith recently completed the design and bidding of the Northwest WTP Expansion and Upgrades project. The project provides advanced treatment for removal of many contaminants, including PFAS such as GenX, from the source water as well as expands the capacity of the drinking water facility from 24 to 48 mgd. CDM Smith is also providing general services and Resident Project Representative (RPR) inspection during the construction phase.

In January 2018, Brunswick County contracted with CDM Smith for a Water Treatment Evaluation Study that included planning for an expansion of the Northwest WTP and water treatment process upgrades to address

Client: Brunswick County, NC

Project Dates:
2018 – Ongoing

Team Members:

- Dung Nguyen
- Mark White
- Michael Zafer

emerging contaminants in the Cape Fear River. The Cape Fear River source water was found to contain a variety of contaminants, including PFAS, 1,4-dioxane, hexavalent chromium, N-Nitrosodimethylamine (NDMA), endocrine disruptors (EDCs), pesticides, and Pharmaceuticals and Personal Care Products (PPCPs), among others. The watershed of the Cape Fear River has many industrial and municipal wastewater discharges and runoff from agricultural and developed areas contributing to the contamination, including the most well-known source of PFAS contaminants in the State, the Fayetteville Works Chemours Chemical Plant located in Cumberland County. These point- and non-point-sourced pollutants accumulate in the river and many are poorly removed by conventional surface water treatment processes.

The Water Treatment Evaluation completed by CDM Smith included: (1) evaluation of source water quality and emerging contaminants, (2) desktop alternatives analysis for advanced treatment options to address the contaminants, (3) evaluation of WTP process improvements for expansion to 36-mgd, (4) pilot testing of RO to evaluate removal of 1,4 Dioxane, PFAS, and other contaminants, (5) preliminary discharge permitting, and (6) preparation of draft/final reports and presentations to the County's Board of Commissioners. Notably, CDM Smith mobilized the pilot testing equipment to the Northwest WTP and, in collaboration with the County's staff, began taking pilot samples within three weeks of notice to proceed.

Working with Public Utilities staff, CDM Smith completed the initial phases of pilot testing, a treatment alternatives analysis, and a conceptual design phase



for the improvements within two months. This aggressive schedule allowed the team to present a draft report of initial findings and recommendations to the Board of Commissioners ahead of finalizing the final County budget. Following completion of the treatment evaluation, the Board of Commissioners approved the recommendation to expand the WTP to 48 mgd and include 36 mgd of low-pressure reverse osmosis (LPRO) for removal of emerging contaminants.

CDM Smith completed the Preliminary Engineering Phase to fully define the basis of design of the Northwest WTP expansion and new RO facility in three months. The process was highly collaborative and included the initiation of several specialized assignments for CDM Smith and its subcontractors.

Examples of these assignments include:

- An investigation into sources of toxicity in plant discharges, coordination with NCDEQ on an approach to address toxicity
- Evaluation of options for solids handling improvements
- Review of other chemical improvements at the plant that resulted in upgrades for chlorine and fluoride facilities
- Evaluation of the potential for groundwater blending at the Northwest WTP that included a field investigation and completion of test wells
- Data collection and modeling to support the NPDES application for discharge to the Cape Fear River

In October 2018, CDM Smith's team began the design phase of approximately \$120 million in plant improvements, including an off-site 4-mile concentrate disposal pipeline. The design phase for the 48-mgd plant expansion and new RO facility was completed in October 2019. Permitting and Bidding took place in late 2019 and early 2020, with the apparent low bid being \$122.6 million. The NPDES permit obtained in February 2020 is the first of its kind and was the result of 18 months of diligent work by the County and CDM Smith.

The construction phase began in summer 2020 and will continue into 2023. CDM Smith is supporting the County throughout the construction phase of the program by providing construction engineering services, RPRs, start-up and commissioning services to support the successful completion of the County's program to expand and improve the Northwest WTP.

At the completion of this project, the Northwest WTP will be the largest RO system on the east coast and the third largest in the U.S. It will also be the largest treatment plant utilizing low-pressure membranes to remove PFAS and other emerging contaminants – highlighting the County as a national leader with respect to emerging contaminants. Even before construction has begun, the Brunswick County Northwest WTP has become a widely known facility due to the cutting-edge treatment approach and bold actions by the County to address PFAS in the drinking water.



PFAS Engineering Support Services

Crystal Lake, Illinois

When the City of Crystal Lake received the unwanted distinction of being the first water utility in Illinois to be identified as having a positive PFAS detection under the Illinois Environmental Protection Agency (IEPA) statewide PFAS investigation, the City contracted with CDM Smith to provide PFAS Engineering Support Services.

Under this project, CDM Smith worked with the City to prepare and implement a PFAS testing investigation to identify the source water wells that caused the contamination and to evaluate the levels of PFAS removal that could be achieved by the existing water treatment plant. CDM Smith prepared and evaluated alternatives to modify the existing aging water treatment facility to implement new treatment for PFAS mitigation. CDM Smith provided a road map to the City for moving forward, including alternatives for treatability testing and temporary PFAS treatment options.

Client: City of Crystal Lake, IL

Project Dates: 2020-2021

Team Members:

- Mark White
- Amrou Atassi
- Al LeBlanc
- Melissa Harclerode
- Meghan Drew

SECTION 3:

Project Team

WWW needs the support of a project team that will help guide it to the right solution for its PFAS problem. CDM Smith is the most qualified team to help you accomplish that goal. We offer WWW in-depth experience developing treatment strategies for emerging contaminants, including PFAS; a track record of successfully performing bench- and pilot-scale testing of the full spectrum of PFAS treatment options; PFAS treatment design and implementation success; and first-hand knowledge of WWW and your high standards and expectations. Equally important is our regulatory knowledge and big-picture understanding. We stay on top of Federal, State, and local regulations for PFAS and many other contaminants so we can design facilities with current and projected future regulatory requirements in mind, providing peace of mind and long-term cost savings to our clients and the communities they serve.

Our team is highly qualified and capable of delivering your project on time, within budget, and in accordance with your requirements. The CDM Smith team is available to start work on your project immediately and support the work for its duration. Additionally, CDM Smith has the full in-house resources to support WWW on future phases of your PFAS work should that be deemed necessary.

Brief introductions to our key personnel are provided on the following pages. Detailed resumes are included in **Appendix A**.

Introducing the CDM Smith Team

Matthew J. Bednarski, PE, ENV SP Principal-in-Charge

Mr. Bednarski is a project manager and principal-in-charge who specializes in water resource engineering with expertise in large and collaborative public works projects. His experience encompasses project management, contract administration, client relations, construction supervision, community relations, and special assignments. He brings a strong understanding of how to work effectively with WDNR through successful collaboration on numerous projects.



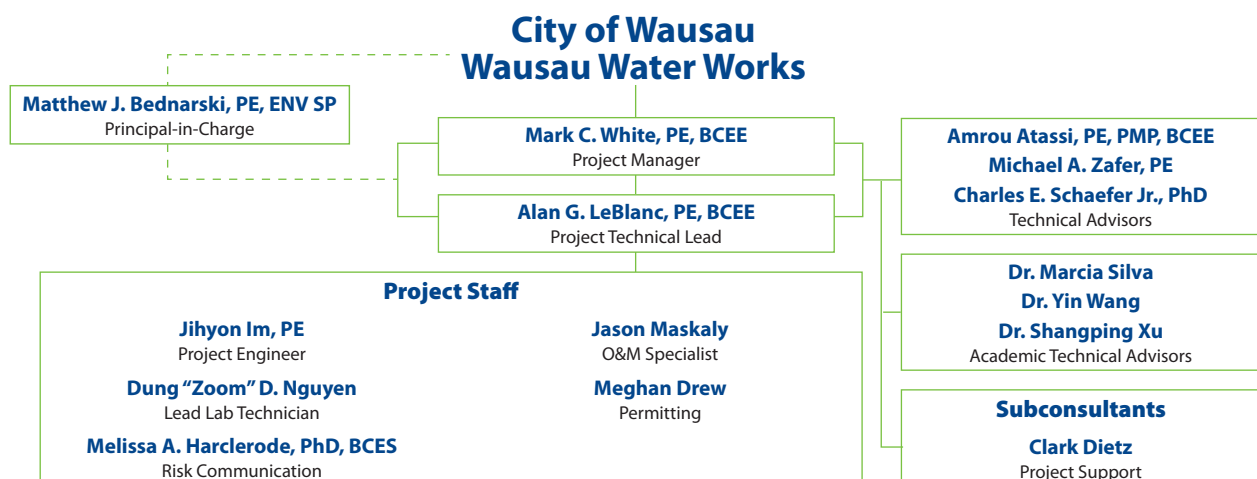
Mark C. White, PE, BCEE Project Manager

In his 25+ years with CDM Smith, Mr. White's experience has spanned the full range of project activities, from pilot investigation and design, to construction, start-up, and operations and maintenance. He has managed more than 40 projects related to water treatment, optimization, and pumping systems, including several water treatment plant improvements projects in Wisconsin. He recently served as a technical advisor for the design of a new 41-mgd low-pressure reverse osmosis (LPRO) treatment facility for Brunswick County (NC) Public Utilities to provide for removal of PFAS from the Cape Fear River raw water supply. In addition, he has recently led the evaluation of PFAS treatment alternatives for a groundwater system in Crystal Lake, IL and prepared a recommended PFAS sampling program for the City of Decatur, IL.



Alan G. LeBlanc, PE, BCEE Project Technical Lead

Mr. LeBlanc has 27 years of design and construction experience, focusing on municipal water treatment planning, study, design, construction and operations. Most recently, **Mr. LeBlanc has worked on more**



than 20 PFAS projects ranging in scope from studies and testing through design and construction. He managed the bench-scale testing, final design and construction of the 4-mgd Owen District Road WTP in Westfield, MA, using GAC treatment to remove PFAS from drinking water. That facility has been in service since 2000. Additionally, he managed the PFAS removal alternatives analysis and final design for two 2-mgd WTPs in Ayer, MA, one using AIX to treat PFAS went online in 2021 while the other, deploying GAC to treat PFAS, is currently under construction. Mr. LeBlanc performed similar responsibilities for a GAC treatment addition to the Spectacle Pond WTP in Littleton, MA, that is currently under construction. He has advised on several other PFAS removal projects, including for the East Orange County Water District, CA, and the City of Garden Grove, CA, the 12-mgd Park Avenue WTP in South Plainfield, NJ, among others.

Amrou Atassi, PE, PMP, BCEE
Technical Advisor

Mr. Atassi is a senior project manager and senior project engineer specializing in drinking water treatment, and he is one of CDM Smith's foremost experts on corrosion control. With 22 years of experience, he has worked on all phases of water treatment projects, including pilot testing, corrosion control and water quality studies, master planning, water quality compliance issues, design, and construction phase services. He has worked on a wide range of projects from 0.2 mgd to 1.2 bgd plants ranging in cost from \$5,000 to \$250 million. Mr. Atassi has led the conceptual and detailed design of several water treatment plant project in Illinois, Indiana and Wisconsin. Mr. Atassi has presented on water distribution, corrosion control, and treatment topics at various local and national AWWA conferences. He has **led several Water Research Foundation (WRF) projects related to corrosion control and distribution system water quality** and is a member of the Project Advisory Committee for WRF 4713 – "Full Lead Service Line Replacement Guidance."



Michael A. Zafer, PE
Technical Advisor

In his 35 years with CDM Smith, Mr. Zafer has focused on drinking water treatment solutions, including treatment process selection and verification, treatability studies for the optimization of plant process design and operations, and assisting water suppliers with complex regulatory compliance and water quality issues. Mr. Zafer's experience removing PFAS from groundwater and surface water supplies includes bench-, pilot-, and demonstration-scale studies for GAC, ion exchange (IX), novel adsorbents, reverse osmosis; alternatives analysis; facilities design; startup/commissioning; process optimization; research for fate and transport, removal, concentration, and destruction; and permitting. **He has participated in more than 10 PFAS projects nationally** and a variety of drinking water projects in Wisconsin, Illinois,



Minnesota, and Michigan. He was a technical advisor for the treatability studies and design for a 36-mgd plant to remove PFAS from the Cape Fear River in Brunswick County, NC; and assisted CDM Smith's design teams with the commissioning of the 4-mgd GAC plant for removal of PFAS from groundwater in Westfield, MA. He also provided technical review for treatability study results for GAC and IX for two PFAS removal and facilities design projects in Ayer, MA.

Charles E. Schaefer Jr., PhD
Technical Advisor

Dr. Schaefer has 25 years of experience as a chemical engineer and is the Director of CDM Smith's Bellevue Research & Testing Laboratory. As **a nationally-recognized expert and leading researcher in PFAS**, he specializes in bench- and pilot-scale development of technologies for treating emerging contaminants, and for understanding their fate and transport in multiple settings. Dr. Schaefer contributed to the U.S. Department of Defense's Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP) Workshop on Research and Demonstration Needs for Management of Aqueous Film-Forming Foam (AFFF)-Impacted Sites and co-authored the Summary Report. He has **authored/co-authored more than 20 peer-reviewed papers on PFAS**, and is currently serving as Principal or co-Principal Investigator on 15 PFAS-focused research grants funded through the U.S. Department of Defense (DoD) and the Water Research Foundation (WRF). Dr. Schaefer led the bench-scale testing analysis for PFAS/PFOA treatment in Westfield, MA. Additionally, he led similar bench-scale studies on the two PFAS projects in Ayer, MA, and for the Park Avenue WTP in South Plainfield, NJ.



Jihyon Im, PE
Project Engineer

Ms. Im is an environmental engineer who has spent her eight-year career specializing in drinking water treatment projects. She has experience in the design of new WTPs and upgrades to existing facilities. Her most recent work has focused on the design of PFAS treatment solutions. **Ms. Im has quickly earned her place among CDM Smith's most experienced PFAS engineers with more than a dozen projects to her credit.** Her PFAS experience includes everything from risk assessments and planning studies to bench- and pilot-scale testing, to preliminary and final designs. She was the Project Engineer for the testing and design of the PFAS treatment facility in Westfield, MA, this is now in service; was the Project Engineer for the testing, planning, and design of two PFAS facilities in Ayer, MA, is the Project Engineer for the desktop study and bench-scale testing phases of the PFAS upgrade to the Park Avenue WTP in South Plainfield, NJ; and was heavily involved in an Emerging Contaminants Planning Study for multiple sites in central New Jersey.



Dung “Zoom” D. Nguyen Lead Lab Technician

Mr. Nguyen is a chemical and environmental engineer experienced in bench-, pilot-, and full-scale design and implementation of in-situ and ex-situ soil and treatment systems in the US and internationally. He manages CDM Smith’s Research and Testing Laboratory where **he leads design support treatability studies and innovative research and development work on fate and transport, along with treatment of PFAS.** He serves as Principal or co-Principal Investigator on a number of Department of Defense-funded projects evaluating fate and transport of PFAS in the environment and demonstrating potentially applicable PFAS treatment technologies. He has conducted treatability studies in remediation areas including bioremediation, chemical oxidation, and biogeochemical transformation of chlorinated solvents.



Melissa A. Harclerode, PhD, BCES Risk Communication

Dr. Harclerode is an environmental sustainability scientist with 16 years of experience in environmental management across a variety of market sectors, including remediation, water resources, and solid waste management. She specializes in life cycle assessment, footprint analysis, community impact evaluation, stakeholder facilitation, risk communication, and resilient adaptation measures. She is an international expert in the evaluation and integration of the social dimension in remediation decision-making, with **leadership roles in the Sustainable Remediation Forum (SURF) and the Interstate Technology Regulatory Council (ITRC)s PFAS Risk Communication Technical Guidance and Toolkit.** Her responsibilities also include serving as Project Technical Lead or conceptual site model (CSM) lead for various site remediation projects, including emerging contaminants PFAS and 1,4-dioxane.



Jason Maskaly O&M Specialist

Mr. Maskaly has 22 years of total expertise, 12 years of which have been with CDM Smith, in the maintenance, startup, testing and commissioning of equipment; developing maintenance management programs; and developing and presenting training programs for a wide range of facility types, including water treatment plants employing dissolved air flotation treatment systems, as well as GAC and AIX treatment solutions for PFAS. Mr. Maskaly has successfully **provided O&M services during the scheduling, start-up, and testing of PFAS water treatment facilities in Westfield and Ayer, MA.**



Meghan Drew Permitting

Ms. Drew is an environmental engineer with four years of experience with AutoCAD, Bluebeam Revu, and Microsoft Office. She also has experience applying for permits and helping clients obtain SRF funding. Her project work has focused on water and wastewater infrastructure improvements projects in Wisconsin and Illinois. She recently assisted in the design of the intake structure into Lake Michigan, including intake pipe, potassium permanganate chemical piping, icing prevention tactics, and the intake crib in Sheboygan, WI. She also organized and coordinated the permitting and funding efforts and communicated with WDNR and USACE permitting departments.



Academic Technical Advisors

There are currently no PFAS treatment/removal systems in Wisconsin for drinking water, and WWW likely will become the first Badger State municipality to do so. CDM Smith knows what it takes to identify the right PFAS treatment solution, design the system and place it online because we’ve done it before. That same team of national PFAS experts will serve WWW on this project, and they will be strengthened by the inclusion of some of Wisconsin’s leading PFAS researchers. Our technical advisors from the University of Wisconsin-Milwaukee will bring a deep understanding of local water conditions and challenges, as well as valuable insight from their PFAS research experience. Furthermore, their involvement will strengthen in-state talent and expertise in the long-term battle against PFAS, which will benefit all Wisconsin residents.

Dr. Marcia Silva Technical Advisor

Dr. Marcia Silva (PhD in Engineering and MBA) is an Associate Scientist and Director of the Water Technology Accelerator (WaTA), University of Wisconsin-Milwaukee. She has more than 29 years of experience in industry, academia, and technology accelerator combined, 16 invention disclosures and patents, and three licensing agreements with national and international companies from the technologies developed in her lab. Her lab is focused on the development of water remediation technologies and sensors for detection of pollutants in water. Dr. Silva’s lab is currently evaluating multiple degradation pathways for PFAS and is currently developing and evaluating multiple filtration materials for removal of PFAS from water.

Dr. Yin Wang Technical Advisor

Dr. Yin Wang is a Lawrence E. Sivak ’71 Associate Professor in the Department of Civil and Environmental Engineering at the University of Wisconsin – Milwaukee. He received his Ph.D. in Energy, Environmental and Chemical Engineering at the Washington University in St. Louis in 2012. Dr. Wang’s research

investigates the occurrence, fate and transport, and treatment technologies for emerging and recalcitrant waterborne pollutants. He has more than 15 years of experience in the field of environmental engineering, published 35 high-impact peer-reviewed journal publications, co-authored more than 40 presentations in national and international conferences, and received over \$4 million extramural research funds. Specifically, he has served (and been serving) as the Principal Investigator (PI) and Co-PI on 13 research projects related to PFAS detection, environmental behavior, and treatment sponsored from various agencies such as the Department of Defense (DoD), the National Oceanic and Atmospheric Administration (NOAA) Wisconsin Sea Grant, the Wisconsin Department of Natural Resources, and industry.

Dr. Shangping Xu ***Technical Advisor***

Dr. Shangping Xu is an Associate Professor in the Department of Geosciences at the University of Wisconsin – Milwaukee. He received his Ph.D. in Environmental Engineering and Water Resources from Princeton University. Dr. Xu's research focuses on the experimental investigation and mathematical modeling of contaminant transport within the subsurface system and the development of novel water treatment techniques. His research related to PFAS includes the occurrence and spread of PFAS within the vadose soil zone and groundwater aquifer, and the development of water filters and bioreactors for the removal of PFAS.

Subconsultant Support

Tonia Westphal, Clark Dietz ***Project Support, Local Office Liaison***

Tonia's experience with the City makes her an invaluable partner for this project. Her strong communication skills, coupled with her



technical expertise, enable her to facilitate collaborative efforts with stakeholder groups in a meaningful manner. She frequently serves as a liaison between municipal entities, technical staff, clients, stakeholders, regulatory agencies, and the general public. Clark Dietz provides local strength and attention to detail in operations and technical functions in Wausau. With staff in downtown Wausau, just a few blocks from City Hall, they will provide local resources as needed to supplement CDM Smith's in-house resources. CDM Smith and Clark Dietz are partners on WWW's Corrosion Control Treatment Study and its Lead Service Line Replacement Plan.

APPENDIX A

Resumes

- **Matthew J. Bednarski, PE, ENV SP** – Principal-in-Charge
- **Mark C. White, PE, BCEE** – Project Manager
- **Alan G. LeBlanc, PE, BCEE** – Project Technical Lead
- **Amrou Atassi, PE, BCEE, PMP** – Technical Advisor
- **Michael A. Zafer, PE** – Technical Advisor
- **Charles E. Schaefer Jr., PhD** – Technical Advisor
- **Jihyon Im, PE** – Environmental Engineer
- **Dung D. Nguyen** – Lead Lab Technician
- **Melissa A. Harclerode, PhD, BCES** – Risk Communication
- **Jason Maskaly** – O&M Specialist
- **Meghan Drew** – Permitting
- **Tonia Westphal, PE, LEED AP** - Project Support

Matthew J. Bednarski, PE, ENV SP

Principal-in-Charge



For 24 years, Matt has refined his experience and expertise in large and collaborative efforts on a number of watercourse and public works projects. He is a project manager, principal-in-charge, and municipal engineer specializing in water resource projects. Matt's experience encompasses project management, contract administration, client relations, construction supervision, Stormwater management and modeling, community relations, and special assessments.

Envision Sustainability Professional, Edgewood Near Surface Collector, Milwaukee Metropolitan Sewerage District, Milwaukee, Wisconsin. Mr. Bednarski conducted an evaluation of this relief sewer project's potential for improved sustainability based on the ISI Envision checklist. Criteria for this project were sorted by potential to be met allowing designers to increase the use of sustainable practices in design, specification, and construction.

Local Permitting Liaison, Site Plan and Stormwater Management, The Great Water Alliance, Waukesha Water Utility, Wisconsin. Mr. Bednarski was responsible for local permitting requirements for the water supply line and return flow pipeline that supplies potable water from Lake Michigan to the City Waukesha. In this capacity he convened meetings with the communities through with the pipelines passed to ensure the regional project met local permit requirements and local outreach needs. Additionally, he led the team responsible for site plans, structural design, and stormwater management for the Booster Pump Station and Chemical Feed Station.

Project Manager, Kinnickinnic River Rehabilitation, Milwaukee Metropolitan Sewerage District, Milwaukee, Wisconsin. Mr. Bednarski managed a large team of regional and local experts – including DBE firms – for this long-term flood risk reduction project for MMSD. The project included long-range planning for Milwaukee County Parks facilities, bridge improvements, and stakeholder and public outreach and involvement. Matt organized and managed many team members to allow the technical experts to excel without needing to navigate a difficult project from a public and political point-of-view.

Project Manager, Stormwater Management Plan Reviews, City of Franklin, City of Port Washington, City of Mequon, Village of Caledonia, and City of New Berlin, Wisconsin. Reviewed and approved developments for compliance with City, State, and MMSD Stormwater Management Regulations.

Project Manager, Mid Moraine Water Quality Collective, Ozaukee and Washington Counties, Wisconsin. The Mid Moraine Water Quality Collective is a collaboration among 12 communities and two counties to meet upcoming TMDL standards on the Milwaukee River. The Collective includes engineering expertise, NGO partners for public outreach, regulatory experts, and funding partners to lead communities to meet water quality goals, economic goals, and collaboration goals. Matt was instrumental in organizing and leading this group into its genesis. Matt's role included finding creative and innovative ways to meet TMDL standards and find funding for future projects.

Project Engineer, Milwaukee Avenue Reconstruction, Wauwatosa, Wisconsin. Replacement of a portion of two existing storm sewer systems, to alleviate flooding problems in the neighborhoods. Challenges included

Education

- Executive MBA-- University of Wisconsin-Milwaukee, 2014
- BS –Civil Engineering, University of Wisconsin-Milwaukee, 1998

Registration

- Professional Engineer: Wisconsin

Professional Certification

- Envision Sustainability Professional

design of a cost-effective, constructible storm sewer system in coordination with the roadway design. Another challenging aspect was development of outfall designs that minimized scour and erosion at the Menomonee River.

Client Service Manager, Village Engineer, Village of Newburg, Wisconsin. Involved in an array of day-to-day and project engineering duties, including administrative services ranging from construction to planning. These include attending council, committee, and commission meetings; leading presentations and public hearings; overseeing bidding; and managing capital improvement projects. Responsible for annual reporting requirements. Responds to resident phone calls and complaints. Negotiates for easements and manages engineering, planning, and construction budgets. Completed Pavement Management Plan, Comprehensive Outdoor Recreation Plan, "Smart Growth" Plan, and Sanitary Sewer Master Plan.

Project Manager, Fish Passage, Ozaukee County, Wisconsin. Designed a culvert replacement on Mole Creek in Ozaukee County to alleviate an impassable section of a high quality trout stream. Coordinated effort to show compliance with multiple jurisdictions including FEMA, Ozaukee County, WisDOT, WDNR, Village of Grafton, and Town of Grafton.

Project Manager, Stormwater Pollution Prevention Plan (SWPPP), Marine Materials Handling Corporation, Downers Grove, Illinois. Developed IEPA compliance plan for Stormwater discharge from petcoke receiving dock.

Client Service Manager Town Engineer, Town of Grafton, Wisconsin. Oversaw day-to-day project engineering duties from construction to planning; performed planning/zoning duties; distributed project work to office staff; completed special assessments; attended town board, committee, and commission meetings; led presentations and public hearings; oversaw bidding process; and managed capital improvement projects.

Project Manager, Mequon-Thiensville Dam Fish Passage, Ozaukee County, City of Mequon, and Village of Thiensville, Wisconsin. Completed design, construction documents, bidding, and construction management of a fish passage channel around the dam on the Milwaukee River. This project included fish passage channel design, floodplain compliance, constructability review, and grant funding management. Project involved complex coordination between the County, City, Village, WDNR, NOAA, and contractors.

Project Manager, Stormwater Discharge Permit/NR 216, Cities of Franklin, Port Washington, and Glendale; Villages of Caledonia, Pleasant Prairie, Pewaukee, and Jackson; Town of Grafton; and Milwaukee and Ozaukee Counties, Wisconsin. Oversaw the completion of various Stormwater discharge permit elements including permit application, public education and outreach, water quality modeling, SWPPP, illicit discharge inspection, and annual reports.

Project Manager, Regional Stormwater Facility Design, City of Port Washington, Wisconsin. Completed a feasibility study, design, and construction documents for a regional Stormwater detention facility for flood mitigation and water quality treatment as part of a large WisDOT reconstruction/round-about project.

Project Manager, Business Park Pond Retrofit, City of Franklin, Wisconsin. Identified grant opportunities and obtained grant from WDNR to convert dry Stormwater detention facilities into wet ponds with a water quality component. Completed construction documents, bidding, and construction management.

Mark C. White, PE, BCEE

Project Manager



Mr. White is a registered professional engineer and Board Certified Environmental Engineer with more than 25 years of international experience in the planning, design, operations and maintenance, and construction of water treatment facilities. He has evaluated and/or designed improvements to more than 40 water treatment plants (WTPs) totaling more than one-billion-gallons-per-day of capacity. He is well versed in both conventional and advanced water treatment processes. As a water treatment industry leader, Mark serves on various state and national committees and was recently appointed as a Trustee to the Engineering and Construction Division of the American Water Works Association (AWWA). He has authored more than 20 technical presentations on water treatment technologies at AWWA National Conferences and has taught classes on the design of water treatment systems at the University of North Carolina-Chapel Hill and the University of Wisconsin-Madison. In addition, he has authored chapters of drinking water manuals of practice, including the AWWA M53 Manual of Practice for Microfiltration and Ultrafiltration Membranes and the Indian Water Works Association M5 Manual on Augmentation and Upgradation of Water Treatment Plants.

Senior Technical Reviewer, Low-Pressure Reverse Osmosis Treatment Improvements, Brunswick County, North Carolina. Mr. White served as a senior technical reviewer for the design of a new 41-mgd low-pressure reverse osmosis (LPRO) treatment facility for the Brunswick County Public Utilities to provide for the removal of PFAS from the Cape Fear River raw water supply. During this project pilot testing was used to confirm that LPRO was the most cost-effective treatment approach for removing PFAS and providing protection against other potential future contaminants of concern.

Project Technical Lead, PFAS Engineering Support Services, Crystal Lake, Illinois. Mr. White served as the project technical lead for PFAS support services to the City of Crystal Lake after PFAS was detected in the finished water of the City's groundwater treatment plant. Mr. White developed a PFAS testing investigation to identify the source of the PFAS contamination. He also developed and evaluated short-term and long-term strategies for the City to address the PFAS contamination.

Project Technical Lead, Long-Term Sustainability Plan, Decatur, Illinois. Mr. White served at the project technical lead for the multi-discipline condition assessment that identified, evaluated, and prioritized WTP improvements projects anticipated for a 40-year planning period, including improvements to the existing lime softening and anionic exchange treatment systems. He developed a conceptual evaluation of alternatives to using elemental chlorine to reduce the storage of hazardous chemicals. He also led the development of water quality regulatory assessment, including strategies to address potential concerns with disinfection by-products and PFAS.

Project Manager, Membrane Treatment Cold Water Capacity Project, Appleton, Wisconsin. Mr. White served as the project manager for an engineering assessment to improve the operation of an 18-mgd UF system for Appleton. CDM Smith evaluated the causes of excessive fouling of the UF system. CDM Smith recommended improvements to reduce membrane fouling and successfully demonstrated the performance of these improvements during pilot-scale and full-scale testing. CDM Smith developed recommendations and preliminary evaluation of a series of improvements to the Appleton WTP to reduce fouling, improve operation, and reduce operational costs.

Education

- MSEE - Water Resources Engineering, University of North Carolina at Chapel Hill, 1996
- BS - Civil Engineering, University of Illinois, at Champaign-Urbana, 1993
- BS - Architecture, University of Illinois at Champaign-Urbana, 1989

Registration

- Professional Engineer: Illinois, Wisconsin, New Mexico, and North Carolina (2000)

Honors/Awards

- Board Certified Environmental Engineer (BCEE) - American Academy of Environmental Engineers and Scientists
- 1998 AWWA Best Paper Award (Water Quality Division)
- 1998 AWWA Publications Award
- AWWA Thomas R. Camp Scholarship
- Ira O. Baker Prize - University of Illinois

Project Technical Lead, Raw Water Intake and Pump Station Design, Sheboygan, Wisconsin. Mr. White is the project technical lead for the design and construction of a new 34-mgd low lift pump station, new primary intake into Lake Michigan (60-inch diameter, 6,500 feet long), new sodium permanganate chemical storage and feed system, new standby power generators, and associated piping, and building systems.

Project Manager and Treatment Process Design Lead, Ultrafiltration Membrane Improvements, Racine, Wisconsin. Mr. White served as the project manager and treatment process lead for the design, construction and start-up of a new 50-mgd ultrafiltration membrane system for the Racine WTP. This is currently one of the largest membrane facilities within the US. Following commissioning, Mr. White worked with Racine staff to optimize operational performance of the installed membrane system to increase capacity, improve redundancy, and lower operational costs.

Treatment Process Design Lead, Membrane Filtration System, Manitowoc, Wisconsin. Mr. White served as treatment process design lead for the addition of a new 24-mgd membrane filtration system retrofit into the existing Manitowoc Public Utilities WTP. This project included the implementation of new submerged membrane treatment within existing conventional filtration basins.

Process Design Lead, Design-Build of the Pojoaque Basin Regional Water Treatment Plant, Santa Fe County, New Mexico. Mr. White is the process design lead for the design-build of a new 6.23-mgd WTP utilizing high-recovery ultrafiltration and nanofiltration membrane systems. This project is being implemented for the United States Department of the Interior, Bureau of Reclamation to develop a new potable water supply for the pueblos of Nambe, Pojoaque, San Ildefonso, and Tesuque; and unincorporated areas of Santa Fe County.

Project Technical Lead, Howard Avenue WTP Filter Underdrain and Media Replacement, Milwaukee Water Works, Wisconsin. Mr. White is the project technical lead for the design of filter underdrain rehabilitation project for the Howard Avenue WTP. The project includes replacement of failed plastic block underdrains with new stainless steel underdrains and the implementation of a new air scour auxiliary wash process.

Technical Advisor, Catskill and Delaware Water Supply Treatment Evaluation for New York City, NYCEP. Mr. White is a member of the Technical Advisory Committee, a group composed of senior water quality and treatment experts from academia and consulting, that is providing direction to the planning for new 2-billion-gallons-per-day treatment facilities to supply potable water to New York City.

Water Plant Assessment Lead, Oak Creek, Wisconsin. Mr. White served as water plant assessment lead for a condition assessment at the Oak Creek WTP. The project included a multi-discipline condition assessment that identified, evaluated, and prioritized WTP improvements projects anticipated for a 20-year planning period. The project included a review of current and anticipated future regulations and an evaluation of opportunities for optimizing WTP treatment performance. The project also included evaluation and prioritization of distribution system improvements, creation of a distribution system hydraulic model, and development of a water-main replacement prioritization plan.

Process Specialist, Facility Plan and Treatability Testing, Louisville Water Company, Kentucky. Mr. White served as the process specialist, evaluating process improvements and regulatory compliance, for the Louisville Water Company Facility Plan update. This project included review of raw water supply alternatives as well as an evaluation of the lime softening treatment processes. This project also included a pilot test evaluation of advance treatment technologies to improve water quality and address future regulatory compliance.

Alan G. LeBlanc, PE, BCEE

Project Technical Lead



Mr. LeBlanc is a civil engineer with 27 years of design and construction experience, including municipal water and wastewater treatment, PFAS removal, hydraulic piping and pumping analysis, sanitary and storm sewer collection systems, application of sustainable design concepts, and construction cost estimating. Mr. LeBlanc served as Chair of the New England Water Works Association Filtration Committee for eight years and has led training courses on filtration and granular activated carbon (GAC) adsorption design and operation for the past 17 years.

Project Manager, Bench-Scale Testing, Design and Construction for Per- and Polyfluoroalkyl Substances (PFAS) Removal, Westfield, Massachusetts. Mr. LeBlanc led CDM Smith's work for the City of Westfield's 2,700-gallon-per-minute Well 7 and Well 8 treatment facility. The \$5.5 million project evaluated granular activated carbon (GAC) at bench scale to treat the City's source water, followed by the design and construction of a new plant using GAC. The plant was placed into service in 2020 and has been removing regulated PFAS from hundreds of parts per trillion to non-detect in over 400,000,000 gallons of water treated since startup.

Project Manager, PFAS Removal Alternatives Analysis and Final Design, Ayer, Massachusetts. Mr. LeBlanc led the establishment of treatment goals, analysis of water quality data, and the assessment of technologies for future implementation at the Town's 2-mgd Grove Pond WTP. Bench scale testing of coal-based and coconut-based granular activated carbon (GAC) products and two ion exchange resins led to the design being based on one of the anion exchange resins. Close coordination with MassDEP was required through the pilot testing, design review, and final approval phases. The \$3.1 million PFAS system went on-line in early 2021 and has removed regulated PFAS in the hundreds of parts per trillion to non-detect since startup.

Project Director, PFAS Removal Alternatives Analysis and Final Design, Ayer, Massachusetts. Mr. LeBlanc oversaw the review of water quality data, establishment of treatment goals, and the design of PFAS treatment at the Town's existing 2-mgd Spectacle Pond WTP. Point of Use device testing for PFAS removal efficacy and coordination with MassDEP are key elements of the project. Granular activated carbon was identified at bench scale as most effective on this site's water. The low Contractor bid of \$5.1 million was received in fall 2020, and construction will conclude in spring 2022.

Technical Advisor, PFAS Mitigation, Littleton, Massachusetts. For the Littleton Water Department (LWD), Mr. LeBlanc oversaw the AIX and GAC bench-scale testing for PFAS removal from the Spectacle Pond WTP source water and consulted on the blending of Spectacle Pond WTP water with the lower-PFAS Beaver Brook WTP water. LWD has been achieving compliance via blending while its new GAC plant is designed and constructed.

Technical Director, PFAS Removal Planning in Massachusetts. Mr. LeBlanc serves as technical director for several CDM Smith projects that provided PFAS treatment planning to communities in Massachusetts, including work at the 1-mgd Avon WTP in Brockton, MA; at the 4-mgd Horn Pond WTP in Woburn, MA; and the 0.38 mgd Lincoln Street Well in Manchester-by-the-Sea, MA.

Education

- ME - Civil Engineering. Colorado State University, 2007
- BS - Civil Engineering. Northeastern University, 1994

Registration

- Professional Engineer: Colorado (1999), New Hampshire, Massachusetts, Connecticut, New Jersey, Maryland, Illinois, Maine and Rhode Island
- State of New Hampshire Water Works Operator, Combined Grade CIA

Certifications

- Confined Space Entry Certification

Honors/Awards

- Board Certified Environmental Engineer (BCEE), American Academy of Environmental Engineers and Scientists

Professional Activities

- Vice Chair, Sustainable Infrastructure Committee, American Water Works Association
- Past Chair, Filtration Committee, New England Water Works Association
- Member, American Society of Civil Engineers
- Member, New Hampshire Water Works Association

Publications/Presentations

LeBlanc, A. "Find Fix for PFAS Crisis"; Viewpoint article published in Engineering News Record (ENR), March 21/28, 2022.

LeBlanc, A. "The Current and Future Practice of PFAS Treatment in New England and Beyond." Presented at the New England Water Works Association / Rhode Island Water Works Association Joint Membership Meeting. Virtual meeting platform. July 2020.

LeBlanc, A. "Treatment Technologies for PFAS Mitigation." Presented at the New England Water Works Association Groundwater Committee PFAS Symposium, Milford, Massachusetts. December 2019.

LeBlanc, A. "Pennies on the Dollar – Using A Rigorous Bench- and Pilot-Scale Testing Program to Inform PFAS Treatment Decisions." Presented at the AWWA-New Jersey Fall 2019 Meeting, Neptune, New Jersey. October 2019.

LeBlanc, A. "Evaluation and Design of Ion Exchange for Optimal PFAS Treatment of Groundwater." Presented at the New England Water Works Association Annual Conference, Rockport, Maine. September 2019.

LeBlanc, A. "Current and Future Practice of PFAS Treatment in Wisconsin and Beyond." Presented at the Water Executives of Southeastern Wisconsin Quarterly Conference, Milwaukee, Wisconsin. August 2019.

LeBlanc, A. "Current and Future Practice of PFAS Treatment in Ohio and Beyond." Presented at the Dayton Society of Professional Engineers Luncheon, Dayton, Ohio. July 2019.

Schaefer, C. E., Nguyen, D., Ho, P., Im, J., and LeBlanc, A. "Assessing Rapid Small-Scale Column Tests for Treatment of Perfluoroalkyl Acids by Anion Exchange Resin" published in Industrial & Engineering Chemistry Research, June 2019.

LeBlanc, A. "Design and Operational Considerations for Treatment of PFAS Contaminants – Case Studies." Presented at the New England Water Works Association's 21st Annual Water Quality Symposium, Milford, Massachusetts. May 2019.

LeBlanc, A. and White, M. "Treatment Solutions to Address Emerging Concerns over Per- and Polyfluoroalkyl Substances (PFAS)." Presented at the Illinois Section of the American Water Works Association's WaterCON, Springfield, Illinois. March 2019.

LeBlanc, A. "The Current and Future Practice of PFAS Treatment in New England and Beyond." Presented at the New Hampshire Water Works Association's 2018 New Hampshire Drinking Water Exposition and Trade Show, Concord, New Hampshire. October 2018.

LeBlanc, A. "From Discovery to Remediation: A PFAS Case Study." Presented at New Hampshire Water Works Association Operator Training Forum, Portsmouth, New Hampshire. January 2018.

Technical Advisor, PFAS Removal, Garden Grove, California.

Mr. LeBlanc served as technical advisor for the 3,500 gpm (5 mgd) Well 21 West Haven Well Site. GAC, anion exchange (AIX), impacts on the pumping systems, and associated work requirements were examined to aid the City of Garden Grove's planning efforts. This work is being conducted as part of the Orange County Water District's overall PFAS program, with the end goal of mitigating the appreciable cost of purchased water being incurred by the City.

Technical Advisor, PFAS Removal, East Orange County Water District, California.

Mr. LeBlanc serves as technical advisor for work on EOCWD's two-well system, where entrained air and PFAS removal are key treatment objectives. This work is being conducted as part of the Orange County Water District's overall PFAS program, with the end goal of mitigating the appreciable cost of purchased water being incurred by EOCWD.

Project Technical Leader, PFAS Removal Peer Review Services, Mansfield, Massachusetts.

The Town of Mansfield retained CDM Smith for peer review services overseeing its on-call water consultant's PFAS removal planning and design work for two separate groundwater treatment facilities. Mr. LeBlanc serves as project technical leader for these services.

Project Technical Leader, PFAS Removal Conceptual Design, Confidential Client.

At a surface water treatment plant of nearly 200 mgd capacity in the eastern United States, Mr. LeBlanc is leading the evaluation of how best to implement PFAS removal systems by retrofitting existing filters, installing post-filter GAC contactors, or post-filter anion exchange systems. The work involves planning for pumping and chemical systems modification in addition to PFAS removal, with capital costs potentially more than \$100 Million. Pilot testing will commence in summer 2022.

Project Manager, Process Selection and Design of New Water Treatment Plant, Manchester, New Hampshire.

For the Manchester Water Works' new 7.2-mgd Merrimack River WTP, Mr. LeBlanc is managing the pilot testing, process selection, and design that features greensand filtration and a GAC polishing step for taste, odor, organics, and potential PFAS removal. The \$28.3 million plant is expected to serve Manchester and potentially water systems throughout southern New Hampshire, given water supply shortages and PFAS contamination concerns in the region.

Technical Advisor, PFAS Removal, South Plainfield, New Jersey.

Mr. LeBlanc serves as a technical advisor for the 12-mgd Park Avenue WTP PFAS study and design for the Middlesex Water Company. A treatment alternatives analysis has been completed, as were bench and pilot-scale testing, design and bidding. The work is under construction.

Amrou Atassi, PE, BCEE, PMP

Technical Advisor



Mr. Atassi is a senior project manager and senior project engineer specializing in drinking water treatment. With 22 years of experience, he has worked on all phases of water treatment projects, including pilot testing, corrosion control and water quality studies, master planning, water quality compliance issues, design, and construction phase services. He has worked on a wide range of projects from 0.2 mgd to 1.2 bgd plants ranging in cost from \$5,000 to \$250 million. Mr. Atassi has led the conceptual and detailed design of several water treatment plant project in Illinois, Indiana and Wisconsin. Mr. Atassi has presented on water distribution, corrosion control, and treatment topics at various local and national AWWA conferences. He has led several Water Research Foundation (WRF) projects related to corrosion control and distribution system water quality and is a member of the Project Advisory Committee for WRF 4713 – “Full Lead Service Line Replacement Guidance.”

Senior Project Manager, Lead Service Line Replacement (LSLR) Plan, Inventory and Phase I LSLR Implementation, Chicago, Illinois. Mr. Atassi worked with the City of Chicago and Mayor’s office to develop Chicago’s LSLR Plan, including an inventory of nearly 400,000 lead service lines (LSLs). He led development of various programs phased over time to remove LSLs in the system. The plan included prioritization strategies to phase the program, public outreach, construction details and costs, financing and funding options, and more. Mr. Atassi is currently working with the City to implement the Phase I Program.

Technical Reviewer, LSLR Program, Newark, New Jersey. Mr. Atassi is serving as a technical advisor for the City of Newark’s corrosion control optimization program and replacement of LSLs. He is reviewing corrosion control studies, contract documents, and replacement procedures.

Technical Reviewer, City of Trenton LSLR Program, Trenton, New Jersey. Mr. Atassi is serving as a technical advisor for Trenton Water Work’s corrosion control optimization program and replacement of LSLs, as well as the design of a phosphate system addition.

Project Manager, UV Disinfection Feasibility Study, Sheboygan, Wisconsin. Mr. Atassi served as the project manager and lead project engineer for a UV feasibility study at the Sheboygan 34-mgd WTP. The study evaluated the type and location of a new UV system within the WTP. Mr. Atassi prepared conceptual layouts for different locations to install the UV system at the WTP.

Lead Project Engineer/Corrosion Control Specialist, Water System Assessment and Red Water Control Study, US Navy, NAVFAC, Segionella Navy Base, Italy. Mr. Atassi served as the lead project engineer for the evaluation of Segionella Navy base’s water facilities (reverse osmosis or RO system) and investigation of red water sources in the distribution system. Mr. Atassi led field reconnaissance efforts including field sampling at different sites on Base to evaluate water quality (two-week comprehensive site assessment and field sampling). He developed treatment alternatives to reduce the corrosivity of the water and address red water concerns on base, including modifications to the RO system as well as the addition of a calcite contactor.

Project Engineer, Submerged Membrane Filtration/PAC System Facilities, Racine, Wisconsin. Mr. Atassi served as project engineer for the design of a 50-mgd submerged membrane filtration system in Racine. He assisted in

Education

- MS, Environmental Engineering, Purdue University, 2001
- BS, Civil Engineering, Valparaiso University, 2000
- Registration
- Professional Engineer: Illinois (2004)

Certifications

- Project Management Professional (PMP), 2019
- HAZWOPER
- Confined Space Entry
- OSHA Construction Safety & Health

Honors/Awards

- Board Certified Environmental Engineer (BCEE), American Academy of Environmental Engineers and Scientists
- First Place, AWWA ACE 2006 (Toronto, Ontario) Poster Session
- 2002 Indiana Section AWWA Leo Bessozi Youth Delegate

preparing procurement documents for the selection and evaluation of piloted membrane systems. He was also involved in the design of the membrane system and related ancillary equipment, as well as design of the powdered activated carbon storage and feed system.

Lead Project Engineer, Water Treatment Residuals Management Study, Crystal Lake, Illinois. Mr. Atassi was responsible for completing mass balance analyses of water treatment residuals resulting from ion exchange softening systems. He developed several alternatives for meeting National Pollutant Discharge Elimination System (NPDES) permit requirements and prepared cost-benefit analysis for the alternatives.

Project Manager/Co-Principal Investigator, WaterRF 4317, Non-Intrusive Methodology for Assessing Lead and Copper Corrosion (Teamed with Marc Edwards & Jeff Parks at Virginia Tech University). Mr. Atassi is serving as project manager and co-principal Investigator on WaterRF 4317 to develop and evaluate corrosion control evaluation methods, such as pipe loops, for lead and copper corrosion. Pipe loop systems are currently being design to evaluate corrosion control in the distribution system for five participating utilities.

Project Manager/Co-Principal Investigator, WaterRF 4033, Impact of Phosphate Corrosion Inhibitors on Cement-Based Pipes and Linings (Teamed with Marc Edwards & Jeff Parks at Virginia Tech University). Mr. Atassi served as project manager and co-principal Investigator on WaterRF 4033 to understand the impact of water quality and phosphate products on cement-based pipes. The research project includes 20 utilities using different phosphate corrosion inhibitors.

Co-Principal Investigator, WaterRF 4014, Comparison of Zinc Versus Non-Zinc Corrosion Control for Lead and Copper (Teamed with American Water Service Company and Marc Edwards at Virginia Tech University). Mr. Atassi served as co-principal Investigator on WaterRF 4014 to evaluate zinc-phosphate products and their effectiveness with lead and copper corrosion control.

Professional Activities

Member, American Water Works Association (AWWA) – Indiana, Illinois and Wisconsin Sections

Member, Indiana Section AWWA's Research and Technology Committee and Water for People Committee & Illinois Section AWWA's Technical Program Committee

Member, AWWA Distribution Research Committee

American Society of Civil Engineers: Served as a Corresponding Member from 2002 to 2004 on the ASCE Book of Knowledge (BOK) Sub-committee under the Task Committee for First Professional Degree

Water Environment Association – Illinois Water Environment Association and Central States Water Environment Association

Corrosion Specialist, Highland Park WTP Improvements, Highland Park, Illinois.

Mr. Atassi developed testing protocols for the evaluation of the impact of treatment process changes on corrosion variables. He worked with Virginia Tech University on bench-scale testing to evaluate the impact on changes from conventional treatment to membranes and from chloramines to sodium hypochlorite. He provided the city with key recommendations to maintain compliance with the Lead and Copper Rule.

Project Manager, Chloride-Less Ion Exchange Alternatives Pilot Testing, Crystal Lake, Illinois.

Mr. Atassi led bench scale testing of several ion exchange alternatives being tested by US Filter that would allow the City of Crystal Lake to meet their NPDES permit of 500 milligrams per liter (mg/L) for chlorides.

Lead Process Engineer, Corrosion Control Optimization Study and Revised Lead and Copper Rule (LCR-R) Compliance, Racine, Wisconsin.

Mr. Atassi is working to develop a corrosion control optimization program that includes desktop analysis, bench-scale testing, pipe loop testing, and negotiations with the regulatory agency. He is also assisting the City with LCR-R compliance, including sequential sampling, scale analysis, and LSL inventory.

Michael A. Zafer, PE

Technical Advisor



In 35 years of drinking water experience with CDM Smith, Mr. Zafer has focused on treatment process selection and verification, treatability studies for the optimization of plant process design and operations, and assisting water suppliers with complex regulatory compliance and water quality issues. Mr. Zafer's experience removing PFAS from groundwater and surface water supplies includes bench-, pilot-, and demonstration scale studies for GAC, ion exchange (IX), novel adsorbents, reverse osmosis; alternatives analysis; facilities design; startup/commissioning; process optimization; research for fate and transport, removal, concentration, and destruction; and permitting. He has participated in more than 10 PFAS projects nationally and a variety of drinking water projects in Wisconsin, Illinois, Minnesota, and Michigan.

Project Manager, PFAS Projects with Water Research Foundation (WRF). Mr. Zafer is currently managing two Water Research Foundation Projects: Assessing Poly and Perfluoroalkyl Substance Release from Finished Biosolids (WRF 5042) where CDM Smith is the Principal Investigator; and CDM Smith's role as a subconsultant on Investigation of Treatment Alternatives for Short-Chain PFAS (WRF 4913).

Technical Advisor, Pilot-Study and Facilities Design for PFAS Removal Facilities Design, East Orange County Water District, Orange, California. As technical advisor, Mr. Zafer provided technical review of pilot-scale treatability study results for degasification, IX resin, and a novel adsorbent for a 2.6 mgd groundwater treatment plant. The design is complete, and construction began in early 2022.

Technical Advisor, Northwest WTP, Brunswick County, Brunswick County, North Carolina. Mr. Zafer served as a technical advisor for the treatability studies and design for a 41 mgd facility to remove PFOA, PFOS, GenX, NDMA, and other contaminants from the Cape Fear River in Brunswick County, North Carolina. The team conducted desk-top, bench-, and pilot-scale studies to evaluate GAC, IX, UV-AOP, ozone-biologic filtration, and low pressure reverse osmosis (LPRO) and found membranes to be the most cost-effective solution. He helped develop testing protocols, evaluate test results, establish design criteria, and review design documents.

Technical Advisor, PFAS Conceptual Design Project and Pilot Study for PFAS Removal at the Haworth WTP, SUEZ North America, New Jersey. As technical advisor, Mr. Zafer provided technical review of the Conceptual Design Report that evaluated GAC (as filter adsorbents and post-filter contractors) and IX alternatives for removal of low concentrations of PFAS from surface water at the 188 mgd Haworth WTP. The next phase of work will begin in early 2022 and consist of a 12-month on-site pilot study to evaluate GAC, IX, and novel adsorbents. CDM Smith will: develop the testing protocol; procure, install, and operate the equipment; analyze data; and conduct an alternatives analysis to select the preferred treatment process.

Technical Advisor, PFAS Removal and Facilities Design for Park Avenue WTP, Middlesex, New Jersey. As technical advisor, Mr. Zafer reviewed bench- and pilot-scale PFAS removal study results for GAC and helped to troubleshoot biologic fouling observed in the GAC contactors. The 12 mgd Park Avenue WTP is currently under construction.

Education

- MS - Civil Engineering, Southern Methodist University, 1991
- BS - Civil Engineering, Southern Methodist University, 1986
- Registration
- Professional Engineer: California (1993), Nevada (2008), and New Mexico (2016)

Certifications

- Certified Drinking Water Treatment Operator: California T2 (2013), and New Mexico WS2 (2016)

Professional Affiliations

- Instructor for Water Treatment Operators
- Bay Area Consortium for Water and Wastewater Engineers, in conjunction with Solano Community College, California

Training Lead/Permitting Lead, Anaheim Groundwater Treatment Plant (GWTP) Phase A PFAS Design-Build, City of Anaheim, California. Mr. Zafer is providing technical review and permitting assistance, and will lead operator training activities for the design, construction, and commissioning of four new groundwater treatment plants (24 mgd combined capacity) that will use IX for PFAS removal. The project includes the installation of pilot-scale columns to assess alternative media types (IX, GAC, or adsorptive media) and optimize full-scale performance.

Technical Advisor, Owen District Road PFAS WTP, City of Westfield, Massachusetts. As a technical advisor, Mr. Zafer assisted with the technical review of design documents and commissioning of the Owen Road WTP, a 4 mgd facility that features 12-foot diameter GAC vessels for removal of PFAS from groundwater.

Technical Advisor, GAC and IX Examination for PFAS Removal and Facilities Design for Grove Pond WTP and Spectacle WTP, Town of Ayer, Massachusetts. As technical advisor, Mr. Zafer provided technical review of treatability study results for GAC and IX, and review of specifications for GAC and commissioning activities for the 2-mgd groundwater Spectacle WTP. At the Grove Pond WTP (2-mgd) he is working with the team to investigate accelerated headloss through the IX vessels after pretreatment for iron and manganese removal.

Treatment and Regulatory Specialist, Glendale Groundwater Water Treatment Facility, Glendale Water & Power, California. Mr. Zafer served as a process and regulatory specialist for the Glendale treatment facility that features air strippers, GAC vessels, and ion exchange to remove VOCs, PFAS, and Cr VI. He has worked closely with the client and stakeholders for the past several years on various aspects of the plant and well operations. Mr. Zafer provided technical leadership for the investigation and identification of optimal treatment alternatives to remove multiple contaminants and maximize water production. He also provided regulatory assistance for rehabilitation and disinfection of multiple wells, as well as evaluation of alternative carbons and IX resins.

Professional Activities

Instructor, Operator Certification and Water/Wastewater Professionals Training for Bay Area Consortium for Water and Wastewater Education (BACWEE); and Water and Wastewater Technology Program at Solano Community College, Fairfield, CA

Member, American Water Works Association

Project Advisory Committee for AWWARF Guidance Manual for Coagulant Changeover

Member, Research Committee for the CA-NV AWWA Section

Moderator/Desalination Expert, California-Israel Water Conference, June 2016

Panel Member, California Lake Management Association Seminar on Taste and Odor Control in California Surface Waters, August 1990.

Water Treatment Specialist, Linnwood Water Purification Plant Particulate Study, Milwaukee Water Works, Wisconsin. Mr. Zafer served as one of three Expert Panel members to evaluate the design and performance of the 275-mgd Linnwood Water Purification Plant with respect to particulate removal and other critical water quality and operational criteria. The project concluded with a 2-day workshop at the plant in November 2015.

Project Engineer, Filtration Improvements and Expansion Project, Central Lake County Joint Action Water Authority, Lake Bluff, Illinois. For the Central Lake County Joint Action Water Authority in Lake Bluff, Illinois, Mr. Zafer led the design of pilot filtration equipment that was used to evaluate high-rate biologic filtration for future plant expansion. He also served as an advisor to identify and prioritize process improvements to add capacity to the 50 mgd plant featuring ozone, high-rate clarification, biologic filtration, and UV disinfection.

Technical Advisor, Jardine and South Water Purification Plants Filter Inspections and Improvements, Chicago, Illinois. For the Chicago Department of Water Management (DWM), Mr. Zafer served as a technical advisor for filters investigations at the Jardine Water Purification Plant (1,400-mgd). He is advising on filter investigations and design to upgrade the 120 filters at the Sawyer Water Purification Plants (720 mgd).

Charles E. Schaefer Jr., PhD

Technical Advisor



Dr. Schaefer is a chemical engineer with a wide array of experience in fate and transport of organic contaminants in soil and bedrock. In particular, his studies have focused on pore-scale phenomena, non-aqueous phases in porous media, coupled diffusion and reaction processes, and treatment of emerging contaminants. Dr. Schaefer has carried out bench and field-scale experiments and developed physically based numerical models to describe processes such as diffusion, sorption, interfacial mass transfer, mineral-based reactions, and microbial growth and transport. Much of Dr. Schaefer's work has included work with NAPL systems, where he has worked on issues ranging from rate limited dissolution of chlorinated solvents, to co-solvent/surfactant flooding, to thermodynamic models that predict activity coefficients of hydrocarbon mixtures.

Dr. Schaefer is a leading researcher in treatment of per- and polyfluoroalkyl substances (PFAS), such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). He has served as a principal investigator on several research grants, including projects of the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP). Dr. Schaefer has authored more than 50 peer-reviewed papers and is an active member of the Interstate Technology and Regulatory Council (ITRC). His honors include the SERDP/ESTCP Project of the Year awards in 2013 and 2018.

SERDP, ER-2720: Key Fate and Transport Processes Impacting the Mass Discharge, Attenuation, and Treatment of PFAS and Commingled Chlorinated Solvents or Aromatic Hydrocarbons.

Co-Principal Investigator to attain improved insight into the fundamental processes that control PFAS fate and transport as well as comingled chlorinated solvents and/or fuel hydrocarbons in groundwater at AFFF-impacted sites. Investigated the fundamental mechanisms controlling the release of PFAS from complex source-zone phases. Examined the coupled diffusion and potential abiotic reactions of PFAS and comingled contaminants in low permeability materials. Assessed the biotic transformation of the wide range of PFAS and co-contaminants (chlorinated solvents and BTEX) present in the dissolved plume and the impacts of PFAS on co-contaminant bioremediation. Quantified the impacts of remedial activities targeting co-contaminants (i.e., BTEX, chlorinated solvents) on the PFAS plume. Provided new insight into the fundamental fate and transport processes in these mixed contaminant systems that will facilitate development and optimization of treatment strategies for PFAS sites comingled with co-contaminants.

SERDP, ER18-1259: A Mechanistic Understanding of PFASs in Source Zones: Characterization and Control.

Co-Principal Investigator to characterize the transport of anionic, cationic, and zwitterionic PFAS and their interactions with organic matter and mineral phases of pristine soils/sediments and with PFAS-coated soils/sediments. Characterizing the number and type of thermodynamically stable phases that form when AFFFs are mixed with common non-aqueous phase liquids (NAPLs), such as JP4 and trichloroethene, and their impact on PFAS transport under saturated conditions. Assessing PFAS mobility under unsaturated conditions in the vadose zone to identify the key hydraulic parameters that control PFAS mobility and retention.

SERDP, ER-2424: Investigating Electrocatalytic and Catalytic Approaches for the In Situ Treatment of Perfluoroalkyl Contaminants in Groundwater.

Education

- PhD – Chemical and Biochemical Engineering, Rutgers University, 1997
- MS – Chemical and Biochemical Engineering, Rutgers University, 1997
- BS – Chemical and Biochemical Engineering, Rutgers University, 1993

Certifications

- OSHA 40-hr Hazardous Materials training
- OSHA Site Supervisor training

Principal Investigator to develop and assess the use of electrocatalytic and catalytic approaches for in situ treatment of PFAS in groundwater. Developed electrocatalytic approaches focusing on the ability of ruthenium oxide-coated titanium (Ti/RuO₂) and other mixed metal oxide (MMO) anodes to oxidize PFAS in groundwater under a wide range of conditions; catalytic approaches will focus on the use of supported rhodium-based catalysts for the hydrodefluorination of PFAS in groundwater under ambient conditions. Preliminary bench-scale testing of these technologies by the project team, along with previously published studies, indicate that these technologies hold exceptional promise for the in-situ treatment of PFAS under ambient conditions at many DoD facilities. Evaluated reaction kinetics, reaction intermediates and products, optimal catalyst materials, geochemical and co-occurring chemical impacts on treatment effectiveness, and potential applicability to field-scale remediation as part of this project with four peer-reviewed publications.

SERDP, ER18-1204: Insights into the Long-Term Mass Discharge & Transformation of AFFF in the Unsaturated Zone. Principal Investigator to attain insight into the transformation and mass discharge of PFAS from AFFF sources that reside in the vadose zone and capillary fringe, and to understand how these processes change over time and with AFFF composition and mass. Researched the unique processes that occur in the vadose zone (e.g., varying saturation due to wetting and drying, aerobic/anaerobic cycling, creation of air-water interfaces, and release of natural colloids) and their impacts on PFAS fate and mass discharge to underlying groundwater. Assessed and quantified the relationship between PFAS mass removal and mass discharge; this functionality is known as the source strength function. Identified the processes that control this relationship and possible approaches to characterize this functionality for AFFF-impacted sites.

SERDP, ER19-1205: Assessing and Mitigating Bias in PFAS Concentrations during Groundwater and Surface Water Sampling. Co-Principal Investigator to determine the factors that impact PFAS stratification in water columns (surface water and wells). Evaluated field materials and procedures (including decontamination) to eliminate bias when collecting water samples. Quantified the impact of laboratory sample hold times and storage conditions to eliminate bias in measured PFAS concentrations.

ESTCP, ER20-5088: PFAS Leaching at AFFF-Impacted Sites: Insight into Soil-to-Groundwater Ratios. Principal Investigator to improve insight into PFAS leaching through the unsaturated zone to serve as a basis for developing soil cleanup criteria and facilitating site management. Assessing the factors controlling PFAS leaching in the vadose zone. Determining how soil properties impact PFAS porewater migration and overall source longevity. Identifying unsaturated zone characteristics that impact PFAS migration to groundwater.

Peer-Reviewed Publications

Lippincott, D., Streger, S.H., Schaefer, C.E., Hinkle, J., Stormo, J., Steffan, R.J. "Bioaugmentation and propane biosparging for in situ biodegradation of 1,4-dioxane", Ground Water Monitoring and Remediation, in press.

McGuire, M.E., Schaefer, C.E., Richards, T., Backe, W.J., Field, J.A., Houtz, E., "Evidence of Remediation-Induced Alteration of Subsurface Poly-and Perfluoroalkyl Substance (PFAS) Distribution at a Former Firefighter Training Area", Environ. Sci. Technol., 48, 6644-6652, 2014.

Jihyon Im, PE

Environmental Engineer



Ms. Im is an environmental engineer with eight years of experience specializing in the design of new water treatment facilities and upgrades to existing facilities. For the past several years, she has been on the front lines in the fight against PFAS, working on testing and facility design improvements that can help clients confidently serve their communities with safe potable water. Additionally, she has experience performing studies for master planning, treatment evaluations, regulatory review, and water quality and system analyses.

Project Engineer, Study, Testing, and Final Design for Per- and Polyfluoroalkyl Substances (PFAS) Treatment with Ion Exchange, Ayer, Massachusetts. Ms. Im served as the project engineer for testing, planning, design, and construction of PFAS treatment upgrades at the Grove Pond WTP (2-mgd capacity). She was responsible for the establishment of treatment goals, regulatory review, water quality data analysis, assessment of treatment alternatives, engineering assistance on bench-scale testing of granular activated carbon (GAC) and ion exchange (IX), and final design of the treatment facility with IX and chemical systems in addition to providing support during the construction of the facility.

Project Engineer, PFAS Treatment Alternative Analysis, Bench-Scale Testing and Piloting-Scale Testing, and Temporary Treatment with GAC, Middlesex Water Company (MWCo), New Jersey. Ms. Im served as the project engineer for desktop study and bench-scale testing phases for the 12-mgd Park Avenue Water Treatment Plant (WTP) that has been impacted by PFAS contamination. She was responsible for the establishment of treatment goals, regulatory review, water quality data analysis, assessment of treatment alternatives, and cost evaluation. She provided support on bench-scale testing of GAC and IX and pilot testing of GAC. While the permanent GAC system is being constructed, she worked with MWCo and Contractor to plan and permit temporary GAC treatment on-site.

Project Engineer, Technical Review of Rapid Small Scale Column Tests (RSSCTs) for PFAS Removal and Engineering Support during Bidding, Suez New York, New York. Suez NY hired CDM Smith and another consultant perform RSSCTs for its 21 groundwater facilities with a capacity range from 65 gpm to 2,000 gpm. Ms. Im led the technical review and cost analysis of the RSSCT results to provide a comprehensive recommendation of GAC products to be qualified to bid for supplying media to all of the sites. She also provided engineering support during the bidding phase.

Drinking Water Specialist, Island-Wide PFAS Management Plan, Nantucket, Massachusetts. Ms. Im served as the drinking water specialist to assist the Town of Nantucket in developing a unified PFAS management plan for the Town to protect the groundwater resources by identifying all potential PFAS contaminant sources on the island and assessing their potential risks. She is responsible for creating the PFAS cycle on the island and providing guidance on drinking water compliance and sampling.

Project Engineer, Bench-Scale Testing and Final Plant Design for PFAS Removal, Westfield, Massachusetts. Ms. Im served as the project engineer for CDM Smith's work for the City of Westfield's 2,700-gallon-per-minute Well 7 and Well 8 treatment facility. The \$5.3 million project evaluated GAC at bench scale to treat the City's source water, and also evaluated the facility requirements for GAC contactors, chemical systems, an office and sampling area, and ancillary building spaces.

Education

- MS – Civil Engineering, University of New Hampshire, 2015
- BS – Environmental Engineering, University of New Hampshire, 2013

Registration

- Professional Engineer: New Hampshire (2018)

Professional Activities and Awards

- Young Professional Liaison, Technical and Education Council, American Water Works Association (AWWA) (2018-2020)
- Vice Chair, National Young Professionals Committee, AWWA
- Recipient of the 2021 AWWA's Inaugural 5 under 35 Outstanding Young Professional Award.
- Recipient of the 2018 New England Water Works Association (NEWWA) Younger Member of the Year Award
- Recipient of the 2017 NEWWA Volunteer of the Year Award
- Chair, University Outreach Committee, NEWWA (2015-2018)
- Member, Program Committee, NEWWA
- Member, Engineers Without Borders – New Hampshire Professional Chapter

Publications/Presentations

- Im, J. & Thieler, M. "What to Gain from Both RSSCT Bench-Scale and
- Field-Scale Studies to Evaluate PFAS Treatment", Presented at American Water Works Association New Jersey 84th Annual Conference, Atlantic City, NJ, September 2021.
- Im, J. & Schofield, T. "Pilot Testing, Design, and Construction of Anion Exchange Resins for DBP Precursor Removal", Presented at New England Water Works Association (NEWWA)'s Spring Conference, March 2021.
- Im, J. & LeBlanc, A. "Advancing the Practice: Insights from Four PFAS Treatment System Implementations", Presented on AWWA PFAS Virtual Summit, February 2021.
- Im, J. "Same Town, Two Different Plants and Two Different PFAS Treatment Solutions", Presented on AWWA Florida Contaminants Committee Webinar, August 2021.
- Im, J. & Wetzel, M. "Granular Activated Carbon and Ion Exchange - Common Technologies for PFAS treatment, the Ayer experience", Presented on AWWA Current and Emerging Technologies for PFAS Treatment and Lessons Learned Webinar, June 2020
- Im, J. & Wetzel, M. "PFAS - An Emerging and Evolving Issue - Focus for Water Suppliers", Presented at Rhode Island Water Works Association Annual Training & Exposition, Smithfield, RI, September 2019.
- Im, J. "PFAS - An Emerging and Evolving Issue - Focus for Water Suppliers", Presented on AWWA Florida Contaminants Committee Webinar, July 2019.
- Im, J. & Wetzel, M. "Working Together to Identify and Implement the Optimal Groundwater Treatment Solution for PFAS", Presented at AWWA Annual Conference and Exposition, Denver, CO, June 2019.
- Im, J. "Implementing the Optimal PFAS Treatment Solution for Two Groundwater Systems", Presented at American Water Works Association New Jersey 84th Annual Conference, Atlantic City, NJ, March 2019.
- Im, J. "PFAS - An Emerging and Evolving Issue - Focus for Water Suppliers", Presented at Massachusetts Water Works Association January Membership Meeting, Leicester, MA, January 2019.
- Stayton, H. & Im, J. "Preserving the Value of Existing Wells by Systematically Addressing PFAS Groundwater Contamination." Presented at AWWA Annual Conference and Exposition, Las Vegas, NV, June 2018.
- LeBlanc, A., Im, J. & Billips, D. "Systematic Approach to PFAS Groundwater Contamination - From Study to Design." Presented at NEWWA Annual Conference, Brewster, MA, September 2017.
- LeBlanc, A. & Im, J. "From Discovery To Remediation: A Case Study: City of Westfield, MA." Presented at NHWWA Operator Training PFAS Workshop, Portsmouth, NH, January 2018.

Project Engineer, Testing for PFAS Treatment with GAC, Cambridge, Massachusetts. Ms. Im is serving as the project engineer for evaluating and testing the alternative GAC products that will serve as both the conventional filter media and adsorbent for PFAS removal at the City of Cambridge's 22-mgd facility. She was responsible for the water quality data analysis, assessment of media alternatives, and engineering assistance on bench-scale testing.

Project Engineer, Report on PFAS Treatment with GAC, Confidential Client. Ms. Im led the technical efforts of performing literature review on GAC treatment for PFAS removal, reviewing the client's internal standards for the existing GAC systems and O&M, and producing a comprehensive report on this topic covering treatment, spent media management, sampling/laboratory considerations, and recommendations to prepare for PFAS treatment.

Project Engineer, PFAS Blending Study and Sampling Program, Bedford, Massachusetts. The Town of Bedford detected PFAS at varying levels above and below the state Maximum Contaminant Level (MCL) and Ms. Im assisted the Town in performing the blending analysis to determine various operational scenarios that can blend the finished water level to meet the MCL and facilitating the associated sampling program.

Project Engineer, PFAS Treatment Decision Guidance Tool, Confidential Client. Ms. Im served as a project engineer for a confidential client with sites contaminated with PFAS. She helped product decision guidance tools that summarized available treatment technologies and all available information on their applicability, efficiency, and cost-effectiveness, which will be used to facilitate the client's future PFAS treatment efforts.

Project Engineer, Study and Testing for PFAS Treatment with Granular Activated Carbon (GAC), Ayer, Massachusetts. Ms. Im served the project engineer for testing and planning of PFAS treatment upgrades at Spectacle Pond WTP (2-mgd capacity). She was responsible for the establishment of treatment goals, regulatory review, water quality data analysis, assessment of treatment alternatives, and engineering assistance on bench-scale testing of GAC and ion exchange (IX). She also assisted with the design of the GAC facility.

Project Engineer, PFAS Water Service Line Installations, Manchester, New Hampshire. Twenty-six homes in the City of Manchester experienced well water contamination by PFAS from an industrial source, and CDM Smith was contracted by Manchester Water Works to design water service lines to connect the affected homes to Manchester Water Works' water mains. Ms. Im visited each home to perform field investigation to determine the pipe routing of the water service line and any potential construction constraints and to keep homeowners informed of the project development, especially due to the sensitive nature of the project background.

Dung D. Nguyen

Lead Lab Technician



Mr. Nguyen is a chemical and environmental engineer experienced in bench-, pilot-, and full-scale design and implementation of in-situ and ex-situ soil and treatment systems in the US and internationally. He manages CDM Smith's Research and Testing Laboratory where he leads design support treatability studies and innovative research and development work on fate and transport, along with treatment of PFAS. He serves as Principal or co-Principal Investigator on a number of Department of Defense-funded projects evaluating fate and transport of PFAS in the environment and demonstrating potentially applicable PFAS treatment technologies. He has conducted treatability studies in remediation areas including bioremediation, chemical oxidation, and biogeochemical transformation of chlorinated solvents.

Project Engineer, Chemical Oxidation of Dioxane Using Permanganate, multiple locations.

As a CDM Smith research and development (R&D) project. Mr. Nguyen designed and guided the implementation of experiments evaluating the application of using permanganate to oxidize 1,4-dioxane in soil and groundwater.

Project Engineer, Enhanced Anaerobic Bioremediation of TCE with Glycerin, multiple locations. For another CDM Smith R&D project, Mr. Nguyen assisted in the research evaluating the effectiveness of glycerin as an alternative electron donor in promoting TCE biodegradation.

Project Engineer, Whittaker-Bermite Site, Santa Clarita, California. Mr. Nguyen assisted in culturing and maintaining perchlorate-degrading cultures for soil perchlorate bioremediation.

Project Engineer, In-situ Chemical Reduction Using ZVI, Murphy Site, Murphy, North Carolina. Mr. Nguyen helped in the design and executed the experiment evaluating the use of ZVI in reducing chlorinated solvents such as PCE and TCE in contaminated soil and groundwater.

Project Engineer, South Lake Site, Lexington County, South Carolina. Mr. Nguyen designed and executed experiments evaluating the use of ZVI and EHC in degradation of TCE in contaminated soil and groundwater.

Project Engineer, Union Pacific Railroad, California. Mr. Nguyen designed and executed experiments evaluating the use of different electron donors and bioaugmentation cultures in treating soil and groundwater heavily contaminated with ketones, petroleum products, and chlorinated solvents.

Project Engineer, Chemical Oxidation Using Permanganate and Persulfate with and without Buffers, Athens, Alabama. Mr. Nguyen designed and executed experiments evaluating the use of different oxidants in treating site soil and groundwater contaminated with chlorinated solvents.

Project Engineer, Union Pacific Railroad, California. Mr. Nguyen designed and executed experiments evaluating the use of different electron donors and bioaugmentation cultures in treating soil and groundwater heavily contaminated with ketones, petroleum products, and chlorinated solvents.

Education

- M.S. – Environmental Engineering, Vanderbilt University, 2010
- B.S. – Environmental Engineering, Claflin University, 2008

Project Engineer, Biogeochemical Transformation of TCE, AFCEE, Altus, Oklahoma. Mr. Nguyen executed experiments evaluating different biogeochemical factors that influence the abiotic transformation of TCE in groundwater.

Research Assistant, Department of Civil and Environmental Engineering, Vanderbilt University, Tennessee. Mr. Nguyen conducted a column study for leaching assessment of inorganic contaminants in cementitious barriers.

Research Assistant, Department of Environmental Science and Engineering, Claflin University, South Carolina. Mr. Nguyen designed and conducted microcosm studies evaluating the use of peats in removing MTBE and heavy metals from contaminated groundwater.

Publications

Rizzuti, A.M., A.D. Cohen, and D.D. Nguyen. "Evaluating Peats for Their Capacities to Extract MTBE from Contaminated Water Using Solid-phase Microextraction with Gas Chromatography." *Journal of Environmental Science and Health Part A*, 43: 132-142. 2008.

Melissa A. Harclerode, PhD, BCES

Risk Communication



Dr. Harclerode is a technical specialist with 16 years of experience in environmental management across a variety of market sectors including remediation, water resources, solid waste management, and transportation. Specifically, she specializes in the development and application of integrated assessment approaches to comprehensively define sustainability objectives and evaluate environmental, social, and economic impacts of environmental infrastructure and restoration projects. Dr. Harclerode provides technical support and modeling on environmental footprint analysis, life cycle assessment, community impact evaluations, risk communication, public outreach planning, climate change vulnerability assessments, and development of sustainable best management practices. As a Project Technical Lead (PTL), she is experienced in designing and managing multi-disciplined teams. Dr. Harclerode's responsibilities also include serving as PTL or conceptual site model (CSM) lead for various site remediation projects, including emerging contaminants per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane.

Stakeholder Engagement Specialist, 53V Risk of Harm Assessment Program Framework Document, Private Client, Australia, 2019 to present. Dr. Harclerode led the development of the external stakeholder engagement component of the Framework Document. This component was comprised of external stakeholder mapping via an interest-influence matrix, stakeholder values assessment via a high-level desktop review of public media articles in concert with the current CSM, and communication framework encompassing site assessment stakeholder engagement decision factors and potential communication methods. The external stakeholder engagement component of the framework was prepared as a proactive measure to initiate public communication and stakeholder engagement planning prior to the commencement of site investigation activities. PFAS is the site contaminant of concern.

Public Outreach and Risk Communication Specialist, PFAS Town-wide Assessment, Municipal Client, 2020 to present. Dr. Harclerode facilitated a Public Communication and Outreach Planning Meeting with the client team and PFAS subject matter experts. The objective of the meeting was to identify short- and long-term public communication and outreach needs and action items as part of the Town-wide Assessment. Each action item represents a communication and outreach plan component that may be eventually compiled into a proactive public outreach plan. Based on discussions at the meeting, action items were assigned suggested prioritized as either immediate, short-term, intermediate-term, or long-term. Outreach components include a communication team, outreach strategy matrix, PFAS update in the town electronic newsletter, town-specific fact sheet, FAQs, town website updates, social media, and public engagement activities. CDM Smith is initiating development of a public outreach plan and facilitation of a communication team.

Risk Communication Specialist, PFAS Contingency Plan and Action Plan, Municipal Client, 2020. Dr. Harclerode provided support on development of a PFAS Contingency Plan to support responding to expected upcoming regulations. The plan includes guidance, from risk and public communications perspective, on safe uses of water not treated for PFAS. Subsequently, Dr.

Education

- PhD – Environmental Management, Montclair State University, 2016
- MS – Environmental Science, Rutgers University/New Jersey Institute of Technology, 2010
- BS – Environmental Science and Biology, Muhlenberg College, 2005

Certifications

- American Academy of Environmental Engineers & Scientist, Board Certified Environmental Scientist, Sustainability Specialty, 2017

Years of Experience

- CDM Smith: 15
- Total Years: 15

Honors/Awards

- 28th Annual APEX Awards for Publication Excellence; The winning article, Integrating the Social Dimension in Remediation Decision-Making: State of the Practice and Way Forward, was published in the Winter 2015 issue of Remediation Journal.

Professional Activities

- At-Large Board Member, Sustainable Remediation Forum (SURF), 2014 and 2015
- Social Aspect TI Lead, Sustainable Remediation Forum (SURF), 2013 through present
- Technical Reviewer for Journal of Environmental Management, 2016 through present

Harclerode led the development of a PFAS Action, a communication framework and compilation of outreach tools to aid effective and meaningful public outreach. The objective of the communication framework is to formalize when and how to engage customers and other public stakeholders about distribution system PFAS sampling results. The Action Plan is a living document that will be continuously updated to incorporate community and public stakeholder needs and concerns throughout outreach strategy implementation.

Risk Communication Specialist, Water Supply Well, Private Client. Dr.

Harclerode collaborated with the client to develop responses to “tough questions” for a public engagement event concerning the presence of 1,4-dioxane and PFAS in drinking water supply wells. Message mapping technique was applied to formulate simple, concise responses that comprehensively contain pertinent information.

Project Technical Lead, PFAS Remedial Investigation, Design, and Interim Treatment, New York.

Confidential Client, 2019 to present. Dr. Harclerode is the PTL for an ongoing site investigation of an AFFF discharge and testing area, discharged foam conveyance infrastructure, and an area of an identified accidental release event. Data visualization was used as a tool to assess contaminant migration pathways, PFAS compound specific plume footprints, and relationship of precursors concentrations with carboxylic acid groups, such as PFOA. In addition, the CDM Smith team is performing a six-month design/build of a temporary treatment system to remove PFAS from an existing groundwater air stripper treatment system effluent. The temporary system is response to regulatory drivers and will serve as a pilot study to inform full-scale design of a potential multicomponent remedy to include source zone remediation and risk management. A formal feasibility study, treatability study, and remedial design tasks is commencing.

Workshop Lead

- Interstate Technology Regulatory Council (ITRC) PFAS Risk Communication and Risk Communication Toolkit, Workshop Trainer. Multiple venues and formats, both virtual and in-person training.
- Risk vs. Risk Perception in Remediation. Washington Department of Ecology, Corrective Action Network Meeting, September 22, 2016, Bellevue, Washington. Led training.

Research and Development (R&D) Projects:

- **Sustainable Risk Management Framework.** Dr. Harclerode was Technical Lead for the development of an early decision framework designed to facilitate the identification of metrics and tools to confidently evaluate performance of sustainable risk management strategies in alignment with stakeholder needs and overcome barriers associated with risk perception, uncertainty, and lack of transparency. The framework was published in the 2016 Journal of Environmental Management Special Issue on Sustainable Remediation.
- **National Groundwater Association (NGWA) PFAS Guidance.** NGWA prepared a guidance on per- and polyfluoroalkyl substances (PFAS), an emerging contaminant that has impacted site-specific drinking water supplies. Dr. Harclerode was responsible for preparing the risk communication chapter.
- **Interstate Technology & Regulatory Council (ITRC) PFAS & Public Outreach Guidance.** Dr. Harclerode is the section lead for the risk communication chapter for the ITRC PFAS Guidance and ITRC Risk Communication Toolkit, both published in 2020. She is currently a workshop trainer for both ITRC resources.

Jason Maskaly

O&M Specialist



Mr. Maskaly has 22 years of total expertise, 12 years of which have been with CDM Smith, in the maintenance, startup, testing and commissioning of equipment; developing maintenance management programs; and developing and presenting training programs for a wide range of facility types, including water treatment plants employing dissolved air flotation treatment systems, as well as GAC and AIX treatment solutions for PFAS. Mr. Maskaly brings directly applicable experience to this project through his most recent assignments as an Operations Specialist for the scheduling, start-up, and testing of the new Owen District Road WTP in Westfield, MA, that uses GAC to treat PFAS. He performed similar duties for the 2-mgd Grove Pond WTP upgrade in Ayer, MA, that implemented an AIX treatment system for PFAS.

Operations Specialist, Owen District Road Water Treatment Plant (WTP) PFAS Treatment Facility, Westfield, Massachusetts. Mr. Maskaly assisted in the scheduling, startup, and testing of a new 3.88-mgd water treatment plant that was designed to remove Per- and polyfluoroalkyl substances (PFAS) from groundwater through four carbon adsorption vessels that contain 40,000 pounds of granular activated carbon (GAC) and the filtered water was then doses with sodium hypochlorite and a phosphate chemical prior to entering into the water distribution system. Mr. Maskaly was responsible for witnessing equipment checkouts, testing, and startup activities. Mr. Maskaly wrote the facility Operations and Maintenance (O&M) Manual and reviewed all equipment vendor Operation and Maintenance Manuals. Mr. Maskaly also edited the pre-existing Emergency Response Plan (ERP) to include the new water treatment plant.

Operations Specialist, Grove Pond WTP PFAS Treatment Facility, Ayer, Massachusetts. Mr. Maskaly assisted in the scheduling, startup, and testing of an upgraded 2-mgd Grove Pond Water Treatment Plant that was designed to remove PFAS from groundwater through two ion exchanger vessels that contain 18,000 pounds of resin each. The filtered water was dosed with calcium thiosulfate to dechlorinate prior to the ion exchangers and zinc orthophosphate and sodium hypochlorite prior to entering into the water distribution system. Mr. Maskaly was responsible for the witnessing equipment checkouts, testing, and startup activities. Mr. Maskaly wrote the facility Operations and Maintenance (O&M) Manual and reviewed all equipment vendor Operation and Maintenance Manuals. Mr. Maskaly also created a standard operating procedure for flushing the ion exchanger resin and startup and testing plan for the Ion Exchangers that was approved by Massachusetts Department of Environmental Protection.

Operations Specialist, Canoe Brook Water Treatment Plant, Millburn, New Jersey. Mr. Maskaly assisted in the scheduling, startup, and testing of a new 15-mgd water treatment plant equipment that included two (2) Ozone production and destruction systems, three (3) Dissolved Air Floatation (DAF) units, four (4) rapid multi-media filters. Mr. Maskaly was responsible for the witnessing equipment checkouts, testing, and startup activities of the plant process equipment. During the commissioning phase of the water treatment

Education

- MS- Environmental Science, University of Idaho, 2017
- BS - Nuclear Engineering Technology, Thomas Edison State College, 2008
- Navy Nuclear Power School, Charleston, South Carolina

Certifications/Training

- Grade 4 Drinking Water Operator License: Massachusetts
- Grade 6 Combined Wastewater Operator License: Massachusetts
- OSHA 10 hour Construction Safety and Health Course
- OSHA 40 hour HAZWOPER Course
- OSHA HAZWOPER Site Supervisor Course
- NASSCO certified Pipeline, Lateral, and Manhole Assessment and Certification Program
- Universal Refrigeration License

Completed Navy trade schools in the following subject areas:

- Mechanical machinery construction and maintenance
- Leadership and management
- High pressure air compressor operation and maintenance
- Quality assurance inspections
- Quality assurance officer
- Nuclear Propulsion Plant Operators Welding
- R-114 Maintenance School
- EPA Universal Refrigerant certification

plant Mr. Maskaly monitored and made recommendations to the plant staff on changes to the plant equipment operational setpoints to optimize plant operations. Mr. Maskaly also developed a Lockout Tagout (LOTO) System, asset data for a computerized maintenance management system (CMMS), and a complete valve list for the facility. Mr. Maskaly coordinated the purchase of food grade lubricants for all equipment that is in contact with the water flowing through the treatment plant.

Operations Specialist, Department of Defense, United Air Force. Mr. Maskaly was the head writer for the Unified Facilities Criteria (UFC) for domestic wastewater treatment (UFC 3-240-02) and a technical reviewer for the Water Treatment UFC (UFC-3-230-03). Mr. Maskaly ensure that all current and applicable information for the operation and maintenance of both the wastewater and water treatment plants was written in both UFC's such that operators can use the documents to operate their plant.

Operations Specialist, Department of Defense, United States Navy. Mr. Maskaly reviewed the assets at a 7.5 mgd conventional water treatment plant to create a complete asset list and assessment of the assets at the water treatment plant. While on site, Mr. Maskaly also reviewed the plant operations, standard operating procedures (SOPs), various construction drawings, and interviewed the operations staff to learn and understand the current treatment plant operations. Mr. Maskaly then took this information and updated the water treatment plants operation plan and created SOPs that matched the current plant operations and other applicable industry standards. Mr. Maskaly also provided training to the plants operation staff of the updated operations plan and SOPs to ensure that all staff were aware of the new changes in documents and ensure that they were all operating the treatment plant in the same manner. Mr. Maskaly provided recommendations to the task manager that were incorporated into a memo that documented safety and operational improvements recommendation to the client for future planning.

Operations Specialist, Confidential Company, New York. Mr. Maskaly is part of the managing contractor that reviews and provides technical guidance on operation, maintenance, and asset management to the owner and operating contractor for ground water remediation and building air contamination. The groundwater systems include recovery pumps, airstrippers, and two clearwell pumps each. The managing contract includes two groundwater treatment systems, a Sub Slab Depressurization System, and a Soil Vapor Extraction System.

Operations Specialist, Water Pollution Control Facility (WPCF) Upgrade, Stratford, Connecticut. For the 11.1-mgd (average daily flow with a peak flow of 35-mgd) Stratford WPCF Upgrade, Mr. Maskaly assisted with instrumentation checkouts, equipment checkouts, testing and startup activities. He is also contributing to the development of sections for the facility Operations and Maintenance (O&M) manual. The Stratford WPCF upgrade includes an upgraded headworks facility, upgraded primary treatment system, a two-stage biological treatment system, ultraviolet disinfection and solids handling facilities. Mr. Maskaly also conducted training on the facilities new methanol system.

Operations Specialist, CMMS Training, New York City, New York. Mr. Maskaly conducted training at various locations for the New York City DEP, each location containing more than 100 personnel for periods of up to three weeks at each location. He conducted training on the Oracle Utilities Work and Asset Manager version 1.7.15.3.2. This program is all inclusive for work orders, work request, asset management, PM management, and inventory control. The training was conducted by "hands-on" training through computers on a training version of the production program.

Meghan Drew

Permitting

Ms. Drew is an environmental engineer with four years of experience with AutoCAD, Bluebeam Revu, and Microsoft Office. She also has experience applying for permits and helping clients obtain SRF funding.



Sheboygan Raw Water Intake Design, Sheboygan, Wisconsin (2020-2021). Ms. Drew assisted in design of the intake structure into Lake Michigan including the intake pipe, potassium permanganate chemical piping, icing prevention tactics, and the intake crib. She performed calculations, reviewed design standards, communicated with suppliers, coordinated drafters and assisted in writing specifications. Ms. Drew also assisted in the design of raw water pump station yard piping. Ms. Drew organized and coordinated permitting and funding efforts and communicated with Wisconsin DNR and US Army Corps of Engineers permitting departments regularly.

Oak Lawn Transmission Main Expansion Project (Bid Packages 6A and 4B), Sheboygan Raw Water Intake Project, DuPage Electrical Improvements Project, Illinois (2018-2022). Ms. Drew completed funding requests and applications for various regulating bodies including the Illinois EPA State Revolving Fund Loan program and the Wisconsin DNR Safe Drinking Water Loan Program. She also coordinated disbursements for projects in Rock Island, Wilmette, and Racine.

CLCJAWA Centrifuge Replacement Project, Illinois (2019-2020). Ms. Drew assisted in the design of the project including calculations, drawing review and specification writing. She assisted in the project's centrifuge equipment procurement and coordination of a subcontractor's sound impact study. She also assisted in bidding services, permitting, and the construction phase of the project.

Bloomington Chemical Improvements Project, Illinois (2020-2021). Ms. Drew assisted in the design of a new anhydrous ammonia application system and a new chlorine scrubbing system. She also completed a technical memorandum comparing the use of anhydrous ammonia, liquid ammonium sulfate, and aqua ammonia. She communicated with vendors, designed the ammonia system layout, drafted and reviewed drawing sets, and wrote specifications.

NEWPP Houston, Texas (2019). Ms. Drew assisted in multiple rounds of review of the filtration facility design. She also assisted in coordinating multiple technical specialist's reviews for drafting.

Joliet Water Supply Plan Study, Independent Cost Review, Illinois (2019). Ms. Drew reviewed the cost estimates made by another engineering firm for multiple different water supply options for the city of Joliet for validity of assumptions and cost comparison with CDM's previous experience.

Oak Lawn Transmission Main Expansion Project, Illinois (2019-2021). Ms. Drew assisted in the design and permitting of a 60-inch diameter transmission main. She also conducted site visits and reviewed contractor submittals. She also obtained an SRF Loan from the Illinois EPA, coordinated all disbursement requests and communicated updates to IEPA.

Naperville Water Reclamation Center UV Disinfection Improvements, Illinois (2021-2022). Ms. Drew assisted in the design of a new UV treatment

Education

BS – Civil Engineering, University of Illinois at Urbana-Champaign, 2018

system. She reviewed proposals from vendors and assisted in creating a contract with Trojan and coordinating the design of the facility with Trojan.

Bloomington Water Treatment Plant Improvements Pre-Design Study, Illinois (2021-2022).

Ms. Drew completed multiple tasks within this improvements study. Ms. Drew performed a field investigation of the water treatment plant's chemical systems' compliance with regulatory requirements and design standards. She also completed a technical memorandum detailing the chemical system investigation results and detailed regulatory improvements to each of these systems and additional safety improvements. She also completed a technical memorandum evaluating recarbonation system alternatives including addition of recarbonation basins, basin by-pass and in-pipe recarbonation, and impacts of pH and phosphate application. Ms. Drew also completed a technical memorandum presenting new raw water intake alternatives and pump station improvements. Ms. Drew also completed a technical memorandum identifying multiple improvements to the filtration system at the water treatment plant including hydraulic improvements, taste and odor removal, backwash improvements, and filter expansion.

City of Decatur Long-Term Sustainability Plan, Illinois (2020-2021). Ms. Drew assisted in writing a summary report of multiple studies and condition assessments pertaining to the City of Decatur's water sources, treatment facilities, and distribution system. She also assisted in creating a financial plan for the utility coordinating capital improvements projects.

Oak Creek Water and Sewer Utility Master Plan (2020). Ms. Drew assisted in writing a summary report of multiple studies and condition assessments pertaining to the City of Oak Creek's water sources, treatment facilities, and distribution system.

Marion Water Utilities, Risk and Resilience Assessment (2020-2021). Ms. Drew performed a risk and resilience assessment for the City of Marion's Water Utility using CDM Smith's Risk and Resilience Assessment (RRA) excel tool. She wrote a report detailing findings and associated recommendations to increase Utility resilience.

City of Naperville, Risk and Resilience Assessment (2020). Ms. Drew performed a risk and resilience assessment for the City of Naperville using CDM Smith's RRA excel tool. Ms. Drew assisted in performing risk assessments of each of the Utility's assets. She wrote a report detailing findings and associated recommendations to increase Utility resilience.

City of Oak Lawn, Risk and Resilience Assessment (2020-2021). Ms. Drew performed a risk and resilience assessment for the City of Oak Lawn using CDM Smith's RRA excel tool. She wrote a report detailing findings and associated recommendations to increase Utility resilience.

Professional Activities

- Member, American Society of Civil Engineers
- Member; American Water Works Association

TONIA WESTPHAL, PE, LEED AP

Project Support

As an experienced civil engineer, Tonia is keenly aware that decisions made today, have a lasting impact on future improvements and the community's vitality. Highly engaged with her clients, Tonia proactively facilitates informed decision-making to optimize the impact on the community. Her clients have come to rely on her experience and insights to provide engineering solutions that support their goals.

Tonia's strong communication skills, coupled with her technical expertise, enable her to facilitate collaborative efforts with stakeholder groups in a meaningful manner. Tonia frequently serves as a liaison between municipal entities, technical staff, clients, stakeholders, regulatory agencies, and the general public. She excels at presenting technical information to the general public and in receiving and understanding public input as it relates to the project design.

- Wausau Waterworks Lead Compliance Consulting, Wausau, WI
- Wausau Waterworks Water Quality Investigation, Wausau, WI
- Wausau Waterworks Drinking Water Risk Resilience Assessment (RRA) and Emergency Response Plan (ERP), Wausau, WI
- Drinking Water Treatment Facility (DWTF) Electrical Design and Construction Services, Wausau, WI
- 72nd Avenue Lift Station and Building Design and Construction, Wausau, WI
- DWTF Solar Array, Wausau, WI
- Infiltration and Inflow (I/I) and Interceptor Sewer Rehab Study, Wausau, WI
- Industrial Park Lift Station Pump Addition and Rehabilitation, Wausau, WI
- Industrial Park Lift Station Construction Services, Wausau, WI
- Industrial Park Lift Station Upgrades and Force Main Cleaning, Wausau, WI
- Stewart Avenue Force Main and Interceptor Sewer, Wausau, WI
- Cleveland and 72nd Avenue Lift Stations, Wausau, WI
- Kronenwetter Water Utility, Future Water Capacity and Quality Study, Kronenwetter, WI
- Sanitary Sewer Master Plan Update, Weston, WI
- Apache Lane Utilities and River Crossing Design and Construction Services, Weston, WI
- Trotzer Avenue and Ryan Street Lift Station Design, Weston, WI
- Weston School Neighborhood Reconstruction Design and Construction Services, Weston, WI
- 2017-2021 WPS Weston Plant Grading and Paving Design and Construction, Rothschild WI
- WPS Weston Plant Storm Sewer and Outfall Replacement, Rothschild, WI
- WPS Weston Power Plant Crusher House, Weston, WI



Education: BS, Environmental Engineering

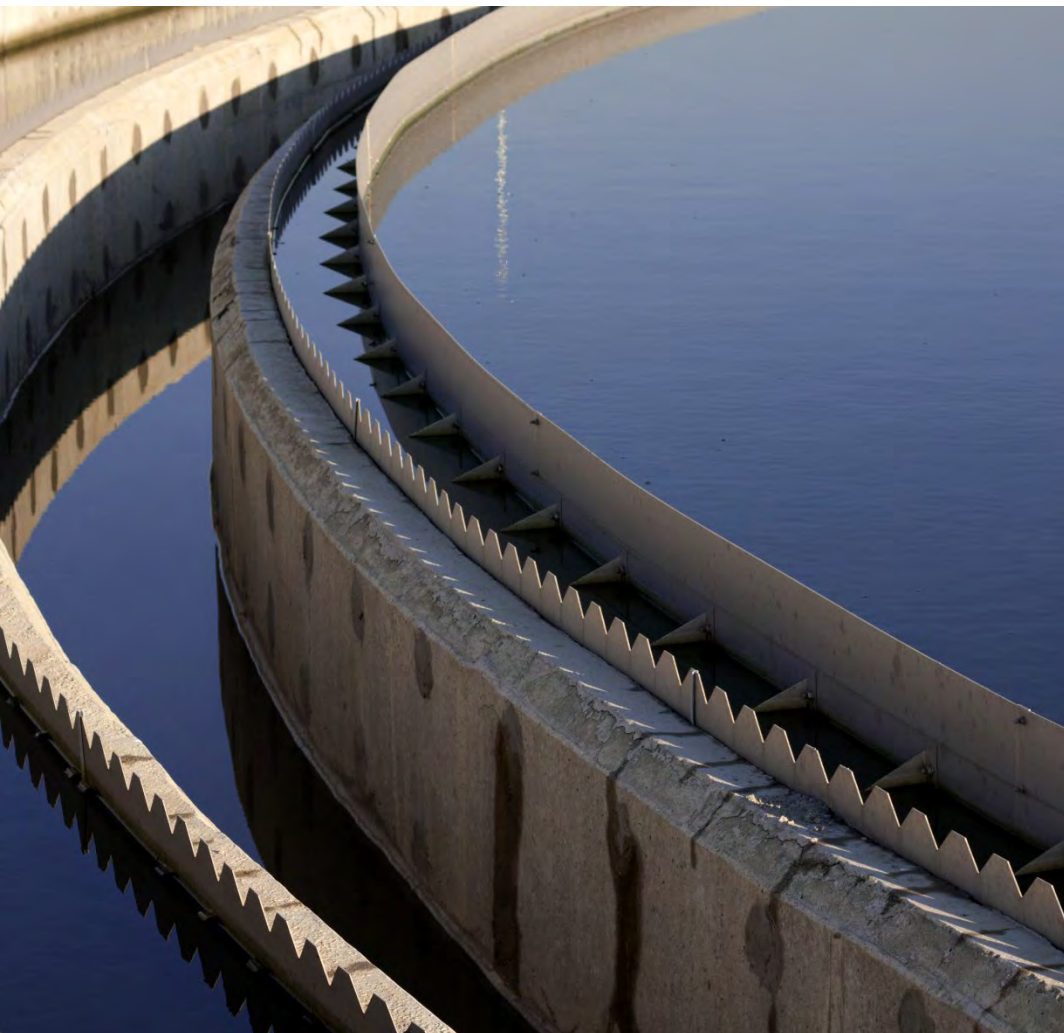
Registration: PE: WI, MI; LEED Accredited Professional (LEED AP)



Professional Experience Related to PFAS Treatment & Removal for Drinking Water and Wastewater

City of Wausau
Wausau Water Works
Wausau, Wisconsin

March 28, 2022





Wood Environment & Infrastructure Solutions, Inc.
16 N. Carroll St.
Suite 700
Madison, WI 53703
USA
T: 608-819-6494

March 28, 2022

Eric Lindman, PE
City of Wausau – Director of Public Works & Utilities
407 Grant St.
Wausau, WI 54403

www.woodplc.com

**Subject: Request for Engineering Professional Qualifications & Scope of Services
Professional Experience Related to PFAS Treatment & Removal for Drinking Water and Wastewater**

Dear Eric Lindman,

Wood Environment & Infrastructure Solutions, Inc. (Wood) is pleased to submit this Statement of Qualifications (SOQ) for the City of Wausau – Wausau Water Works (WWW) in response to the Request for Qualifications (RFQ) received March 10, 2022.

Wood understands that the WWW is seeking qualified engineering services for expertise related to Per- and polyfluoroalkyl substances (PFAS) treatment and removal options for Wausau's drinking water. Wood will assist WWW and the project team, which include the engineering firms Donohue & Associates and Becher Hoppe & Associates, to evaluate the ongoing PFAS treatment pilot study and to consider a broad range of alternatives to identify the best, most cost-effective solution for Wausau.

Our proposed project team has extensive experience with PFAS treatment in drinking water and groundwater, Wisconsin regulations and permits, PFAS chemistry, fate and transport, and investigations for PFAS in multiple media (including biosolids), risk communication and risk assessments, as well as the evaluation of alternative water supply options. Our team combines local leadership, expertise of Wisconsin regulations, and PFAS and water treatment subject matter experts from around the country and Canada.

As outlined in this SOQ, our Team is exceptionally qualified to support this work because we have:

- **Extensive expertise with PFAS drinking water and groundwater treatment.** We have completed a variety of water treatment projects across the U.S. ranging from conceptual studies to bench, pilot, and full-scale treatment projects. Our team has experience designing and evaluating a variety of drinking and groundwater treatment technologies including granulated activated carbon (GAC), single use ion exchange (IX), regenerable IX, foam fractionation, organoclay, and reverse osmosis.
- **A local presence with strong State regulatory understanding.** Our proposed project team includes Wood's licensed Wisconsin professional engineers in our Madison, WI office combined with national and international PFAS experts. Our key staff have experience working with regulatory agencies and obtaining approvals for drinking water treatment designs. Whether it requires approvals through State regulators for water treatment alternatives and waste stream analysis / solids handling or assistance with SRF funding, our team will provide the expertise needed for this project.
- **Track record of delivering water and wastewater projects.** Wood has been executing traditional water and wastewater projects for more than 70 years. Since 2017, Wood has completed more than 600 water/wastewater

projects using teams comprised of more than 870 experienced professionals. Typical services include plant condition assessments & modernizations, energy and operational and maintenance support to improve compliance and reduce costs. Our proposed project team combines PFAS and drinking water subject matter experts to provide integrated solutions.

- **Expertise supporting State and International Governments with PFAS.** Wood has been supporting State, Federal and international clients, including Wisconsin, Michigan, Minnesota, New York, and Vermont, with challenges posed by PFAS since 2008. Wood recently completed the Drinking Water Conceptual Plan and evaluated alternative water supply options for 14 communities and more than 140,000 East Metro community members in Minnesota. Wood has also been supporting the Wisconsin Department of Natural Resources (DNR) since 2019 with technical oversight and evaluation of PFAS in towns of Peshtigo and Campbell, WI. Our team has also worked with the States of Wisconsin and Minnesota developing a framework for evaluating PFAS across each state.
- **PFAS Leadership roles in industry organizations.** In late 2016, Wood (previously as Amec Foster Wheeler) co-authored the proposal for the initiation of a PFAS Team to the Interstate Technical Regulatory Council (ITRC), <https://pfas-1.itrcweb.org/>. The team is now nearly 500 volunteers, the largest in ITRC history. Wood's proposed team members Shalene Thomas and Dora Chiang continue to serve in leadership roles on the Team for PFAS Training, AFFF, and Risk Communication and Regulations.
- **Leadership in PFAS research and development.** Wood participated in the invitation-only Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP) PFAS workshop held in May 2017. Wood is currently supporting action items from that workshop and is near completion on two key projects: (1) Combined In-Situ/Ex-Situ Treatment Train for Remediation of PFAS Contaminated Groundwater (Project ER18-1306) and (2) Removal and Destruction of PFAS and Co-contaminants from Groundwater (Project ER18-5015). We are also awaiting additional DOD related research funding on PFAS background in multi-media, foam fractionation, and onsite destruction of PFAS waste via a novel Gasification technology that produces a beneficial gas for reuse.

We look forward to discussing how our Team can work with the WWW. Should you have any questions, please feel free to call Evan Thomas, Project Manager at (608)-819 6494.

Regards,

Wood Environment & Infrastructure Solutions, Inc.



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1. Project Understanding and Approach

Wood Environment & Infrastructure Solutions (Wood) understands Wausau Water Works (WWW) is soliciting consulting engineering services with expertise related to treatment and removal of Per- and polyfluoroalkyl substances (PFAS) from Wausau's drinking water. Wood will assist WWW and support the project team, which includes the engineering firms Donohue & Associates and Becher Hoppe & Associates, to evaluate and select the most appropriate PFAS removal and treatment options for the City's drinking water.

If selected for this project, Wood will utilize our company wide PFAS expertise and more than 16 years of PFAS experience to support water supply development efforts through design and implementation of practical, cost-effective water treatment and PFAS removal technologies. The information obtained from the collaborative pilot study and Wood's extensive research and development portfolio will be used to evaluate and provide solutions for your water supply challenges and needs.

Approach to Wausau Water Work's Needs

Wood will establish a partnership with Wausau Water Work's project team early in the project, involving all major stakeholders to identify key project concerns and to foster a trusting relationship that delivers value throughout the life of the project. An effective working relationship, including clear and timely communication, will be important in the design and implementation of an efficient and cost-effective project. Our first task will be to meet with WWW's project team to determine their specific needs and expectations, refine the scope of work, and establish an effective chain of communication. Woods approach to meeting WWW's objectives includes:

- Focus on understanding and meeting WWW's current and future project needs
- Assess and apply innovative and/or established water treatment processes used for drinking water treatment
- Evaluate near-, mid- and long-term PFAS mitigation strategies to help WWW ensure a reliable water supply
- Investigate available funding opportunities for alternatives considered (if desired)
- Support regulatory approvals through our involvement and in-depth understanding of State and Federal PFAS regulatory activities
- Provide PFAS risk communication and public outreach services, if requested
- Identify and proactively managing potential project constraints that could jeopardize project development
- Execute the approved scope of work in a cost-effective manner
- Focus efforts on completing the project on schedule and within budget through effective project management and resource allocation

Wood has an extensive track record of delivering high value projects that meet and exceed clients' expectations.

2. Firm Profile

Wood is a global leader in the delivery of project, engineering, and environmental services, operating in more than 60 countries with revenues of over \$8 billion (USD). Our staff of over 40,000 people offer full-service solutions to public and private sector clients throughout North America and internationally. Wood has more than 7,000 professionals in the U.S. in 69 locations. We draw on our experienced local managers and geographical reach to support the needs of clients.

In the Great Lakes, Wood has six offices with 148 staff in support of our local project deliveries. Our local project teams are supported by our Global Technical Excellence Network (GTEN) comprising key specialty leaders and subject matter experts (SMEs) to ensure our projects are delivered with high quality exceeding client's expectations, including those SMEs that comprise Wood's PFAS Work Group.



Wood is a Global Leader in PFAS and We Provide High-Value Solutions

When it comes to emerging contaminants, PFAS in particular, Wood has been taking on the challenges as an industry leader and delivering results since 2006. We have a mature practice with hundreds of PFAS projects around the globe, providing a full spectrum of services including **bench and pilot scale testing, full-scale treatment system design and construction**, system operation and maintenance, as well as source identification, risk communication, and education. Wood is committed to advancing the practice and participates in nearly \$2M in PFAS research and development annually. Exhibit 1 below illustrates our full range of PFAS services.

Exhibit 1. Wood offers the full range of PFAS Related Services



Wood's PFAS recognitions include:

- **Peer-reviewed publications** on PFAS emerging/novel treatment technologies (separation and destruction technologies), fate and transport, precursor analysis and investigation, risk assessment and PFAS background studies.
- Developing and demonstrating **innovative PFAS treatment technologies** with federal Department of Defense (DOD) and industrial funding to work collaboratively with leading universities (e.g., Clarkson University, Oregon State University, University of Georgia, McGill University, Princeton University, Duke University) to advance our understanding of the characteristics, risks, and potential remedies for PFAS.
- **Pilot study, design and operation** of the world's first-ever closed loop PFAS removal and destruction facility.
- Established partnerships with leading technology vendors to support advances in emerging chemicals science and engineering (including ECT2 for **regenerable ion exchange** (IX) resin; Purolite for **single use ion exchange** resin; 374Water for **supercritical water oxidation** for destruction of PFAS-laden wastes).
- Facilitating and collaborating with non-profit organizations to help educate stakeholders, and regulatory agencies. Wood members actively lead as members of the ITRC PFAS team and share knowledge through technical work sessions with State agency teams, such as WDNR PFAS Work Group and Minnesota Pollution Control Agency (MPCA) PFAS Stakeholders Advisory Group. We are also a member of the Emerging Contaminant Working Group of American Water Works Association (AWWA) as well as a member of several State Manufacturing Association PFAS Work Groups (for example, the Michigan Manufacturers Association and the North Carolina Manufacturers Alliance).
- An established PFAS laboratory auditing program to ensure consistent delivery and the highest data quality; this is particularly vital for PFAS which require the use of alternative materials, sampling and analysis techniques.
- Long-standing **PFAS best management practices and procedures** and internal training modules associated with monitoring/sampling, fate/transport, and treatment technologies, to support project execution across the Wood global team. These training modules can be easily adopted for external training modules.
- **Internal treatability testing laboratory capabilities** (*Exhibit 2*).

Exhibit 2. Wood's In-house Laboratories Advance Technical Excellence and Innovation



Our treatability study laboratories located in San Diego, Atlanta and Cambridge, Ontario are fully equipped to customize treatability studies, jar testing and technology development for technologies such as chemical oxidation, metal precipitation, stabilization and solidification, granulated activated carbon (GAC) column studies, specialized media columns (zeolite, organoclay, biochar), filtration, coagulation, membranes, biodegradation microcosm studies, biofiltration, air sparging, and various drinking water, wastewater, surface water quality testing.



Our laboratory services integrate with our remedial design and operation practice to evaluate, develop, design and optimize treatment technologies throughout a project's remediation life cycle. We also collaborate with research universities to unbiasedly develop technologies that provide the best value to our clients.

Partnering with Clients to Deliver High Quality PFAS Projects Locally

In the Great Lakes Region, we have 6 Wood offices and have been supporting clients with PFAS projects since 2008 (**Exhibit 3**).

Wood has been executing PFAS projects in Wisconsin since 2019. Wood has supported the Wisconsin Department of Natural Resources (WDNR) with technical oversight of PFAS investigation and treatment of groundwater impacted by AFFF testing in Marinette, Wisconsin. Additionally, Wood has conducted door-to-door private potable well sampling at more than 400 properties in town of Peshtigo, Wisconsin and more than 200 properties in Campbell, Wisconsin.

In Minnesota, Wood is assisting the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Natural Resources (MN DNR) to develop and assess long term projects to provide clean drinking water to communities of the East Metro Area affected by the 3M PFAS contamination of the groundwater supply. Fourteen communities and nearly 140,000 people in the southeast suburbs of Minneapolis – St. Paul, Minnesota are affected by the contaminated groundwater. Wood developed a conceptual drinking water supply plan (CDWSP) that determines long-term solutions for each community.

Exhibit 3. Locations of our PFAS projects in the Upper Great Lakes



Wood performed the following tasks, on behalf of the State, that are relevant to WWW's proposed scope of work:

1. **Performed an evaluation of existing, emerging/novel treatment technologies, and potential relevance to each of the 14 communities water supplies.** Wood evaluated regional solutions (surface water treatment, new well fields and regional water treatment facilities), community solutions (establish small community water systems in rural areas, install treatment for PFOS/PFOA/PFBA/Fe/Mn. at municipal wells and private wells), or individual solutions (point of use or point of entry treatment systems) to provide clean drinking water.
2. **Reviewed data collected and project from community-specific PFAS pilot testing and provided recommendations for improvements and additional testing. Performed peer review of project deliverables.** Wood supported the State as technical reviewer for the pilot study timeline, work plan, execution, troubleshooting, results, and reporting completed by another engineering firm for the City of Cottage Grove during the CDWSP development. Wood continues to review project application submittals (bid packages) from communities to ensure alignment with the CDWSP and appropriate and acceptable approach and costs to address PFAS contamination.
3. **For more than 2 years, participated in technical workshops, monthly meetings and one-on-one sessions with more than 100 stakeholders, from local government units (LGUs), elected officials, State Commissioners to public works directors, water utilities, city engineers, citizens, and consultants.** Wood supported the State with monthly meetings

with a citizen and business workgroup, a government and 3M working group as well as a Technical Sub-group. Wood provided educational sessions around PFAS treatment technologies as well as progress and updates for the CDWSP.

4. **Developed and presented cost estimates for PFAS treatment and drinking water options for each community to Stakeholders.** Wood developed recommendations and cost estimates for each of the drinking water projects identified in the CDWSP for each community. Information was presented to the State and then to Workgroups, technical sub-groups, and the public.
5. **Reviewed to water quality across the 14-community area and encountered at existing drinking water systems to evaluate pre-treatment options.** The water quality study was performed to determine requirements for pre-treatment. Where pre-treatment was anticipated, cost estimates were completed and included in the CDWSP.

For more information on this product and to review Wood's work product, videos for Work Group and public meetings and more, go to: <https://3msettlement.state.mn.us/>

Water and Wastewater Capability

Wood has been delivering traditional water and wastewater projects for more than 70 years. Since 2017, Wood has completed more than 600 water/wastewater projects using teams comprised of more than 870 experienced professionals. Typical services include plant condition assessments & modernizations, energy and operational and maintenance support to improve compliance and reduce costs.

More recently, our team has provided advanced and side-stream water treatment analysis for municipal WTPs targeting PFAS and other soluble constituents found in drinking water supply that cannot be removed through traditional coagulation and settlement treatment schemes. Our team brings knowledge and experience with targeting various soluble constituents with IX, GAC, Greensand Plus, Reverse Osmosis, Nanofiltration, UV and other advanced treatment technologies to ensure the right treatment solution is matched with the individual treatment facility and source water.

3. PFAS Project Experience and Descriptions

Wood has conducted PFAS projects across the full lifecycle of treatment including feasibility studies, bench scale testing in our Cambridge, Ontario and San Diego, California laboratories, pilot testing, and full-scale design, construction, and operations, maintenance, and monitoring (OMM). **Our PFAS treatment experiences are highlighted as:**

- **Full-scale groundwater treatment systems.** Wood is contracted by Department of Defense (DOD) to operate and maintain full-scale PFAS treatment systems at two air force bases (AFBs). Wood is currently under contract to manage, operate, maintain, and monitor two granular activated carbon (GAC) systems and one single-use ion exchange resin system at Wurtsmith AFB. Wood is also operating two PFAS treatment systems at Pease AFB with one system using single use ion exchange (IX) resin and one using regenerable ion exchange resin coupled with IX regeneration processes and PFAS still bottom destruction technology.
- **Scaling up regenerable ion exchange resin demonstration.** Envisioning the future risk of disposing PFAS treatment derived waste streams (e.g., single use ion exchange resin) through incineration or landfilling, Wood kicked off the consideration of regenerable ion exchange resin to demonstrate the ion exchange resin can be regenerated on site and the regenerant wastes (i.e., still bottom) laden with PFAS concentrates will be destroyed on site using a PFAS destruction technology. The approach allows reuse of regenerable ion exchange resin and will leave no PFAS waste for off-site disposal. From laboratory testing to full-scale treatment system design, OMM, Wood builds the unique experience and documents the lessons learned from pre-treatment to discharges of treated water.



The Pease AFB PFAS Groundwater Treatment Team was awarded the EPA's FY19 Federal Facility Response Outstanding Achievement Award

- **PFAS destruction technology development and demonstration.** While utility providers have as a top priority to remove PFAS from water and wastewater; the market available technologies are limited to PFAS separation technologies (GAC, IX and reverse osmosis (RO)). There is a common vision about the future of permanently breaking down PFAS without the possibility of returning PFAS back to the environment. As a PFAS thought leader, Wood has PFAS experts, assessed, studies and demonstrated PFAS destruction technologies. Our achievements are evident through peer-reviewed publications and presentations at national conferences. Appendix A lists our PFAS publications. The PFAS destruction technologies (enzyme degradation, plasma destruction, electrochemical oxidation, gasification, supercritical water oxidation) are mostly at bench or pilot scales, but we are supporting efforts to further scale when cost, energy consumption and treatment efficiency prove the commercialization potential.
- **PFAS treatment performance evaluation.** As part of a settlement agreement with a PRP, Wood was engaged as the settlement advisor for a CDWSP. The project included treatment system conceptual design, water process treatment system lead, cost estimating and contribution to evaluation of elements of this PFAS master planning project. Wood is assisting the Agency to develop and assess long term projects to provide clean drinking water to the communities of the district impacted by PFAS/PFOS contamination of the groundwater supply. Wood considered removal efficiency, media longevity, waste generation and disposal, and long-term treatment efficiency in the development of designs and long term cost projections for the client.
- **Pre-treatment to remove iron and manganese.** The importance of co-contaminant impacts on PFAS treatment systems cannot be overstated. In managing the operation of granular media or ion exchange systems both iron and manganese in elevated concentrations will result in bed fouling reducing bed effectiveness and media life. Wood has completed many projects for the removal of iron and manganese in drinking water systems and observed and managed the impacts on projects for Wurtsmith AFB, Pease AFB and MPCA in East Metro of Minnesota. For municipal WTP treatment applications, our staff has recent experience utilizing Greensand Plus Media as an effective way to efficiently remove Iron and Manganese ahead of secondary treatment systems such as Reverse Osmosis, GAC, or IX filtration as well as other, more traditional treatment technologies for iron and manganese removal.
- **Pre-treatment to remove TOC and color.** Our team has experience evaluating the use of microfiltration/ultrafiltration and nanofiltration for dissolved compounds, and is ideal for color reduction, removal of divalent ions including hardness and the rejection of certain pesticides, protozoan pathogens, bacteria, and viruses. Nanofiltration membranes are also well suited for organics removal which greatly reduces disinfection by-product precursors (DBPs) from chlorinated, finished water.
- **Corrosion control treatment optimization.** Corrosion is a common issue in drinking water supply supplies resulting in the deterioration of the conveyance material, typically metals. Corrosion in distribution systems can be caused by the materials used, infrastructure age, water age and the system water quality (pH, alkalinity, hardness). Changes to the drinking water process or water source may have a bearing on corrosion rates in the system and in end-user plumbing systems. In most cases the primary contaminant of concern is lead, which is a typical trigger to initiate corrosion control programs. Other corrosion products include copper and iron, which are usually found to be an aesthetic concern rather than a health-related concern. In any drinking water system design, Wood considers the water chemistry at source and post treatment to understand the impacts on system and end-user corrosion issues. Our staff has experience in annualizing drinking water additives and dosage of orthophosphate and zinc pyrophosphate for corrosion protection.
- **Waste management of spent media.** Wood currently manages a PFAS groundwater treatment system comprised of GAC and resin units. The spent GAC is currently reactivated at the GAC supplier, and the spent resin is hauled off site to subtitle C landfills. These methods are not bullet proof and more concerns are raised on future releases of PFAS into the environment from these disposal methods. Novel sorbents are under development and demonstration to increase sorption efficiency, reduce the use of sorbents, increases the lifespan of sorbents, and at the same time, Wood is collaborating with a technology provider to convert the spent media and PFAS into water and energy. We recognize the future PFAS treatment system designs will need to be flexible and adaptive for future changes of treatment technologies as well as to address future regulatory changes.

Exhibit 4 provides a summary of our experience with PFAS investigation, feasibility studies and treatment. Brief project profiles for the selected projects are provided as Appendix B.

Exhibit 4. Project Examples

Project	Media			PFAS Treatment					Scale				Co-contaminants
	Drinking Water	Groundwater	Wastewater	GAC	Single Use IX	Regenerable IX	Reverse Osmosis	Organoclay	Conceptual	Bench	Pilot	Full-Scale	
East Metro Drinking Water Supply Plan, Minneapolis, MN	•	•		•	•	•			•				•
PFAS Feasibility Study, Confidential Client, OH	•	•			•	•	•		•				•
Pease AFB, PFAS Treatment, Portsmouth, NH		•		•	•	•				•	•	•	
Treatment Conceptual Design, Bethany, OK	•			•	•	•	•		•				•
Activated Carbon Column Testing, Torrance, CA		•		•						•			•
Long-Term Management Wurtsmith AFB, Oscoda, MI		•		•	•					•	•	•	
Pilot-Scale PFAS Treatment at MCAS Miramar			•	•	•			•		•	•		
PFAS Removal of Waste Streams, MCAS Beaufort, SC		•		•	•			•		•	•		•
Landfill PFAS Pilot Scale Treatability Study, MI		•	•	•	•					•	•	•	•

4. PFAS Communications, Relationship Building and Technology Transfer

PFAS is a class of chemicals that includes more than 6000 compounds, and communication of risks posed by this emerging class of contaminants can be challenging. The manufacturing and uses of PFAS containing products began in early 1950s. Some PFAS are highly persistent and bioaccumulative resulting in long-term impact to human health and the environment. PFAS chemistry and manufacturing processes are complex. Advanced analytical methods allow low detections of PFAS down to trace parts per trillion levels. Combining all factors, PFAS have been detected in blood of 99% of US population sampled. PFAS have been continued to be used by the industry and consumers resulting in wide spread of PFAS contamination. The releases and environmental impact were not monitored or characterized until early 2000. Regulatory agencies had no programs to track and develop PFAS guidance until 2006. Wood's PFAS experts have been involved in PFAS projects since 2007 and have trained state regulators on sampling, characterization, and treatment since 2012. While the state regulations continue to evolve and draw scrutiny, Wood has tracking records of developing and leading PFAS communications and technology transfers. Several Wood's PFAS experts are active team members and subgroup leaders to the ITRC PFAS team that develops PFAS technical guidance for state regulatory agencies and for the industry. We are ITRC PFAS trainers to communicate and bridge knowledge gaps. Our extensive PFAS experience can accelerate the team building, technology transfer to the local engineering firms and to accelerate the treatment process approvals.

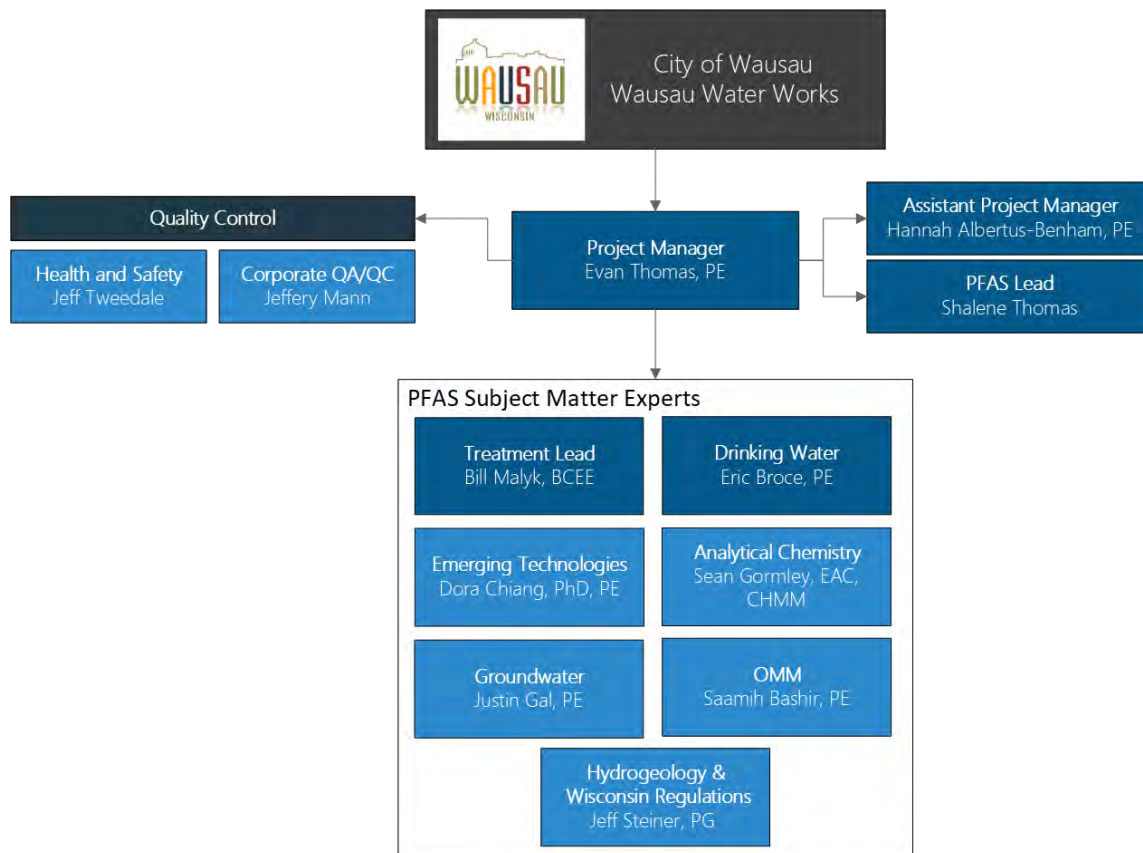
Funding Evaluation:

With the amount of Grant Funding from the Bipartisan Infrastructure Law issued to the State Safe Drinking Water SRF program, specifically for PFAS and other emerging contaminants, it's important to have a team with experience working with State SRF loan programs. Our team can provide funding evaluations that consider these new grant opportunities for the City to reduce its long-term costs of project financing using various sources. With PFAS treatment specifically targeted for 100% principal forgiveness for the first time through many State's Safe Drinking Water SRF programs, this new opportunity could help the City minimize financial impacts to the residents. Our team includes Eric Broce, municipal finance specialist. Eric will use his experience in utility finance and SRF programs to evaluate funding opportunities for this project.

5. Project Team

Exhibit 5 introduces our proposed project team. Our proposed team represents a multi-disciplined group of experts. Our team has proven experience working together including extensive experience on a wide variety of PFAS projects. Biosketches of our proposed team are presented below.

Exhibit 5. Organizational Chart



Key Personnel

Evan Thomas, PE – Project Manager, Madison, WI

Mr. Thomas was born and raised in Wausau and began his engineering career by spending his summers interning for the City of Wausau's Engineering Department. Mr. Thomas has since joined Wood and is currently a Project Manager and Wisconsin-licensed Environmental Engineer with 11 years of experience supporting and managing multifaceted projects for governmental and industrial clients. Since 2019, Mr. Thomas has **managed some of the highest profile PFAS projects for the Wisconsin Department of Natural Resources**. In Marinette, Wisconsin Mr. Thomas coordinates a team of PFAS subject matter experts to provide technical oversight of groundwater investigation and interim remedial treatment, along with leading a field team evaluating more than 400 private residential potable wells for PFAS contamination. In Campbell, Wisconsin, Mr. Thomas mobilized a team for emergency PFAS sampling of more than 200 private and public supply wells on French Island. Mr. Thomas's technical expertise lies with designing statistically robust sample designs, the development of 2D and 3D geostatistical models of contamination, and visualizing complex geospatial data and site features. Mr. Thomas has effectively presented complex technical material at public meetings, to clients, agency work groups, project stakeholders, and at conferences and has a successful track record of partnering with other engineering firms to leverage specialties and drive value for clients. Mr. Thomas was born and raised in Wausau and now leads the Madison, WI Wood office consisting of ten engineers, geologists, and data scientists.

Hannah Albertus-Benham, PE – Assistant Project Manager, Minneapolis, MN

Hannah is a senior engineer with more than eleven years of experience in the environmental and water resources field following completion of a master's degree in Civil Engineering with Environmental Emphasis. A variety of project experience with per- and polyfluoroalkyl substances (PFAS), most notably managing a multi-million dollar, multi-disciplinary project utilizing resources from across the company to assist the state of Minnesota in **developing a bespoke conceptual drinking water supply plan** that will guide the use of \$850M NRDC PFAS settlement funds for 14 communities into the future. Other PFAS work experience involves field management for several site investigations and a research project at government facilities, as well as preliminary assessments, and guidance documents authorship. Past work experience has built a wealth of knowledge in the areas of sampling, analysis, and interpretation at government and private sites involving soil, groundwater and soil vapor contamination; construction and demolition management; providing technical assistance for the construction of, and creating specifications for, environmental remediation systems; various projects involving stormwater plan (SWPPP) design and inspections; Phase I and Phase II environmental assessments in rural and urban settings; and SPCC plans and inspections at industrial/commercial facilities.

Shalene Thomas – PFAS Lead, Minneapolis, MN

Ms. Shalene Thomas is the Emerging Contaminant Program Manager for Wood. She has more than 22 years of experience in environmental consulting that includes 14 years of experience supporting PFAS evaluations. She has extensive program and project management and has supported State, Federal and industrial clients with PFAS evaluations including leading the development of an information clearinghouse on the emerging contaminant class. She currently serves as a PFAS lead for the State of MN and the State of WI and **was the Program Manager for the East Metro CDWSP project**. She currently serves as the PFAS Work Group Manager for Wood and has supported PFAS projects at military installations in 32 different states in 9 of the 10 USEPA regions as well as in Europe, Australia and Canada. She leads the AFFF sub-team of the PFAS ITRC team and supports regulatory updates for ITRC's PFAS Water and Soil Values tables. In her role, she will support with evaluating regulatory trends and applicability to project outcomes as well as serve to guide the PFAS SMEs.

PFAS Subject Matter Experts

Bill Malyk, P.Eng. BCEE – Treatment Lead, Cambridge, Ontario, Canada

Mr. Malyk is a Principal Engineer with over 29 years of experience in managing water and wastewater treatment projects. His areas of expertise include treatment selection and design, operational troubleshooting and economic evaluation for water and wastewater treatment systems. **Bill worked as the PFAS Treatment lead for the East Metro CDWSP project**. His experience has been developed while working on projects in Canada, the United States, Europe, the UK, India, Africa, Australia and China. Mr. Malyk is a Board Certified Environmental Engineer as accredited by the American Academy of Environmental Engineers and Scientists (AAEES).

Eric Broce, PE – Drinking Water Treatment, Wichita, KS

Mr. Broce has over 23 years of experience with municipal drinking water and wastewater projects. He has extensive design and construction project management skills for many large and complex projects for municipalities, government agencies and private industry. He also has experience and knowledge in municipal water and wastewater treatment selections and design. **Eric worked as the Senior Technical Reviewer for the East Metro CDWSP project**. He has assisted clients in obtaining State SRF applications and funding while working closely with State and Federal regulators throughout the design and construction phases of the projects.

Justin Gal, PE – Groundwater Treatment, Novi, MI

Mr. Gal has 13 years of consulting experience in the development, design and construction of innovative remedial strategies. He specializes in the development and implementation of remedial strategies for NAPL impacted properties with extensive project experience at variety of former industrial and manufacturing facilities throughout the U.S., resulting in successful negotiation of site closure with regulatory agencies and provides a variety of methods to maximize client cost avoidances. He is widely sought after for evaluating NAPL mobility and recovery, Per- and Polyfluoroalkyl Substances (PFAS) site characterization plans and remedial alternatives, and the vapor intrusion to indoor air pathway (VIAP). Mr. Gal has consulted on a variety of technologies such as NAPL recovery trenches and wells, in situ chemical oxidation (ISCO), thermal remediation, dig and haul, permeable reactive barriers (biotic and abiotic reactive media), containment barriers, in-situ solidification and stabilization, sub-slab depressurization systems (SSDS), and a variety of ex-situ soil and ground water treatment technologies, as well as performing treatability and feasibility studies for technology application.

Saamih Bashir, PE – Treatment Operation and Maintenance, Novi, MI

Mr. Bashir has extensive experience focusing on managing and performing various compliance, field investigation, remediation, due diligence, and operation and maintenance (O&M) projects for federal and commercial industrial clients. Mr. Bashir has intensive experience in managing and preparing compliance plans including Due Diligence Integrated, Environmental Compliance Evaluations, Contingency Plans, Spill Prevention Control and Countermeasure Plans, Facility Spill Plans, Stormwater Pollution Prevention Plans, Environmental Protection and Community Right-to-Know Act calculations and reporting. Mr. Bashir has managed projects since 2009 in value from \$50K to \$2M. Mr. Bashir has focused on perfluoroalkyl substances (PFAS) investigation and evaluation since 2015 including preliminary assessments, site inspections/investigations, supplemental site inspections, and O&M of PFAS treatment systems. While focusing on PFAS investigation, Mr. Bashir was involved with private well samplings, and community coordination including supporting and conducting public meetings. Mr. Bashir also has extensive O&M experience supporting a \$9M project for three PFAS GAC and IX treatment systems at former Wurtsmith AFB.

Sean Gormley, EAC, CHMM – Chemistry Lead, Portland, OR

Mr. Gormley is a Principal environmental chemist with more than 30 years of experience in industrial chemistry and waste management, environmental forensics, applying environmental chemistry to site characterization and remediation activities, analytical chemistry and field analytics, and analytical quality management. Mr. Gormley recently served as the Wood program chemist for PFAS site investigation activities related to use of AFFF at 39 Air Force installations across the U.S., where his role included analytical chemistry of PFAS, quality assurance planning, and oversight of laboratory programs. In his role, Mr. Gormley may direct a review of laboratory procedures, including modifications to EPA Method 537, on-site audits of laboratory facilities, interlaboratory split samples, and proficiency testing samples to evaluate data comparability. In his role as chemistry lead, he will ensure data collected and analyzed are done so in an accurate, and complete manner.

Dora Chiang, PhD, PE – Emerging Technologies, Atlanta, GA

Dr. Chiang is Global Technical Leader for Environmental Remediation and PFAS innovation lead at Wood. She holds a Ph.D. in Environmental Engineering from Georgia Institute of Technology and has 25 years of consulting and engineering experience including serving as director of PFAS and emerging contaminants at AECOM and CDM Smith from 2016 to 2021. In her career of developing technical excellence, she works on PFAS projects from PFAA and precursor sampling, analysis, characterization, source identifications, exposure and migration pathway assessment, and PFAS treatment. As PFAS build their own migration patterns in the water cycles over decades, Dr. Chiang has worked closely with different funding organizations and academic researchers to pioneer novel PFAS destruction processes to permanently remove PFAS. She developed and demonstrated combined technologies to separate, concentrate and destroy PFAS with 10+ peer reviewed publications and participating 100+ technical presentations and panel discussions since 2012. She had built practices for PFAS and emerging contaminants within the firms and worked with project teams to design build a couple of the largest water treatment plants in the nation to address PFAS. She continues to provide PFAS consulting to all types of clients including drinking water, wastewater, landfills and contaminated sites at Wood. She is also passionate on technology transfer. She is PFAS treatment trainer and PFAS training subgroup leader for ITRC PFAS team. She is also an active member on emerging contaminant working group of AWWA. For this City of Wausau project, she will provide updates on development and demonstration of emerging technologies on PFAS treatment and will participate discussions on PFAS treatment technology evaluation of commercialized, demonstrated and emerging technologies.

Jeffery Steiner, PG, PH, CPG – Wisconsin Regulations & Hydrogeology, Madison, WI

Mr. Steiner joined Wood in 2021 as a senior associate hydrogeologist with 33 years of experience in environmental consulting for industrial, municipal, and regulatory clients, and 1.5 years of regulatory experience working at the Wisconsin Department of Natural Resources (WDNR). He assists clients seeking solutions to problems in groundwater resource management, groundwater development, waste management, and environmental protection. Jeff specializes in subsurface investigation, aquifer characterization, and remediation including the fate and transport of PFAS and other emerging contaminants and brings insight and prospective to this project through his previous hydrogeologic investigation experience in the project area. The majority of Jeff's professional tenure has been understanding and working with Wisconsin's Statutes and Natural Resources Codes related to environmental protection including, the Clean Water Fund Program (ch. NR 162), and Safe Drinking Water Loan Program (ch. NR 166) as well as other administrative codes that are relevant to this project including, but not limited to: General Environmental Protection (NR 100 series), Wisconsin Pollution Discharge Elimination System (NR 200 series), Water Regulation (NR 300 series), Solid Waste Management (NR 500 series), Hazardous Waste management (NR 600 series), Investigation and Remediation of Environmental Contamination (NR 700 series), and Water Supply (NR 800 series). Jeff also has considerable experience working with Federal regulations include RCRA, CERCLA, and TSCA.

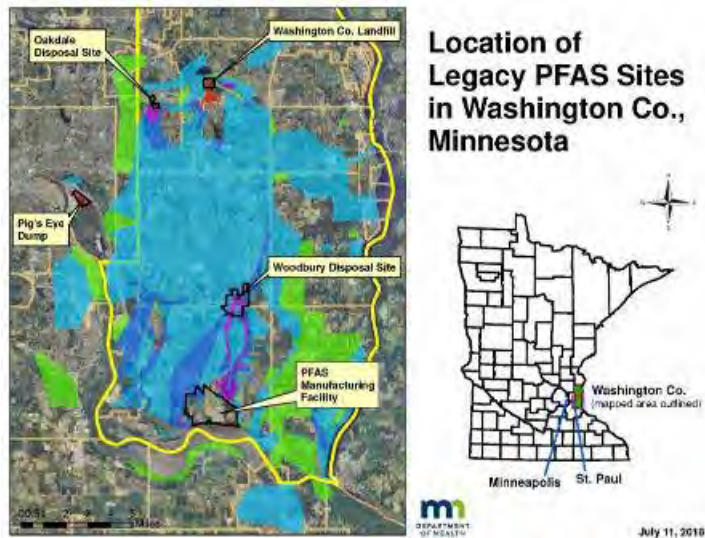
Appendix A: Relevant Publications

List of PFAS Publications with Wood as Lead or Co-Authors

- **Remediation Journal**. Key advances in poly- and perfluoroalkyl characterization, fate, and transport. <https://doi.org/10.1002/rem.21703> (Dora Chiang/Dave Woodward), Evolution from past to present, current efforts, and potential futures. <https://doi.org/10.1002/rem.21705> (Nathan Hagelin), PFAS Toxicology and Risk Assessment in 2021 and risk assessment in 2021—Contemporary issues in human and ecological risk assessment of PFAS. <https://doi.org/10.1002/rem.21706> (Usha Vedagiri)
- PFAS Sources **Enviro WIKI**, https://www.enviro.wiki/index.php?title=PFAS_Sources
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Appendix B – Project Descriptions

East Metro Conceptual Drinking Water Supply Plan, Minneapolis, MN



Established both groundwater and hydraulic models for the entire East Metro area to determine most effective drinking water solutions for current municipal and rural community members as well as future community needs (into 2040).

Brief Description of Project

Wood assisted the MPCA and the Minnesota Department of Natural Resources (MDNR) in developing long term projects to provide clean drinking water to the communities of the East Metro Area affected by the 3M PFAS contamination of the groundwater supply. Fourteen cities and communities and an anticipated 250,000 people (by 2040) in the southeast suburbs of Minneapolis – St. Paul, Minnesota are/will be affected by the contaminated groundwater. Wood developed a conceptual drinking water supply plan (CDWSP) that will determine long-term solutions to provide safe and clean drinking water to the affected population. MPCA and MDNR are co-trustees entrusted with \$850 million in 3M settlement funds to address the groundwater contamination. This project was initiated in mid-2018 and has an estimated budget of \$1.8 million.

The Conceptual Drinking Water Supply Plan evaluated regional solutions (surface water treatment, new well fields and regional water treatment facilities), community solutions (establishment of small community water systems in rural areas, installation of treatment for PFOS/PFOA/PFBA/Fe/Mn. at municipal wells and private wells), or individual solutions (point of use or point of entry treatment systems) to provide clean drinking water.

Wood has provided technical oversight and input for a pilot treatment system that has been operational for over six months. Early indications show iron fouling of the media bed, even at low levels of 1 mg/l or less. Due to this, Fe/Mn pre-treatment has been incorporated into the groundwater treatment plant conceptual designs and cost estimates. After considering several treatment technologies, the most cost-effective treatment was determined to be using 8' diameter x 40' long three-cell pressure vessels with

Customer

Minnesota Pollution Control Agency

Location

Minneapolis, MN

Project Duration

Mid 2018 – Present

Project Relevance and Benefits

- Groundwater modelling to support the determination of PFAS treatment solutions
- Ex-situ pilot study oversight identified potential scaling issues
- Assessment of Fe & Mn impact to PFAS treatment systems
- Low treatment target (below regulatory levels)
- Technical oversight of a pilot treatment systems
- Site space constraints
- PFAS Treatment System Alternatives Evaluation

Key Team

- Bill Malyk, P. Eng, BCEE
- Hannah Albertus-Benham, PE
- Shalene Thomas
- Eric Broce, PE

This project was awarded Wood's prestigious "Inspire award" for Teamwork

Appendix B – Project Descriptions

greensand media. Fe/Mn treatment systems have been evaluated and sized for a wide range of capacities from 100 gpm to 15,600 gpm.

The CDWSP included the development of hydraulic models of the potable water infrastructure in the area and the development of a comprehensive groundwater model. These were used to evaluate new water supply sources (groundwater and surface water), water treatment plants, and water distribution improvements necessary to meet Year 2020 water demands and Year 2040 water demands for the area. The hydraulic models were calibrated for each individual community or city prior to being merged into an overall regional hydraulic model. Utilizing the hydraulic models, over 100+ alternatives have been modeled to evaluate impacts to the existing water distribution systems, well pumps, booster pump stations and to identify the necessary upgrades and improvements to minimize the impact of installing centralized treatment systems. Cost estimates were developed for each alternative. A final report of the CDWSP was completed in 2021 and Wood is currently supporting the MPCA with oversight and review of community drinking water project grant applications. Some of the key solutions Wood team successfully deliver to the client's challenges on this project are as follows:

- An **understanding of current groundwater source, behavior, and transport** across the 150-square miles impacted by PFAS contamination. Wood developed a regional groundwater model to better understand both current PFAS contamination and transport, via particle tracking, of contamination over the next 20 years.
- **Current drinking water system infrastructure and future water demand and supply needs** for fourteen communities. At the onset of the project, water supply and demand needs were not clearly defined for the entire project area. Wood developed hydraulic models for the regional area across all communities to understand how much water would be needed by 2040 and where the water demands would be.
- **An alternatives evaluation of PFAS treatment** to forecast and showcase where, when and what PFAS treatment needs would be for each community to ensure safe drinking water into the future. This included an evaluation of innovative treatments as well as State-approved treatments and work with the MDH to define a path to State approval for ion-exchange resin treatment for drinking water application. Wood developed and delivered educational presentations to work group members and community members to discuss available options, pros and cons, as well as how treatment technologies evolve from research and development, through demonstration and validation, and on to full-scale commercialization.
- **A resilient approach to treatment criteria that addresses the evolving understanding of impacts to PFAS human health.** In Minnesota, a health index of 1 for PFAS contamination triggers a health advisory and drinking water action. Wood supported the evaluation and selection of an alternative health index (0.5) that would not only be resilient enough to accommodate potentially changing toxicity values but also accommodate proposed treatment projects within the available settlement funds.
- **Clear, concise, and open communication and collaboration across all stakeholders.** Through the entire process, as Wood worked through the CDWSP, we developed educational materials, supported public meetings, public comments and feedback, one-on-one meetings with stakeholders, and coordination and collaboration with key stakeholders to ensure an open and transparent process that resulted in a solution that everyone could stand behind.



Polyfluoroalkyl Substances (PFAS) Feasibility Study for Water Treatment Facility, Confidential Client, OH



Wood was retained by a confidential client to conduct a feasibility study for pre-treatment of PFAS-contaminated groundwater. The groundwater of the subject site is contaminated by perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) at concentrations up to 1200 ppt. The designed flowrate is expected to be around 15 MGD. Other contaminants of concern include Volatile Organic Compounds (VOCs) and 1,4-dioxane.

Scope

Wood has been engaged in similar projects where VOCs, complex organic species and PFAS are chemicals of concern. The feasibility study included:

- Review of related literature and best management practices;
- Generation of a list of potential treatment options;
- Evaluation and screening of the potential options by applying the stochastic knock-out criteria approach;
- Performing a scoping-level process design to each of the selected options;
- Preparation of Conceptual designs including layouts and costing analysis for the PFAS treatment options at the central treatment facility and well head.
- Developing a bench-scale test plan for each of the selected options.

A detailed literature review was conducted using Wood's internal search resources and global water treatment network. According to the literature review, a preliminary list of treatment options for PFAS, 1,4 dioxane and VOCs was developed. Given the physical chemical properties of PFAS and 1,4 dioxane, it is not likely they can be removed by one single treatment technology. Wood assessed different treatment technologies for PFAS and 1,4 dioxane respectively. The listed treatment options were evaluated against site-specific conditions and requirements. Other general factors that were considered included:

- Treatment effectiveness;
- Ease of operation and maintenance;
- Waste stream treatment and disposal; and
- System life-cycle cost.

Based on the results of the evaluation a multi-step treatment train was recommended to address all contaminants of concern. Wood continues to provide ongoing support as required by the client.

Wood's Involvement:

- Groundwater supply well field treatment for PFAS and 1,4-Dioxane to complement the existing Air Strippers removing VOC's.
- Centralized Water Treatment Facility secondary filtration / side-stream treatment for PFAS and 1,4-Dioxane.
- Evaluate PFAS removal technologies.
- Evaluate advanced treatment technologies to remove 1,4-Dioxane.
- Develop capital improvement cost, life-cycle cost, annual operating cost.
- Compare performance, safety, flexibility and risk between treatment technologies.
- Non-Detect Finished water quality goal for PFAS.
- Operation continuity during construction
- Evaluation compared 15 MGD groundwater treatment system vs. 96 MGD centralized treatment at the Water Treatment Facility
- Evaluated 3 flow train alternatives, representing a total of 7 vendor configurations.

Appendix B – Project Descriptions

Pease AFB, PFAS Groundwater Treatment Extraction Systems, Portsmouth, NH

At the former Pease Air Force Base in Portsmouth, New Hampshire, addressing PFAS in groundwater required developing a treatment approach despite the limited proven and rapidly developing technologies available. Wood concurrently designed and built two groundwater extraction and treatment systems (GWETS) covering a construction footprint of over 60 acres. Wood accomplished the feat in 32 months at this active military and civilian airport while minimizing disruption by closely collaborating with the Air Force, regulators, our technology partners, and other stakeholders.



The first system – the Former Fire Training Area (FTA) GWETS – uses a first-of-its-kind, regenerable ion exchange treatment system to remove PFAS from groundwater. The technology was developed specifically under this project and has now been deployed by the technology supplier at sites world-wide. The in-place, ion exchange resin regeneration system concept allows the resin to be reused and concentrates the PFAS waste to a minimal volume.

In the midst of construction of the second system – the Airfield GWETS – and without impacting schedule, Wood worked with the AFCEC to change the treatment technology and thereby delivered leading-edge and less costly treatment technology that was an improvement over the original concept by adapting the system to newly available data.

Through September 2020, the FTA GWETS has generated approximately 1,000 gallons of concentrated still bottoms with over 34 million gallons of water treated. These still bottoms are further treated with IX resin to reduce the waste stream volume. Wood projects that an additional 20 million gallons of PFAS-contaminated water can be treated before 110 gallons of spent media will need to be disposed off-site. This ability to concentrate over 50 million gallons of highly contaminated groundwater to less than 110 gallons of waste represents a highly sustainable solution to this challenge of addressing these recalcitrant contaminants.

Beyond the technical challenges of developing a state-of-the-art treatment process for these emerging contaminants, Wood was also challenged to develop a design concept and construction implementation strategy that minimized disruption to existing redevelopment plans and airport operations. Wood attended weekly airport operations meetings and, based on the meetings, adjusted work sequencing and work hours in order to minimize disruption to flights and impact to travelers. Wood also developed an approach to install the majority of subsurface piping and conduit beneath the airfield using trenchless technology, thus further minimizing the disruption to operations and substantially reducing pavement demolition and restoration needs.

Wood's commitment to successful completion resulted in the US Environmental Protection Agency awarding the Pease Groundwater Cleanup Team its *Federal Facility Response Outstanding Achievement Team Award for FY2019*, noting the "extraordinary efforts" taken.

Wood's Involvement:

Designer of Record and General Contractor

Treatment Media:

GAC, single-use IX, regenerable IX

Capacity:

150 gpm and 700 gpm

Cost:

\$26.5M (Completed 2019)

Water Treatment Facility Conceptual Process Design, Bethany, OK

Brief Description of Project

The City of Bethany requested Wood develop conceptual project cost, annual operating cost and a net present value estimate for the necessary upgrades to their 8.4 MGD WTP to effectively regain use of their raw water sources while providing a safe, reliable drinking water to their consumers. The existing municipal WTP treatment process was last upgraded in 2005 with the primary goal of reducing known constituents contained in the City's raw water supply to below the primary and secondary drinking water standards. These known constituents included iron, manganese, hardness, and organic carbon (TOC).



Wood's Involvement:

- Reactivate groundwater supply well discontinued due to contamination.
- Centralized treatment for unregulated contaminants
- Remove VOCs, hydrocarbons, 1,4-dioxane, heavy metals and PFAS compounds found in source water
- Operation continuity during construction

In 2010, it was discovered that some of the City water supply wells had become contaminated with constituents not previously known to be present in the raw water supply. The apparent source of the groundwater contamination stemmed from an industrial manufacturing facility related to aerospace manufacturing and/or airport activities located approximately 2 miles east of the WTP. The City's existing WTP does not currently have adequate treatment capabilities to remove many of these contaminants without substantial upgrades and modifications to the treatment processes. Based on known constituents used in the aerospace manufacturing process, groundwater sampling analysis and assumed concentration levels of the chemicals of concern (COC's) in the groundwater, a "worst case" scenario for the source water quality to be treated at the WTP was evaluated because complete characterization of the source had not been completed by the responsible party. The primary COC's discovered included the following:

- Volatile organic compounds (VOCs) including chlorinated and non-chlorinated VOCs
- 1,4-dioxane
- Petroleum fuel related VOCs and hydrocarbons
- Metals including hexavalent chromium, total chromium, antimony, arsenic, barium, cadmium, copper, lead, mercury, nickel, selenium, and thallium.
- Per and Polyfluorinated compounds (PFAS)

Multiple technologies for each step in the treatment process were evaluated and the best available technologies (BAT) for treatment of the COC's were selected. The selection was based upon other verifiable treatment experience and effectiveness of similar contaminant removals. The BAT selected have shown the ability to remove the evaluated constituents to levels at or below USEPA Primary and Secondary Drinking Water Standards and/or the most stringent State standards or Health Risk concentrations as established by the USEPA. A conceptual process flow diagram, hydraulic profile and site plan were developed. The conceptual site plan includes layout of proposed Infrastructure that would be integrated into the existing facility site as well as process buildings and equipment that would be added off-site. Lastly, a conceptual cost estimate for the proposed water treatment facility upgrades were developed.

The conceptual cost estimate also includes a new laboratory, pilot testing, additional staffing and specialized construction techniques and sequencing to keep the WTP operational during construction of the conceptual upgrades and improvements.

Activated Carbon Rapid Small Scale Column Test

Brief Description of Project

Rapid small scale column testing (RSSCT) was completed to assess the relative removal of Per- and polyfluoroalkyl substances (PFAS) and volatile organic carbons (VOCs) from groundwater by three types of granular activated carbon (GAC). Testing was completed according to the RSSCT procedure ASTM Method D6586 to reduce the time and water volume required.

Details

Wood designed and plans to install a groundwater treatment system for VOCs for an industrial manufacturing client in Southern California. Following detections of PFAS during a groundwater investigation, the designed GAC treatment was evaluated for efficacy and optimization by an RSSCT.

RSSCT is a technique that allows the operating cycle of GAC media to be accelerated in a way that represents the full-scale system, through systematic scale-down of the size of equipment and GAC. GAC was carefully reduced in size from the manufacturer's sample of 12 x 40 mesh to a smaller size of 60 x 80 mesh. The RSSCT conditions simulated approximately 65 days of run time in 2.7 days of operation and with a much smaller volume of water sample.

Testing was completed to meet several objectives, including:

- evaluate which parameter would be first detected in the treated effluent and drive the media change out frequency; and
- to select a GAC type based on treatment capacity and long-term O&M costs.

Wood also tested PFAS using a total oxidizable precursor (TOP) assay to compare the hydroxyl radical-assay process to the advanced oxidation peroxide/UV treatment process (AOP) included in the groundwater treatment system design.

Three types of GAC were included in the study, two coal-based and one coconut shell based GAC. Two of the GAC performed well, removing almost all of the VOCs and PFAS for the duration of the test.

Performance

Wood successfully completed the test work, keeping the project on track while managing the sampling, testing and treatment issues which arose. By communicating issues within and outside the project team, Wood was able to draw on varied technical expertise in PFAS, treatability and treatment design to troubleshoot problems while also considering implications for the full-scale system. Despite the challenges, data collected during the testing was able to prove GAC is effective at treating site VOCs and PFAS, allow for comparison of the GAC types and provide insight into the comparison of TOP assay and AOP pre-treatment effects on PFAS.

Challenges:

- formation of gas bubbles which can impact the reliability of the test. Corrective actions were carefully implemented.
- schedule delays,
- sample variability,
- water pre-treatment,
- fabrication and commissioning the test apparatus,
- analytical turn around times, and
- lower than anticipated influent contaminant concentrations

Remedial Action – Operations (RA-O), Long Term Management, and Site Closeout (Former Wurtsmith AFB); Sub to LCES JV, Oscoda, MI

Brief Description of Project

LATA-CTI Environmental Services LLC (LCES) and its teaming partner Wood Environment and Infrastructure Solutions Inc. (Wood), have been contracted to perform the Base Realignment and Closure (BRAC) Environmental Construction and Optimization Services (BECOS) requirements at the Midwest Region BRAC Installations which includes the former Wurtsmith Air Force Base (AFB). Wood is the technical lead for Wurtsmith on behalf of the prime LCES JV and is leading the groundwater Remedial Action-Operations (RA-O), long term monitoring (LTM), and Land Use Controls (LUC) for 25 Installation Restoration Program (IRP) Sites at the Former Wurtsmith AFB.

Wood's Involvement:

- Ex-situ treatment of PFAS contaminated groundwater
- Granulated Activated Carbon (GAC)
- Single-use ion exchange resin,
- Both treatment trains include pre-treatment

The scope of work includes the implementation of the full range of environmental, construction and optimization services necessary to conduct site restoration including maintenance of established remedies, implementation of optimization, and remediation activities to achieve performance objectives to include emerging requirements for environmental remediation as identified. Activities include collecting periodic, either quarterly or annual, groundwater sampling, tabulating groundwater data, and analyzing contaminant concentration trends using the Mann-Kendall model for optimization recommendations as well as conducting the annual base-wide groundwater gauging event and maintaining and updating the base groundwater model.



Wood is also operating and maintaining three pump and treat ground water remediation systems to treat PFAS within the former Wurtsmith AFB. Activities include conducting daily system pressure and pumping capacity readings and collecting weekly/monthly system sampling, as well as troubleshooting and optimizing the treatment systems.

Wood is also leading monthly BRAC Cleanup Team (BCT) meetings between the US Air Force, additional consultants onsite, and the regulatory stake holders as well as supporting quarterly Restoration Advisory Board (RAB) meetings.

Wood was responsible for all aspects of the project, with the exception of the sample analyses, which were completed by an accredited laboratory, drilling, and waste removal services, which were provided by subcontractors retained by Wood. Wood led all field work, completed the required permitting and utility clearances, coordinated subcontractors and the associated security requirements for working on site. Our team of qualified professionals conducted all sampling following Wood's specific Standard Operating Procedures including but not limited to PFAS Sampling. In addition, Wood carried out all data management and validation, analyzed the results against the existing dataset for the site, integrated considerations from other similar sites where we have experience, and presented conclusions and recommendations based on the interpretation of results. Wood followed all prescribed project management tasks related to managing budget, schedule, and quality, and maintained on-going communication with the US Air Force at all stages of the work.

Pilot-Scale Treatment of PFAS Contaminated Wastewater Associated with AFFF at MCAS Miramar



With PFAS as the Navy and DoD's largest water compliance issue, Wood is always driving innovation and solving the most complex water program issues. **We have successfully treated a complex wastewater matrix contaminated with total PFAS concentrations over 8 parts per million (ppm) down to less than 2 parts per trillion (ppt) or 6 logs of PFAS mass reduction, with the effluent well below the EPA health advisory level of 70 ppt at MCAS Miramar.**

Location

San Diego, CA

Project Duration

2018 - 2021

Project Relevance and Benefits

- Self-performed bench-scale treatability for the pilot system design and rapidly identifying best solutions during implementation
- Ex-situ pilot study to remove PFAS from wastewater
- Successful treatment of PFAS at multiple wastewater sources using a mobile treatment system
- Treatment train system to remove co-contaminants and maximize PFAS mass removal
- PFAS concentrations reduced from ppm to 2 ppt equivalent to 6 logs of mass reduction

This project involved developing a treatability study and pilot test for managing wastewater associated with operation of equipment containing AFFF. The study evaluated the pilot treatment of PFAS (with a focus on PFOA and PFOS) from AFFF in wastewater to concentrations below the EPA Lifetime Health Advisory (LHA) levels and Regional Screening Levels (RSLs) to allow for discharge of treated water to the sewer system. Once the LHA and RSL levels were achieved, Wood helped the base obtain permits to **discharge up to 480,000 gallons of treated wastewater from 9 USTs located at five hangars**. The wastewater was treated with a trailer mounted treatment system that was moved from hanger to hanger and successfully treated the PFAS down to less than 2 ppt (non-detect levels) and the base received approval and discharged approximately 200,000 gallons of wastewater to the sewer currently.

To achieve these objectives, Wood PFAS experts designed the treatment system which includes an innovative combination of multiple treatment media including organoclay, granulated activated carbon, and ion-exchange resin setup on a portable trailer to allow the treatment system to be easily relocated to treat AFFF contaminated wastewater at each hanger. The mobile treatment system was conducted in accordance with design specifications presented in the Work Plan to ensure all data quality objectives for the Treatment Method Evaluation were met. Operation and maintenance activities were routinely performed to ensure the system functioned as designed. This project included bench-scale testing to evaluate colloidal scavenger resin and to ensure the system was sufficiently reducing PFOS in the treated wastewater. During this phase, the treatment system was successfully modified to treat the remainder of the high concentration of PFAS impacted wastewater to levels below the project treatment criteria of 70 ppt for discharge to the sewer system.

Appendix B – Project Descriptions

For sampling, treating and disposing of the AFFF wastewater and rinsate from the AFFF storage and distribution systems, **Wood collected all environmental samples and evaluating system data to ensure the data was of the utmost quality to ensure accuracy and usability.** To meet all the requirements for the wastewater discharge, Wood is utilizing a rapid turn-around time for batch discharge samples which has allowed treated water to be discharged quickly to the sanitary sewer system. Wood prepared and supported the base with coordination with the local municipality for all batch discharge requests and approvals. During the PFOS micelle issue, **Wood conducted multiple sampling rounds from the bench scale study on rapid turn arounds, which allowed Wood to identify solutions quickly to achieve the treatment goals and remain on schedule.**



Award

This project received the Secretary of the Navy's Environmental Award for MCAS Miramar on 9-23-2020. This was present to MCAS Miramar Environmental Director by ASN Williams in front of Wood's Innovative PFAS Wastewater Treatment Systems, an innovative cost-effective solution for managing the Navy and Marine Corps environmental liabilities

Wood provided regulatory compliance and insight into the PFOS/PFOA requirements. Wood has helped the Navy and Marine Corps protect the public with an innovative cost-effective solution for managing environmental liabilities. Additionally, due to the high visibility and sensitivity of this issue and evolving regulations, Wood also collaborated with and assisted the Navy and Marine Corps in preparing a project information pamphlet to distribute to site visitors and entities interested in this innovative approach. As recognition for Wood's exceptional leadership and expertise in navigating the ever-evolving issue of PFAS for the Navy and Marine Corps, this project helped Miramar win the 2020 Secretary of the Navy Environmental Award from the Assistant Secretary of the Navy, Charles A. Williams, during his visit to MCAS Miramar. This award recognizes Wood's ability to support NAVFAC and MCAS Miramar's efforts to ensure mission accomplishment, and the protection of human health and the environment. Additionally, this site has been visited by the Commandant of the Marine Corps, Craig Sakai MCICOM Director of Environmental Programs, and all the NAVFAC FEC EV1's during the 2020 annual meeting in San Diego.

PFAS Removal of Waste Streams Impacted by AFFF, MCAS Beaufort, SC

Brief Description of Project

Multiple PFAS-impacted waste streams were identified at MCAS Beaufort and included groundwater collected near the Air Control Tower foundation during rain events, water in the fire loop system located along the flight line, water collected during construction dewatering activities and groundwater samples collected during groundwater sampling and subsurface investigation (e.g., IDW). The installation was containerizing and disposing of the PFAS-impacted waste streams offsite via DOD-approved disposal methods. Based on the volume of impacted waste streams being generated, the installation has funded a project to treat the waste streams onsite and discharge the treated waste streams to the local sanitary sewer. Before discharging, the Air Station had to obtain the appropriate discharge permits and approvals from the local POTW, which required the pre-treatment of the PFAS-impacted waste streams.

Customer

MCAS

Location

Beaufort, SC

Project Features and Benefits

- Multi-media approach to treat PFAS-impacted waste streams and co-contaminants
- Onsite treatment of waste streams to reduce offsite disposal costs

In order to develop a treatment strategy, PFAS samples were collected to confirm influent PFAS concentrations, type of PFAS present, presence and concentration of co-contaminants and water quality parameters (i.e., metals, inorganic ions, total organic carbon, etc.). An SAP was developed, field work was performed, and a background data was developed and documented. As part of this project, Wood



conducted a bench-scale treatability study to confirm pre-treatment required prior to removal of PFAS and to identify treatment media for PFAS removal. Following the results of the treatability study, Wood provided a mobile treatment system consisting of organoclay, GAC, and IX resin media to remove PFAS. The treatment train was designed to treat the PFAS-impacted waste streams so that the installation could reduce disposal costs and discharge the treated waste streams to the local POTW. Operation of the system included site inspections, optimization of the system, sampling and general maintenance activities.

Wood developed a treatment strategy for the removal of PFAS from multiple waste streams impacted by AFFF at MCAS Beaufort. The treatment approach builds upon the multi-media treatment train developed to treat high concentrations of PFAS with co-contamination.

PFAS Support Services, Confidential Landfill, MI



Wood constructed and operated a column study onsite.

Wood's Involvement:

- Reactivate groundwater supply well discontinued due to contamination.
- Centralized treatment for unregulated contaminants to lowest State adopted MCLs or Health Advisory levels established by the USEPA
- Remove VOCs, hydrocarbons, 1,4-dioxane, heavy metals and PFAS compounds found in source water
- Advanced treatment evaluations
- Finished water quality goal included total hardness less than 120 mg/L
- Finished water quality goal included total organic carbon less than 0.5 mg/L
- Operation continuity during construction

Overview

In May 2018, Wood started supporting the landfill client with their investigation at the landfill in Michigan to determine the presence of PFASs. PFAS was identified in several on-site groundwater samples at concentrations above its respective USEPA drinking water advisory (PFOS and PFOA). The client next completed a receptor survey and sampled residential wells downgradient of the site. Although some residents had detectable concentrations of PFAS in their drinking water, no samples were detected above the USEPA drinking water advisory levels (70 ppt for PFOS & PFOA). In addition, the on-site groundwater pump and treat system was sampled for PFAS to determine discharge concentrations. Wood is evaluating optimization plans for the existing system to add PFAS treatment to the remediation treatment train.

Remediation System Column Study - Samples collected from the on-site groundwater treatment system influent and effluent show PFOS & PFOA exceeding the USEPA health advisory levels of 70 ppt and shorter chain PFAS compounds above Michigan's proposed health-based drinking water values. To evaluate potential PFAS treatment upgrades for the system, Wood designed, constructed, and operated an onsite PFAS Treatment Column Study that demonstrated the effectiveness of GAC and non-regenerable IX resin. Based on the study results, we estimated change-out frequencies for both PFAS test media, generated cost estimates to treat PFAS and other chemicals of concern entering the groundwater treatment system, and presented our findings to EGLE to support our client's remedial schedule and planning considerations. We also summarized our findings in a technical memorandum and presented key components to the client's team and legal counsel.

Design and Bid Specifications (100-percent Design) - Wood designed the groundwater treatment system and prepared bid specifications to remediate PFAS in groundwater captured from the landfill pumping wells. The system was designed to treat groundwater at 140 gallons per minute, consisting of 3 x 70-cubic feet ion-exchange resin vessels for PFAS removal, an air stripper for VOC removal, and a deposit control and solids management system to maximize system uptime. Our design also included the treatment system building and the controls system to remotely monitor the system.



REQUEST FOR PROFESSIONAL ENGINEERING SERVICES

Professional Experience Related to PFAS Treatment & Removal From Drinking Water **QUALIFICATIONS & SCOPE OF SERVICES**

Madison, Wisconsin Office

March 29, 2022

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March 29, 2022

Mr. Eric Lindman, P.E.
City of Wausau – Director of Public Works & Utilities
407 Grant Street
Wausau, Wisconsin 54403
715-261-6740
eric.lindman@ci.wausau.wi.us

RE: PROFESSIONAL EXPERIENCE RELATED TO PFAS TREATMENT & REMOVAL FROM
DRINKING WATER; CITY OF WAUSAU; WAUSAU WATER WORKS

Dear Mr. Lindman:

Shannon & Wilson, Inc. (Shannon & Wilson) is pleased to submit to you for your consideration our qualifications for the City of Wausau's *Request for Engineering Professional Qualifications & Scope of Services* (RFQ) document related to the treatment and removal of PFAS from the Wausau Water Works (WWW) drinking water system. It is our understanding that Shannon & Wilson utilize our PFAS and water system project experience from across the country to support the City of Wausau's current engineering consultants Donahue & Associates (Donahue) and Becher Hoppe & Associates (Becher Hoppe) in conjunction with WWW to determine the best available PFAS removal/treatment options.

Shannon & Wilson is an employee-owned environmental and geotechnical consulting firm based in Seattle, with an office in Madison, Wisconsin. Since 1954, Shannon & Wilson has helped the private and public sectors resolve the most pressing project environmental issues and engineering challenges. Shannon & Wilson is a full service, nationally recognized leader in geotechnical and environmental engineering, providing integrated services to private and public clients. Services include consulting, project development, engineering design, environmental remediation, construction management and project performance monitoring.

Our experience and staff come from our offices around the country and emphasize solutions ensuring a prompt response while supporting our client's missions. With over 300 professionals in 13 offices nationwide, the size of our staff allows us to respond to projects with short time frames, under a range of diverse needs, with concurrent deliverable schedules.

Along with our extensive water well and PFAS project experience, Shannon & Wilson provides comprehensive services to remediate contaminated groundwater, surface water, soil, and



sediments. Our team of environmental professionals has the knowledge and experience to select the most cost-effective and timely cleanup solution to meet regulatory goals and satisfy our clients' project objectives. We provide a full range of remediation services extending from technology selection and system design through construction, monitoring, and closure. Our approach to remediation projects incorporates an attitude of teamwork between our engineering staff and our clients' technical resources. This team strategy provides the maximum opportunity for the client to be involved in the engineering and design process as it relates to their site and their budget.

Shannon & Wilson has demonstrated "a working knowledge of PFAS remedial solutions as well as knowledge of project funding mechanisms in conjunction with PFAS research work being conducted by UW-Madison on behalf of the City of Rhineland. Shannon & Wilson has brought innovative strategies for source area remediation as potential long-term solutions to PFAS-impacted soil near public water supply wells." Mayor Christopher Frederickson and City Administrator Zach Vruwik – City of Rhineland

Our staff have provided comprehensive solutions to public water supply issues, including water quality assessments, new well field design and construction (including water rights and cost controls), existing well performance evaluation and rehabilitation, and water supply storage and conveyance. We employ licensed geologists, hydrogeologists, chemists, water resource specialists, and professional engineers to provide these services for our municipal clients across the country.

A representative sampling of the integration of water supply and environmental consulting services required for the City of Wausau's PFAS project are presented in the exhibit below.

Shannon & Wilson Engineering & Environmental Services	
Environmental Site Assessments	Waste characterization and source reduction
Remedial Investigations/Feasibility Studies	Infrastructure improvement at Water/Waste Water Plants
RCRA/CERCLA Investigations	Construction Oversight
Risk Assessment	Construction specifications
Fate & Transport Modeling	Regulatory correspondence
Remedial Action Plans	Environmental & Human Health Assessments
Value Engineering	Environmental program training
Environmental monitoring	Geotechnical engineering

Project Understanding

It is our understanding that the Wisconsin Department of Natural Resources (WDNR) has issued a drinking water advisory for the City of Wausau's drinking water. Concentrations of PFAS were reported below the United States Environmental Protection Agency's (EPAs) current health advisory concentration of 70 parts per trillion (ppt) but above the WDNR's proposed drinking water standard of 20 ppt in all six of the city drinking water wells ¹.

Furthermore, Shannon & Wilson understands that currently Donahue and Becher Hoppe along with the WWW are in the process of completing the construction of a new drinking water treatment facility (DWTF) scheduled to be operational in the third quarter of 2022. As part of the DWTF construction, Donahue has proposed a pilot study to test the viability of PFAS treatment options to be employed

¹ Mayor Katie Rosenberg's memo to the Wausau Common Council and members of the WWW Utility Commission. February 8, 2022.

at the new facility. The pilot test will be used to evaluate the compatibility of various media in treatment process trains that would work in conjunction with the existing treatment technologies built into the new DWTF (anion exchange and granulated activated carbon [GAC]).

Objectives

Based on our understanding of the need for PFA mitigation at the new public DWTF, Shannon & Wilson understands that the City of Wausau, WWW, Donahue, and Becker Hoppe are looking for assistance in determining the best PFAS treatment and remedial options that can be integrated into their new DWTF in order to reduce to the concentrations of PFAS detected in the City of Wausau water supply wells. Shannon & Wilson understands that in the interim, WWW would like a water treatment system that would be able to:

- Achieve PFAS removal to below current the WDNR drinking water standard of 20 ppt;
- Evaluate the life cycle and disposal options for the treatment media used; and
- Predict the effectiveness of the system in reducing/removing PFAS from their drinking water.

Shannon & Wilson also recognizes the need for the City of Wausau to evaluate and employ a permanent strategy to ensure that the level of system performance (PFAS reduction or elimination to below laboratory method detection limits) is achievable as the state and federal drinking water standards become more stringent. These long term objectives can include:

- Groundwater PFAS source area investigation and treatment;
 - Establishing working relations with the WDNR staff to ensure the system is approved for use and that the spent treatment media and backflush water is properly managed;
 - Management and treatment of PFAS impacted wastewater treatment plant (WWTP) sludge/biosolids;
 - Completion of groundwater fate and transport modeling to include assessment of well capture zones and basic well head protection/evaluation studies; and
 - Creating a drinking water treatment system that reduces or eliminates PFAS as a constituent of concern in the City of Wausau public drinking water supply.

SCOPE OF WORK

Shannon & Wilson intends to execute the Scope of Work as provided in the RFQ document. These tasks include:

- Prepare technical memos based on research and Shannon & Wilson's project experience of best practices for PFAS drinking water treatment;
- Review and analyze pilot test data;
- Drive additional pilot test trials in order to fine-tune or adjust treatment strategies to achieve optimal results;
- Support City of Wausau and the Donahue/Becker Hoppe consulting team develop presentations, recommendations, and cost estimates for interim (short-term) and permanent (long-term) PFAS removal options;
- Participate in technical workshops;
- Participate in monthly meetings (virtual or in-person) with the WWW commission;
- Review project schedules and continue to provide pilot test data review;
- Support City of Wausau and engineering staff after DWTF is fully operational; and
- Review drinking water quality at the new DWTF.

Shannon & Wilson will utilize not only our experience with PFAS projects from across the country to support the PFAS pilot study and City of Wausau's drinking water objectives and tasks outlined above, but also utilize the experience of teaming partners in determining the appropriate treatment methods to achieve WWW's interim (short term) goals of PFAS reduction in drinking water and the permanent (long-term) goals of reducing or eliminating PFAS from Wausau's public drinking water supply, WWTP biosolids treatment, groundwater source investigation and remediation, and PFAS waste stream regulatory compliance.

Waste Water Treatment Sludge/PFAS Impacted Soil Treatment

Orin Technologies, Inc. (Orin) is a Shannon & Wilson teaming partner. At other high profile project sites, Orin has been contracted by the WDNR to run chemical reagent pilot tests at PFAS sites using proprietary chemical reagents applied in-situ (in-place) and ex-situ (in excavated pits or lagoons) to evaluate their ability to sequester/break down the PFAS molecule. Orin's chemical reagents can be used to reduce the concentrations of PFAS in the subsurface soil and groundwater. They have demonstrated success in lowering PFAS concentrations from parts per million (mg/kg) to nanograms per million (vg/kg) in subsurface soil, sludge and in AFFF (firefighting foam).

Key personnel from Orin as well as their relevant project experience is provided in a later section of this document.

Water Treatment

Shannon & Wilson works with a number of companies that provide either treatment system media, treatment technologies or both for our PFA projects. We are ready to utilize their technologies and

expertise in conjunction with the pilot study anion exchange and GAC as a solution for PFAS removal/reduction in drinking water.

Project Funding

In addition to the Scope of Work described in the City of Wausau's RFQ document, Shannon & Wilson will also assist the city in identifying project funding from a variety of programs managed by both state and federal agencies. Funding recently procured or eligible for PFAS research or environmental projects include:

2021. SWI internal research grant of \$25,000 to Elliot Draxler for completion of a Master's Thesis entitled Nature and Fate of PFAS Contamination in the City of Rhinelander Drinking Water Wells (UW-Madison).

2017. SWI. United States Fish & Wildlife grant of \$49,995 for funding environmental education programs.

2014. SWI. Wisconsin Economic Development Corporation Brownfield Redevelopment grant of \$500,000 submitted by SWI for Archipelago Village, LLC for redevelopment of the former Mautz Paint factory facility located at 939 E Washington Avenue, 910 East Main Street and 946 East Main Street in Madison, Wisconsin.

SWI has identified two federal agencies that may provide potential funding sources for the PFAS well restoration project. The city may qualify for these programs based on population, median household income, and the threat posed by PFAS to the availability of safe reliable drinking water to the community; these funds may be available on a first come-first served basis. SWI can also bring forward discussions regarding grant options for the city from US Senator Tammy Baldwin's office. Additional details can be provided in the initial project start-up; we would assist the city with these and other funding mechanisms.

KEY PERSONNEL

Key personnel from Shannon & Wilson offices as well as Orin that will be directly involved with the City of Wausau's PFAS treatment are presented below.



Mark A. Rutkowski, P.G. – Sr. Associate/Madison Office Manager Mark is a hydrogeologist and the Project Principal-in-Charge for Shannon & Wilson's Madison Office. Mark brings over 32 years of environmental experience focused on site investigation and remediation of soil, sediment, and groundwater impacts; his clients include municipalities, water utilities, commercial, industrial, and public institutions. Since the project will be managed from our Madison office, Mark will provide QA/QC for project document deliverables as well as any needed hydrogeologic/geologic assessment work needed to define the nature and extent of PFAS impacted to soil and groundwater with strategies for remedial solutions. **Mark's role: Administrative Project Manager; site investigation/remediation.**



Kristen Freiburger, Associate/Senior Chemist -Kristen has led Shannon & Wilson's response to several large PFAS and other emerging contaminant groundwater-contamination projects in Fairbanks and other remote Alaskan areas. Over the last 15 years, she has played a central role in developing residential well search and sampling programs, supported and participated in numerous public-outreach activities for PFAS sites, and has also been integral in the development and use of S&W's environmental-sample analytical database and data-validation, control quality (QC) programs, and the coordination of installation and management of Point Of Entry Treatment (POET) systems for several contaminants, including PFAS. Kristen is our senior representative for the Alaska Department of Transportation and Public Facilities (DOT&PF) Statewide PFAS projects, including investigations at the Anchorage, Bethel, Gustavus, Dillingham, Homer, Iliamna, King Salmon, Kodiak, Yakutat, Valdez, Nome, and Fairbanks airports. She is knowledgeable in federal compliance regulations, and has coordinated with local, state, and federal agencies on environmental issues, including high-



profile written and oral communications on behalf of clients. She works with a variety of clients with different perspectives, resources, and regulatory requirements and understands the need to tailor each project site to meet the objectives of the site. Recently, Kristen was invited to serve as a session chair for the 2022 Combined Chlorinated and Bioremediation Conference to develop a session titled "PFAS Fate and Transport". **Kristen's role: PFAS Technical Project Manager.**

Jim Bailey, LHG, Vice President/Hydrogeologist Jim Bailey serves as Shannon & Wilson's National Well Services Director. He has more than 36 years of water supply development and ground water

management experience. His water resource work has focused on municipal water supply including water rights, well design/construction, and evaluation of well performance issues. He has extensive experience in the coordination and supervision of well drillers, design of drilling programs, development of specifications for such services, and cost control. Jim is a nationally recognized expert on well design, construction, and rehabilitation. Since 2000, he has worked on over 1,000 wells across the U.S. and Canada. **Jim's role: Water system performance.**



Elliot Draxler, Graduate Student PFAS Researcher; Shannon & Wilson/UW-Madison Elliot is completing his PFAS Master's Thesis research on the nature and fate of PFAS contamination in the City of Rhinelander drinking water wells while working at Shannon & Wilson. He has initial experience with field work, geomorphology, soil/rock mechanics and hydrogeology. **Elliot's role: Field technical support & PFAS research**



Agnes C. Tirao, P.E. – Sr. Associate Agnes is the Contract and Project Manager for on-call engineering services for Snohomish County, Washington. As the Project Manager, Agnes was tasked with completing PFAS investigations at two sites located at Paine Field/Shohomish County Airport. One investigation involves sampling downgradient from known AFFF releases to support decision making regarding cost recovery. The second investigation involves evaluating the extent of PFAS in the vicinity of a former fire training pit. Soil and groundwater sampling are proposed and data will be used to evaluate potential remedial measures, potential impacts/consideration to property development, and potentially cost recovery. **Agnes's role: Technical Project Management.**



Todd R. Kincaid, PhD - Sr. Associate/Hydrogeologist Dr. Kincaid is an expert in hydrogeologic modeling and karst hydrogeology having worked extensively on the characterization and computer simulation of complex groundwater flow regimes in numerous aquifers around the world for water resources, mining, groundwater contamination, and dam leakage projects. Since 1999, he has led a team focused on modeling geology, groundwater flow, and contaminant transport through varied types of complex aquifers including the karstified limestones in the Floridan aquifer, heterogeneous glacial sediments comprising contaminated surficial aquifers in New York and Pennsylvania; fractured rock aquifers in Pennsylvania and Washington; and structurally complex volcanic and sedimentary rocks underlying Yucca Mountain and the Nevada National Security Site, Nevada. He has conducted numerous successful groundwater tracing projects in karst and fractured rock aquifers of Florida, Brazil, and Washington, and developed methods of incorporating tracer-testing results into hybrid numerical models of groundwater flow and erodibility along dissolutionally enhanced fracture flow paths. Todd has also provided expert testimony regarding the reliability of groundwater model predictions in several legal proceedings. **Todd's role: Fate and Transport modeling.**

Orin Technologies - Larry Kinsman – Principal Larry Kinsman is the co-owner of ORIN Technologies, a contractor specializing in *ex-situ* and *in-situ* chemical treatments. ORIN has conducted several bench-scale, pilot-scale, and field scale PFAS remedial events ranging from groundwater treatment to soil and biosolid treatments. ORIN has been combining BAM and microbes for remedial treatment of PFAS compounds in soils, biosolids, and groundwater. This groundbreaking technology leads to the complete mineralization of PFAS compounds. Treatment approaches include direct push injection, soil blending application, and wastewater/sludge application. The advantages of utilizing BAM with microbes include the complete absorption and retention of PFAS within the structure of the BAM particle. BAM naturally enhances microbial activity leading to the breakdown of PFAS compounds once the microbial component is incorporated within the matrix. Microbes can be native to the site and are not genetically modified. **Orin's role: Bench scale/pilot testing of PFAS destruction in groundwater, wastewater, and WWTP sludge.**

Included with this submittal are expanded resumes and project experience of our Technical Project leads Kristen Freiburger and Jim Bailey. Their resumes and project experience are provided as attachments to this qualifications document.

PROJECT EXPERIENCE

The following are summaries of the PFAS and water well system project work completed by Shannon & Wilson that are relevant to the City of Wausau drinking water project.

Shannon & Wilson Projects

ALASKA DEPARTMENT OF ADMINISTRATION, DIVISION OF RISK MANAGEMENT (DRM) GUSTAVUS INN POET | GUSTAVUS, ALASKA (2019-Ongoing)

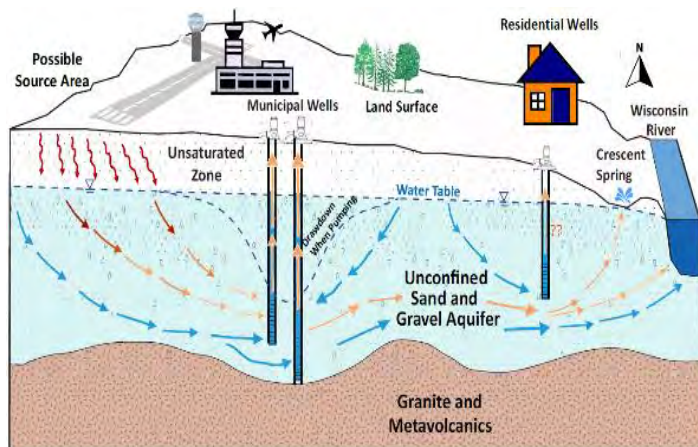
Shannon & Wilson is contracted with the Alaska Department of Administration, Division of Risk Management (DRM) to spearhead the State's PFAS response in the remote community of Gustavus. Planning began within one day of project notification; less than two weeks after receiving notice to proceed we had traveled to Gustavus to participate in a public meeting and identify drinking-water wells in the impacted areas. We have streamlined our firm's quality-control data-review process to provide drinking-water analytical results in a timely manner, without compromising the quality of our deliverables. Our prior experience and adaptive approach allowed us to delineate the extent of private-well impacts within three months. Analytical results for the Gustavus Inn indicated the presence of high concentrations of PFAS compounds in the transient community water supply. After receiving approval from the Alaska Department of Environmental Conservation (DEC), Shannon & Wilson and their subconsultant began to construct and aide in the design of a point of entry treatment (POET) system for the drinking water system serving the Gustavus Inn. This system included a treatment system to address the PFAS and the naturally-occurring levels of iron, manganese, and arsenic and installation of a UV unit for disinfection. Shannon & Wilson is currently involved in quarterly monitoring and maintenance of the system. **PFAS have not been detected in the treated drinking water since installation of the POET.**

Reference: Ken Simpson – Claims Administrator, State of Alaska Division of Risk Management, PO Box 110218, Juneau, AK 99811-0218, (907) 465-2183. Fee: ~\$235,806

Nature and Fate of PFAS Contamination in the City of Rhinelander Drinking Water Wells

As part of this project, Mark Rutkowski and Elliot Draxler teamed with the University of Wisconsin – Madison to study the nature and extent of PFAS impacts in the City of Rhinelander. Detection of PFAS in concentrations above EPA health advisory concentrations led to closure of two of the five City of Rhinelander municipal water supply wells. The contaminated wells were in close proximity to multiple potential PFAS source areas, including the Oneida County Airport and the closed City of

Rhineland landfill. The research will utilize the spider plot signatures, incorporating groundwater sample data, to provide insight into sources of contamination.

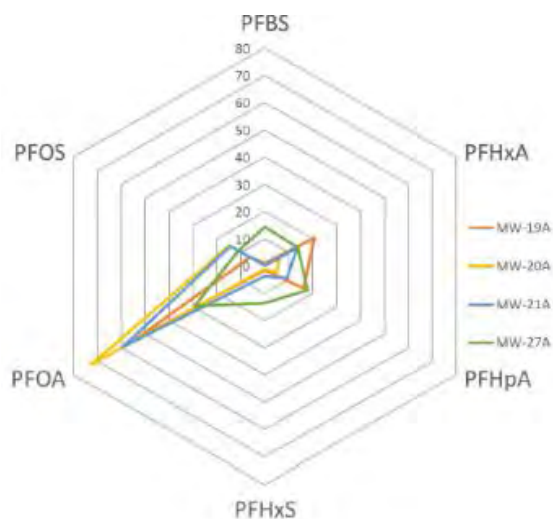


Schematic of contaminant sources and flow to wells.

Groundwater sampling and site characterization field studies were performed in 2021. Groundwater samples were collected for the project in January 2021 to supplement those collected by the City of Rhineland in October 2020. Water samples were also collected from the unsaturated zone using suction lysimeters. Geophysical techniques were used to characterize the subsurface conditions and to develop parameters for the future hydrogeologic model. Ground penetrating radar, electromagnetic, and electrical resistivity survey lines were performed along the borders of

Oneida County Airport. Multiple soil samples were also collected via hand auger around the contaminated wells for laboratory characterization.

Geochemical fingerprinting using spider plot analysis is currently underway. Geochemical fingerprinting examines variation in various PFAS analyte concentrations and the total analyte signature. An initial geochemical fingerprinting analysis of the Rhineland region characterizes the area into three zones, separated by distinctly different geochemical fingerprints. Additional analyses will be performed to link a PFAS source type based on the geochemical fingerprints. Hydrogeologic modeling of the Rhineland region is also underway to provide an understanding of contamination pathways.



Sample spider plot results.

PFAS Investigations – Paine Field/Snohomish County Airport | Everett, WA Snohomish County

Shannon & Wilson is tasked with assisting Paine Field in evaluating two areas for potential PFAS contamination. One area is downgradient of a hangar where multiple fire suppression system releases have occurred. The other area is at and around a pit formerly used for fire

training practice that is being considered for redevelopment. As needed, we will also provide legal and grant application support.

At the **hangar area**, fire suppression systems within two hangars were inadvertently triggered on multiple occasions about 20 years ago. When these events occurred, AFFF was released within the hangars. The foam reportedly flowed overland and via drainage pipes to a nearby drainage ditch, potentially impacting soil and/or water in the ditch. Given the age of the releases, a sampling plan was developed to target media most likely to have had longer-term impacts (soil where sediment may have been deposited from outfalls/low areas where water may infiltrate, water where back diffusion of PFAS from sediment to surface water may occur).

The **former fire pit area** was used by multiple fire departments for training exercises. During training activities, water and petroleum fuel or other flammable liquids were added to the pit and set on fire, and AFFF was used to extinguish the fire. The pit was an approximately 1- to 2-foot-deep oval earthen (unlined) depression extending approximately 40 feet wide by 80 feet long. Nearby, is a large triangular-shaped mound where, during certification events, AFFF was sprayed onto the field and later the mound to demonstrate that appropriate pressure requirements could be achieved. The field and mound were used intermittently for Federal Aviation Authority crash truck certification events between approximately 2000 and 2018. Previous testing detected petroleum (diesel- and oil-range) and lead in soil exceeding Model Toxics Control Act Method A cleanup levels at the time. In 2006, about 170 cubic yards of soil were excavated for offsite disposal and samples confirmed removal to cleanup criteria. Department of Ecology issued a no further action for the fire pit. In 2018, the former fire pit was further evaluated for the PFAS. Soil samples contained several PFAS compounds with PFOS detected at the highest concentration. Similarly, PFOS was detected at the highest concentrations in groundwater. Perched groundwater PFOS and PFOA detections exceeded the EPA Lifetime Health Advisory level of 70 ng/L.

Shannon & Wilson developed a sampling plan to supplement existing data and evaluate the extent of PFAS soil and groundwater contamination, flow direction of perched groundwater, and if PFAS is present in the underlying aquifer. Since PFAS may concentrate at interfaces, soil samples will be collected directly below surface vegetation, organic layers, depth of the water table, or changes in lithology. And the primary drilling method (direct push) was selected to reduce generation of IDW as PFAS-contaminated waste may be regulated as Washington State-only dangerous waste due to persistence. In accordance with standard practice, quality control samples (duplicates, blanks), hygiene practices, and decontamination procedures (use of PFAS-free water) will be implemented.

Various Well Rehabilitation Projects

Well Rehabilitation Highlights (2012 – 2020)						
Owner / Location	Well Condition Y/D/S	Video Inspection	Well Rehab Method	Bid/ Rehab Specs	Field Mgmt. Services	Pumping Tests
Rainbow Water District, Springfield, OR (3 wells)	300-500/63-222/12-16	✓	S, IR,J	✓	✓	✓
Coachella valley Water District, Palm Desert, CA	1500-2000/800-1200/16	✓	S,IR,C	✓	✓	✓
City of Florence, OR (5 wells)	100-200/80-200/12-16	✓	S, IR	✓	✓	✓
Crystal City, MO	1500/85/8	✓	S, IR, C,J	✓	✓	✓
City of Unalaska, AK (3 wells)	1200-1800/53-67/8	✓	S, IR	✓	✓	✓
City of Salisbury, MD (9 wells)	300-1000+/200-400/12-20	✓	S, IR, C,J	✓	✓	✓
City of Vancouver, WA (3 wells)	800-1000/900-950/12	✓	S, IR, C	✓	✓	✓
City of Juneau, AK (5 wells)	450-4000/55-80/12-16	✓	S, IR, C,J	✓	✓	✓
Harstine Pointe Water-Sewer District, Harstine Island, WA	55/158/8	✓	S, IR	✓	✓	✓
Asplund Well, Anchorage AK	375/90/8	✓	S, IR		✓	✓
City of Moxee, WA	1600/978/8	✓	S, IR, C	✓	✓	
City of Lacey, WA (10 wells)	100-2500/200-900/8-20	✓	S, IR, C	✓	✓	✓
California Water Auth., Visalia CA	800/310/16		S, IR, C	✓	✓	✓
City of Madera, CA	1800/540/20		S, IR, C	✓		

Well Rehabilitation Highlights (2012 – 2020)						
Owner / Location	Well Condition Y/D/S	Video Inspection	Well Rehab Method	Bid/ Rehab Specs	Field Mgmt. Services	Pumping Tests
City of Arlington, WA (2 wells)	580-1125/38-50/36-72	✓	S, IR	✓	✓	✓
City of Fairview, OR	675/569/12	✓	S, IR, C		✓	
City of Selah, WA	850/542/12	✓	S, IR	✓	✓	
Suffolk County Water Authority, NY	750/425/16	✓	S, IR		✓	✓
District of Squamish, BC (3 wells)	400-600/85-100/16	✓	S, IR	✓	✓	✓
Township of Langley, BC	610/139/16		S, IR	✓	✓	✓
Freshwater Fisheries Society of BC, Clearwater Hatchery (2 wells)	500-525/150-175/16		S, IR	✓	✓	✓
Shell Canada, Albion Sands Site (7 wells)	50-125/24-37/8		S, IR, C	✓	✓	✓
City of Redmond, WA	450/57/16	✓	S, IR, C	✓	✓	✓
PG&E, Oakley, CA (5 wells)	25-50/24-30/4		S, IR	✓	✓	✓
Teck Coal Greenhill Operation, Elkford, BC (3 wells)	50-100/146-172/8-10	✓	S, IR	✓	✓	
Sound Transit, Seattle, WA	125/175/6		S, IR	✓	✓	✓
Department of Fisheries, Chehalis River Hatchery, BC (2 wells)	650-800/338-343/10-20		S, IR	✓	✓	
Evergreen-Washelli, Seattle, WA (3 wells)	200-650/123-154/6-12	✓	S, IR	✓	✓	✓
City of Bonny Lake, WA	1200/315/12	✓	S, IR	✓	✓	✓
JBLM Hospital, Lakewood, WA	1000/292/14		S, IR	✓	✓	
City of Keizer, OR	820/290/12		S, IR, C, J		✓	✓

Well Rehabilitation Highlights (2012 – 2020)						
Owner / Location	Well Condition Y/D/S	Video Inspect- ion	Well Rehab Method	Bid/ Rehab Specs	Field Mgmt. Services	Pumping Tests
City of St. Charles, MO	3000/80/12	✓	IR	✓	✓	
City of Yelm, WA	2000/630/8	✓	S, IR	✓	✓	✓
City of Oakridge, OR	175/168/12	✓	S, IR		✓	✓
City of O Fallon., MO (4 wells)	1200-1500/80- 110/16		S, IR, C		✓	
City of Everett, WA (2 wells)	275-350/180- 184/8	✓	S, IR	✓	✓	✓
Northeast Sammamish Sewer and Water District, WA	525/650/10	✓	S, IR	✓	✓	✓
City of Scappoose, OR (2 wells)	100-400/170- 197/6-10	✓	S, IR		✓	
USACE St. Louis, MO (5 wells)	50-75/25-40/12	✓	S,IR	✓	✓	✓
USACE, Seattle, WA (4 wells)	450-1200/600- 900/16		S, IR	✓	✓	

Notes:

1. **Bold** text indicates S&W has completed multiple well rehabilitation work with client
2. Y/D/S denotes well yield (gpm), depth (feet)and screen diameter (inches)
3. Rehabilitation Methods used:
S – Surging/swabbing including dual disk, and with continuous pumping
IR – Induced resonance technology with and without simultaneous pumping
J – High pressure water jetting
C – Chemical rehabilitation

LNAPL Delineation & Characterization; Fate & Transport Modeling – Confidential Client | Cincinatti, Ohio

Staff were contracted to help delineate the horizontal and vertical extent of high-density Light Non-aqueous Phase Liquid (LNAPL) plumes at an operational Oil Refinery and estimate the total recoverable volumes. We developed and inter-related multiple 3D and 2D models of high-density geotechnical response data, historical water table and apparent product thicknesses, underground structures, and key hydrostratigraphic surfaces. Response datasets included 4-channel Laser-Induced Fluorescence (LIF), Membrane Interface Probe (MIP) responses from a Flame Ionization Detector (FID) and Photo-Ionization Detector (PID), Hydraulic Profiling Tool (HPT), and Electrical Conductivity (EC) responses recorded by all three tools.

Two types of models were created. Primary models were created for each response parameter, i.e. Total-LIF, LIF channels 1-4, MIP-FID, MIP-PID, EC, and HPT. Where needed, constraints extracted from other 2D and 3D models were used to ensure consistency with respect to model-defined maximum extents.

Other model assessments included: probable LNAPL extent, thickness of sediments containing LNAPL, depth to top of LNAPL, LNAPL intensity as defined by LIF response and thickness, and volume of recoverable LNAPL. Confidence in the model-defined extents was assumed to be limited to within 150 feet of the borings. All model outputs were truncated at that distance buffer. Data gaps were defined as regions at truncated boundaries characterized by parameter values in exceedance of specified thresholds. The models and output were revised as the data gaps were filled by the consulting team within the 6-month project period.

West Coast Basin -Plume Capture; Groundwater Flow Modeling, Torrance CA

Staff developed a 3D steady-state numerical groundwater flow model for the West and Central Basins in Los Angeles County California in order to simulate capture zones for a network of remediation pumping wells. The objectives were to: 1) expand on an existing model to honor new geologic and hydraulic data; 2) calibrate the model to new groundwater level data; 3) use parameter estimation (PEST) to optimize the model variables; and 4) simulate well capture zones to evaluate plume capture under high, normal, and low water level conditions and recovery well pumping rates. Our model simulated 3D flow through the Gage/Gardena, Lynnwood, and Silverado aquifers, variably separated by discontinuous aquicludes and deformed in the north by the Charnock Fault and the Newport-Inglewood Uplift. The model was constructed in FEFLOW™ using geologic data compiled

from more than 300 onsite and offsite boreholes describing hydrostratigraphic contacts and lithology; average head data compiled from more than 10,000 water level measurements collected from 198 monitoring wells in the Gage aquifer, 15 wells in the Lynnwood aquifer, and 39 wells in the Silverado aquifer; and average extraction rates for 136 water supply and recovery wells.

Orin Relevant Project Work

Midwest Airport

The airport tested the AFFF nozzle system every 6 months into grassy areas along the air strip. Across from the injection site, there are 9 potential release locations where PFAS may have been utilized including hangars, fire stations, storage areas, and firefighting equipment testing areas.

ORIN identified an approximate 1,600 sq-ft area to perform an injection event to remediate PFAS in groundwater. Four wells were installed prior to injection in order to characterize the groundwater concentrations and parameters. One well (PW-1) is in the center of the treatment area while the other three are around the perimeter. ORIN utilized a combination of BAM Ultra, Calcium peroxide, and PFAS Degrading Bacteria for 17 injection locations. ORIN utilized vacuum extraction as part of the injection process to assist in treatment chemical distribution. By coordinating the injection locations and rates with extraction, hydraulic movement of the groundwater can be controlled during the treatment amendment application.

Following the injection event, ORIN installed six electrodes in a grid like pattern and at a depth matching the injection interval. The electrodes utilize electrokinetic and electrochemical reactions to generate oxygen within the subsurface. The generation of oxygen is necessary for the aerobic PFAS Degrading Bacteria. ORIN has since been collecting groundwater parameter data and groundwater samples for PFAS analysis.

RECENT PUBLICATIONS AND PRESENTATIONS

- 2022 Freiburger. **PFAS Remediation at Fairbanks Int'l Airport – Fate and Transport and the Use of Colloidal Activated Carbon Explained.** Webinar recording with Regenesys.
- 2022 Rutkowski. **Community-based GO/NO-GO Decision Matrix for PFAS sampling.** (publication pending).
- 2021-2022. Draxler. **Nature and Fate of PFAS Contamination in the City of Rhinelander Drinking Water Wells, (University of Wisconsin-Madison Master's Thesis).** Under the direction of Dr. James Tinjum of UW-Madison, Mr. Draxler is actively completing environmental sampling and investigation activities in order to determine the source of

PFAS impacts to groundwater in the vicinity of the wells #7 and #8.

- 2012. Bailey. Maintenance Approach for Older Pressure Relief Wells. TME Journal.
- 2009. Bailey. Conventional and Modern Technologies Used to Efficiently Rehabilitate Groundwater Wells. Water Well Journal.

OUR SERVICE PROMISE TO YOU

Shannon & Wilson is dedicated to helping your project succeed and to making your experience with us a positive one. Our hope is that, if you enjoy working with us on this project, you will use our services on your next project! To that end, we want you to be completely satisfied with our performance, our personnel, and our project documentation. If you feel that we are not delivering on our promise of quality service, we encourage you to take your concerns straight to me, the Madison Office Manager. Your project is important to us and we want to deliver our services to your full satisfaction.

If you have questions regarding this RFQ response or desire to modify the scope of work, please contact me at (608) 960-7104 or mark.rutkowski@shanwil.com.

We appreciate your confidence in Shannon & Wilson.

Sincerely,

SHANNON & WILSON



Mark A. Rutkowski, P.G
Senior Associate/Office Manager

MXR

Resumes: Kristen Freiburger- Sr. Chemist
 Jim Bailey - Hydrogeologist

KRISTEN FREIBURGER | SENIOR CHEMIST

SHANNON & WILSON

**Education:**

MS, Environmental Chemistry,
University of Alaska Fairbanks,
2008

BS, Chemistry, Ball State
University, 2004

**Professional Registrations/
Licenses and Certifications:**

Environmental Professional -
(ASTM E1527 13)

OSHA Confined Space Training -
(KellerOnline)

HAZWOPER General Site
Supervisor - (Shannon & Wilson,
Inc.)

Hazardous Materials or
Dangerous Goods for Transport -
(49 CFR 172H and IATA DGR1.5)

State of Alaska Qualified
Environmental Professional - (18
AAC 75, 18 AAC 78)

Hazardous Waste Operations &
Emergency Response
(HAZWOPER) - (OSHA 29 CFR
1910.120)

Kristen has led Shannon & Wilson's (S&W) response to several large, high-profile per- and polyfluoroalkyl substances (PFAS) and other emerging contaminant groundwater-contamination projects in Fairbanks and other remote Alaskan areas. Over the last 15 years, she has played a central role in developing residential well search and sampling programs, supported and participated in numerous public-outreach activities for PFAS sites, and has also been integral in the development and use of S&W's environmental-sample analytical database and data-validation, control quality (QC) programs, and the coordination of installation and management of Point Of Entry Treatment (POET) systems for several contaminants, including PFAS. Kristen is our senior representative for the Alaska Department of Transportation and Public Facilities (DOT&PF) Statewide PFAS projects, including investigations at the Anchorage, Bethel, Gustavus, Dillingham, Homer, Iliamna, King Salmon, Kodiak, Yakutat, Valdez, Nome, and Fairbanks airports. She is knowledgeable in federal compliance regulations, and has coordinated with local, state, and federal agencies on environmental issues, including high-profile written and oral communications on behalf of clients. She works with a variety of clients with different perspectives, resources, and regulatory requirements and understands the need to tailor each project site to meet the objectives of the site. Recently, Kristen was invited to serve as a session chair for the 2022 Combined Chlorinated and Bioremediation Conference to develop a session titled "PFAS Fate and Transport".

Relevant Project Experience:**ADOT & PF Statewide PFAS | Various Locations, Alaska (2018-2021/ongoing)**

Senior Chemist/Project Manager. Kristen manages the emergency response, site investigations, and remediation activities at several sites contaminated with PFAS for the ADOT&PF. She is responsible for overseeing our response for sites in Anchorage, Fairbanks, Dillingham, King Salmon, Gustavus, Yakutat, Iliamna, Nome, Homer and Bethel, AK. Duties include project management, reviewing available information, performing data validation, coordinating with regulators and clients, remaining up to date on the ever-changing regulatory environment, and investigating remedial options. Scope of services also include private well searches, site characterization, sampling efforts in different geographic search areas, feasibility studies to outline remedial efforts, and public-outreach support. The contract also includes coordination with several subcontractors including HDR, Inc. and Barr Engineering.

ATL Eielson Field Screening Projects | Eielson Air Force Base, Alaska (2018-2021/ongoing)

Senior Chemist. S&W provided environmental services during various construction projects on Eielson AFB, AK. Services included reviewing the UFP-QAPP, providing a QEP to test soil with PFAS contamination during excavation, and additional services, as needed. Kristen provided Level II data reviews and validations and evaluated data usability to meet project data-quality objectives.

Fairbanks International Airport PFAS | Fairbanks, Alaska (2017-2021/ongoing)

Senior Chemist. Kristen provides guidance and oversight on the project, performing as stand-in project manager as needed, and overseeing collection of private-well samples. She worked closely with S&W staff in St. Louis to provide an application to coordinate communication and reporting of analytical data with the client and regulators in real time. Kristen regularly performs QA/QC reviews of the laboratory data and reporting materials. In 2018 she provided guidance and oversight for the closure of the on-airport fire training pit (FTP), she was involved with planning and implementing corrective actions at

one of the FAI source areas for PFAS contamination. These corrective actions involved the treatment of over 700,000 gallons of contaminated water and the installation of controls to prevent future accumulation of PFAS- and petroleum-contaminated water. Shannon & Wilson backfilled and capped the former FTP as part of an interim remedial action effort. In 2019, Shannon & Wilson and their partners participated in a pilot study to determine the efficacy of PlumeStop® as an in-situ groundwater remediation solution within the FAI PFAS groundwater plume. Kristen recently presented in the results of the pilot study in a nation-wide virtual presentation. Kristen assisted with acquiring permits and maintaining compliance with regulatory agencies. Kristen oversaw the preparation and acquisition of EPA permits to install monitoring wells and injection wells at the project site.

Gustavus Airport PFAS | Gustavus, Alaska (08/2018-2021/ongoing).

Senior Chemist/Project Manager. Kristen manages a contract with the division of Risk Management to spearhead the state's PFAS response in the remote community of Gustavus. Planning began within one day of project notification; less than two weeks after receiving notice to proceed staff had traveled to Gustavus to participate in a public meeting and identify drinking-water wells. Kristen facilitates well searches, drinking water-supply well sampling and analysis, data review and reporting, public outreach, preparing fact sheets and software app development. Kristen and her team have streamlined QC data review processes to provide drinking-water analytical results in a timely manner, without affecting the quality of deliverables. The firm's experience, and adaptive approach allowed for the delineation of the extent of private well impacts within three months. The project included the installation of a point-of-entry treatment system at the Gustavus Inn; Kristen and her team are currently monitoring the effectiveness of that system. To date, PFAS has not been detected in the treated drinking water. She is currently working with the client to develop rain-water cisterns for affected properties. Kristen is currently working with the department to provide alternative water for household uses.

Harding Pit Groundwater Assessment | Salcha, Alaska (06/2020-01/2021)

Senior Chemist/Project Manager. Shannon & Wilson prepared and implemented documents to obtain a ADEC Site Closure at the location of an unauthorized High Expansion Foam (HEF) wastewater solution release at the Rolling Stone, Inc. Harding Lake Gravel Pit in Salcha, Alaska. Scope of work included preparation of a Groundwater Site Characterization Work Plan (WP) to investigate the extent of possible contamination resulting from the discharge of Ansul Jet-X 2% HEF waste. Kristen managed and coordinated all activities related to investigating the extent of contamination, which included drafting and implementing the WP and reporting the findings. The report summarized field observations, analytical results and discussion of data quality, photo documentation, sample locations, and conclusions and recommendations. The client obtained Site Closure notice from ADEC within one year of Shannon & Wilson's initial response.

Alaska Well Monitoring for Sulfolane and PFAS | North Pole, Alaska (2009-2021/ongoing)

Senior Chemist/Project Manager. Project Manager/Data Evaluator. Kristen manages this project involving drinking-water assessment and treatment at residential properties within and near a Sulfolane plume. Kristen led our efforts and coordinated with a local vendor to maintain 165 point-of-entry GAC treatment systems for homes in the affected area. Current efforts include ongoing monitoring of the sulfolane and PFAS plumes in the area. Kristen is also responsible for communication with the public, database management and producing maps using GIS. She manages complete QA/QC review of laboratory data and reporting responsibilities. This site also involves coordination with the overall project team responsible for site characterization and remediation, including regular sampling by our field staff to sample 100s of monitoring wells onsite and offsite on a frequent basis.

Flint Hills Resources Alaska, EcoWater System Sulfolane Treatment | North Pole, AK (2010-2011)

Project Manager. Collected groundwater samples for containing various concentrations of sulfolane to provide to EcoWater Systems LLC for processing. Collected effluent samples from their treatment system to evaluate the experimental in-home system's ability to remove sulfolane from drinking water. Sent samples in for analysis; completed QA/QC review of laboratory data. These systems were later discovered to sequester PFAS.

References:

Sammy Cummings, PFAS Program Manager, Alaska DOT&PF, 907.888.5671

Angie Spear, Fairbanks International Airport Manager, 907.978.8697

Lee Andrews, Williams Alaska Petroleum, Inc., 918.573.6912

JIM BAILEY, LHG | SENIOR ASSOCIATE, NATIONAL WELL SERVICES DIRECTOR SHANNON & WILSON

**Education:**

MS, Hydrogeology,
Washington State University,
1984

BS, Biology, University of North
Carolina, 1979

**Professional Registrations/
Licenses and Certifications:**

Licensed Hydrogeologist – (WA,
1285)

Professional Geoscientist- (WA,
1285)

Jim Bailey serves as Shannon & Wilson's National Well Services Director. He has more than 26 years of water supply development and ground water management experience. His water resource work has focused on municipal water supply including water rights, well design/construction, and evaluation of well performance issues. He has extensive experience in the coordination and supervision of well drillers, design of drilling programs, selection and oversight of analytical services, development of specifications for such services, and cost control. Since 2005 he has completed well evaluation/performance projects, in Alaska, Alabama, California, Hawaii, Idaho, Illinois, Nevada, New York, Ohio, Oregon, Virginia, Maryland, New Jersey, New Mexico, New York, Washington, West Virginia, and Canada. He also has extensive experience evaluating subsurface hydrogeologic conditions for both the management and infiltration of stormwater as not only a disposal method but an approach to aquifer recharge and mitigation of groundwater pumping and increased stormwater runoff due to impervious surfaces. He routinely works with clients to develop site specific infiltration studies and evaluations that minimize the long term risk of facility failure.

Relevant Project Experience:

Sound Transit, Northgate Link Extension, McMillen Jacobs Associates | Seattle, WA

Staff Team. As part of the investigation for construction of a light rail tunnel, dewatering test wells were constructed to determine aquifer properties for dewatering design. The test pumping wells, and associated monitoring wells were installed in two locations of the alignment and 24-hour pumping tests were completed in both locations. Innovative technology was used for the development of both wells to shorten development time and costs. Project completed in May 2011. 2021

Seattle Public Utilities, Green Stormwater Infrastructure (GSI) Program Management, SVR Design Company | Seattle, WA

Staff Team. Performed a technical assessment of Seattle Public Utilities long term operation and maintenance plan for existing and future underground injection control (UIC) sites. Reviewed existing hydrogeologic data, UIC design, UIC performance monitoring data and rehabilitation efforts. Provided

recommendations for improving long term UIC performance monitoring and testing. Seattle Public Utilities UIC Well Testing, Seattle, WA. Currently assisting Seattle Public Utilities with development of a long term approach for monitoring the performance of their underground injection control (UIC) wells. Work includes training SPU staff on UIC well injection testing and supporting staff with development of a stormwater grant application. 2020

FY12 Infrastructure Upgrade, Phase I, Package A, Alutiiq Diversified Solutions LLC | Lakewood, WA)

Project Manager. Mr. Bailey managed and directed the design and construction of two new water supply wells for the USACE Seattle District at Joint Base Lewis McChord. Initial work included preparation of detailed drilling and construction specifications. The Noble Hill Well has a natural gravel packed screen, 784 feet deep, with 36 feet of stainless steel screen. Based on the 24-hour constant rate pumping test, the well has a long term pumping capacity of about 1,200 gpm. The Ross Hill Well, is a naturally developed, 256 feet deep, well with 22 feet of stainless steel screen. Analysis of water quality data,

and pumping test results indicate a well capacity of over 250 gpm but potential poor natural water quality conditions due to high iron and manganese. 2015

Flint Hills) Hills Resources, North Pole Refinery, Rehabilitation of Older Existing Wells, Flint Hills Resources Alaska | North Pole, AK.

Hydrogeologist. The Flint Hills Refinery has installed a groundwater recovery well system to remove and treat contaminated water beneath the site. A number of these wells have lost performance and need to be evaluated for rehabilitation or replacement. Project involved the assessment of the wells condition and development of a rehabilitation plan for each well. Directed the implementation of the rehabilitation work and the testing of the wells after work was completed. The rehabilitation work was successful in improving the wells performance and increasing the recovery rate of contaminants. Project completed in August 2011. 2011

East Tank Farm Gasoline Spill Response, Flint Hills Resources Alaska | Anchorage, AK

Senior Chemist/Project Manager. The Flint Hills Refinery has installed a groundwater recovery well system to remove and treat contaminated water beneath the site. A number of these wells have lost performance and need to be evaluated for rehabilitation or replacement. Project involved the assessment of the wells condition and development of a rehabilitation plan for each well. Directed the implementation of the rehabilitation work using a combination of mechanical and induced resonance technologies, and the testing of the wells after work was completed. The rehabilitation work was successful in improving the wells' performance and increasing the recovery rate of contaminants. 2016

Leach Field Disposal and Waste Water Lagoon, SEH, INC. | Quartzsite, AZ

Project Manager/Well Designer. La Posa Long Term Vehicle Area, Quartzsite AZ. Project Manager/Well Designer. Shannon & Wilson provided hydrogeologic services for a new potable supply well for a large seasonal recreational vehicle camping area south of Quartzsite Arizona. Due to increasing demand, the existing well source is no longer capable of supplying enough water. The scope of services included a site investigation, review of local hydrogeologic conditions, preparation of well drilling specifications, selection of a drilling contractor, drilling of a test well, design and testing of a new 675-foot-deep potable well. Additional services included design of a surface geophysical survey to determine possible locations for additional potable supply wells. 2021

BLM Carlsbad Employee Housing, SEH, INC. | Carlsbad, NM

Project Manager/Well Designer. Shannon & Wilson provided hydrogeologic services for a new potable well for a future employee housing development at an undeveloped site in Carlsbad, New Mexico. The scope of services included a site investigation, review of local hydrogeologic conditions, preparation of well drilling specifications, selection of a drilling contractor, drilling of a test well, design and testing of a new potable supply well. The new well was drilled to a depth of 140 feet into fractured limestone deposits. 2021.

Bureau of Land Management, Gerber Guard Station Klamath Falls Resource Area | Bonanza, OR

Project Manager/Well Designer. Mr. Bailey managed the evaluation and testing of an existing water supply well used for fire suppression and crew quarters. Work included soliciting bids from a pump contractor, preparing a work plan for a constant rate pumping test and monitoring the pumping test. A report was prepared that documented the long term capacity of the well and recommended future maintenance steps to maintain well performance. 2018

City of Florence, Well Assessment and Rehabilitation, City of Florence, OR

Hydrogeologist. Completed oversight and performance of well rehabilitation services for a series of the cities supply wells. The well field consists of several wells installed within a natural dune park and preserve along the Oregon Coast. Special considerations during the rehabilitation of the cities wells included the operation of tools and equipment in harsh environmental conditions which varied from high winds with blowing sand, heavy rain, and cold. Specific capacities on the wells were all increased by more than 50% using a combination of nitrogen impulse, swabbing, isolation pumping, and airlifting techniques. Responsibilities included direction of the redevelopment activities from the field, video logging of the wells, interfacing with the client and other interested parties, and real-time evaluation of redevelopment effectiveness and well performance. Project completed in June 2011. 2012



March 29, 2021

Mr. Eric Lindman, PE
Director of Public Works and Utilities
City of Wausau, 407 Grant Street
Wausau, WI 54403

**Re: Tetra Tech Professional Experience related to PFAS Treatment for Water Supply Systems
Response to Request for Qualifications Related to PFAS Treatment & Removal from Drinking Water
City of Wausau / Wausau Water Works**

Dear Mr. Lindman:

Tetra Tech, Inc. (Tetra Tech) is pleased to present our Statement of Qualifications to the City of Wausau for our professional experience related to Per- and Polyfluoroalkyl Substances (PFAS) Treatment and Removal from Drinking Water for the City of Wausau Water Works. Tetra Tech has experienced staff that have implemented several successful drinking water treatment systems for PFAS removal in California consisting of four ion exchange resin systems and two granular activated carbon systems, involving various flows from 1.4-17 MGD, with a range of facility footprint limitations. Tetra Tech understands the nature and magnitude of Wausau's efforts to provide PFAS-free drinking water to its residents and can accomplish the component tasks described in the request for professional engineering qualifications.

We have assembled a team of highly qualified and experienced water quality experts familiar with PFAS fate and transport and the design and construction of groundwater treatment systems/facilities for traditional and emerging contaminants. Our team will be led by Mr. James (Jamie) Dickson, PE, and Ms. Marsha Meurette, both of whom are located in Wisconsin and have extensive experience collaborating with other consulting firms, working effectively with the WDNR, and with the investigation and remediation of emerging contaminants. Mr. James (Jamie) Dickson, PE, Principal-in-Charge/Program Manager is a Professional Engineer licensed in 10 states with almost three decades of experience working on similar projects involving the treatment of emerging contaminants for federal and state agencies and industrial/commercial clients, and is located in Brookfield, WI. Mr. Dickson will be supported by Ms. Marsha Meurette, Senior Environmental Scientist/Project Manager located in Schofield, WI, who brings over two decades of environmental & industrial hygiene consulting experience for public and private clients to the team.

Additional Tetra Tech experts in ex-situ groundwater & drinking water PFAS treatment systems and in the development of innovative, customized treatment systems for the remediation of PFAS-impacts in municipal water supply wells, as well as PFAS investigation, and treatment system evaluation & testing will also support the project goals. Similar project experience includes the use of treatment options such as air stripping, granular activated carbon (GAC), ion exchange (IX), advanced oxidation processes, batch, and continuous reactions. Our team looks forward to collaboration with the City of Wausau, Donohue & Associates, and Becher Hoppe & Associates, Inc., throughout the PFAS treatment design approach and installation, by adding our expertise to the work already in progress, to most efficiently achieve the project objectives.

We appreciate the opportunity to provide our qualifications in the management of PFAS programs related to municipal drinking water, as well as our project approach, and we commit to maintaining this level of quality and service to the City of Wausau. If you have any questions or need additional information, please do not hesitate to contact us.

Sincerely,

Tetra Tech, Inc.

A blue ink signature of Jamie Dickson, consisting of a stylized 'J' followed by a horizontal line.

Jamie Dickson, PE | Program Manager
Jamie.Dickson@tetrattech.com
(920) 980-1780 (mobile)

A blue ink signature of Marsha Meurette, written in a cursive style.

Marsha Meurette | Project Manager
Marsha.Meurette@tetrattech.com
(715) 297-6277 (mobile)

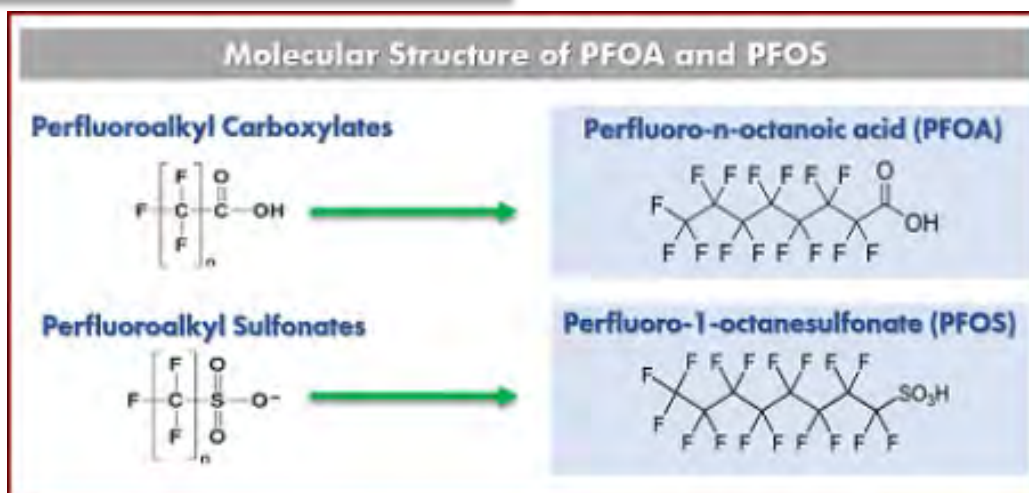
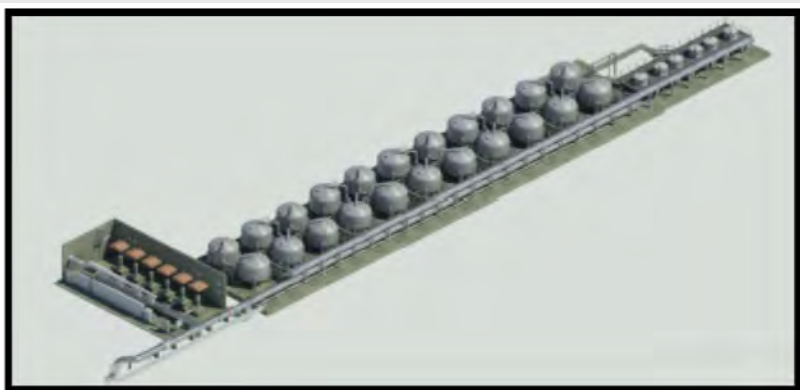
Tetra Tech Inc.
5404 Alderson St., Schofield, WI 54476
Tel 715-355-4180 Fax 715-359-2853 tetrattech.com

Tetra Tech Professional Experience

Prepared for the City of Wausau / Wausau Water Works



Response to Request for Qualifications Related to PFAS Treatment and Removal from Drinking Water Systems



Submitted March 29, 2022

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TETRA TECH OVERVIEW

INTRODUCTION: Tetra Tech, Inc. (Tetra Tech) is a leading provider of high-end consulting, engineering, program management, construction, and technical services globally focusing on resource management, infrastructure, and environmental restoration and protection. Tetra Tech was established in 1966 and is headquartered in Pasadena, California. With over 21,000 employees working together, in more than 450 offices across 100 countries on 7 continents worldwide, Tetra Tech provides clear solutions to complex problems in water, environment, sustainable infrastructure, renewable energy, and international development to various clients.



MISSION: Tetra Tech’s mission is to be the premier worldwide consulting and engineering firm focusing on natural resources, infrastructure, and the environment. The core principles forming the underpinning of how we work together to serve our clients are:

- ❖ **Service:** We put our clients first. We listen closely to better understand our clients’ needs and deliver smart, cost-effective solutions that meet those needs.
- ❖ **Value:** We take on our clients’ problems as if they were our own. We develop and implement real-world solutions that are cost-effective, efficient, and practical.
- ❖ **Excellence:** We bring superior technical capability, disciplined project management, and excellence in safety and quality to all our services.
- ❖ **Opportunity:** Our people are our number one asset. Our workforce is diverse and includes leading experts in our fields. Our entrepreneurial nature and commitment to success provide challenges and opportunities for all our associates.

RECOGNITION: Our firm consistently ranks among the top engineering firms annually according to Engineering News-Record (ENR), a highly regarded industry news magazine. Tetra Tech has currently been ranked by ENR as:

- #1 in Water (Water Supply) – 18 years in a row
- #1 in Environmental Management – 13 years in a row
- #1 in Water Treatment/Desalination – 8 years in a row
- #1 in Wind Power – 6 years in a row
- #4 in Top 500 Design Firm

We have achieved our success by being selective with the projects we pursue and ensuring that our team capabilities meet or exceed the project’s requirements. We have built a reputation as a leader in developing effective solutions to constantly changing, tough engineering challenges. Our reputation is backed by reliable systems, safe working conditions, and client satisfaction. Tetra Tech brings this leadership and integrity to the City of Wausau and Wausau Water Works’ PFAS Treatment and Removal from Drinking Water project. Our firm’s operation expands and specializes in all municipal services including drinking water treatment facilities (DWTF) and wastewater treatment plants (WWTP).

WHY SELECT TETRA TECH?

Tetra Tech has long history of serving the Wausau area, including the previous completion of several successful environmental and industrial hygiene projects for the City of Wausau, and is further backed by both Wisconsin and national staff that have practical experience in the design, installation and startup of municipal PFAS drinking water systems, primarily in California. California has had stringent drinking water notification levels of **6.5 ppt for PFOS and 5.1 ppt for PFOA**. The lead / lag vessel configuration of our systems provides treatment to below detection limits of 5.0 ppt of Total PFAS. We have the capability to provide world-class engineering services to support the City of Wausau and the existing DWTP team for the development of PFAS pretreatment for the new and/or existing drinking water treatment plant as necessary. Tetra Tech has over 100 employees in Wisconsin and a resource pool of over 16,000 professionals nationally to support your project as needed.

- ❖ **Extensive Experience and Track Record:** Our team approaches the design of treatment facilities with a unique perspective that is founded on our experience. The lessons learned from the six successful PFAS treatment projects in California completed for both individual well heads and municipal Drinking Water Treatment Plants (DWTPs) reflect proven success of applied knowledge. Our practical experience of the potential complexities and challenges associated with successfully designing, building, and maintaining DWTP is invaluable. Our team has developed several innovative tools and approaches that are key in the treatment of PFAS and VOC-impacted groundwater that we can communicate clearly to the City of Wausau, Wausau Water Works, as well as Wisconsin Department of Natural Resources (WDNR).
- ❖ **Local Focus – National Expertise:** We are national leaders in the treatment of groundwater impacted by traditional and/or emerging contaminants. Our experienced staff and local office are close to the project site, ensuring that we are easily accessible for all tasks on short notice. Our team will work closely with the City of Wausau, Donohue & Associates, and Becher Hoppe & Associates, as we have in past projects, throughout the design to provide detailed design drawings, collaborate to communicate ideas, and work as a team toward achieving the project objectives. Our team's detailed knowledge of the most current industry standards for both design and operations, and the "best value" solutions to sustainably maintain those standards, will enable us to efficiently and effectively complete the project.
- ❖ **Robust Project Understanding and Approach:** We have assembled a team of highly qualified and experienced water quality experts familiar with the design and construction of groundwater treatment systems/plants for traditional and emerging contaminants. Our team has worked on similar projects involving the use of treatment options such as air stripping, granular activated carbon (GAC), ion exchange (IX), and advanced oxidation processes. Our team's extensive experience designing treatment options for PFAS and other contaminants in DWTP extraction wells has equipped us with the ability to critically assess the opportunity and constraints associated with the PFAS remedial design associated with the new Wausau DWTP. This experience includes the unique fate and transport of PFAS in groundwater, best PFAS removal option technologies, identification of resin type, acceptable empty bed contact times (EBCT), and acceptable hydraulic loading rates, in order to reduce the PFAS below the Wisconsin Department of Health Services (DHS) recommended level of 20 parts per trillion (ppt), as well as keep the total organic carbon (TOC) below 5.0 milligrams per liter (mg/L) and total VOCs below 20 ug/L.
- ❖ **Proven Results:** Tetra Tech has provided similar water treatment engineering services on an as-needed basis to various municipalities, and has conducted successful remedial investigation projects with the City of Wausau, achieving site closure approval from the WDNR. With this experience, we understand the unique nature of continuing contracts, and the necessity to provide timely responses to meet project budgets and schedules and regulatory requirements.
- ❖ **Successful collaboration:** We have a strong history of collaborating effectively and successfully with other engineering and consulting firms, including Becher Hoppe & Associates, to achieve project objectives and the best outcomes to the satisfaction of our clients. Tetra Tech is also well connected with various treatment system subcontractors with whom we partner to provide the most appropriate and effective treatment equipment and media. These partnerships are continuously evolving and include coordination with innovative remedial technologies such as biochar pyrolysis for PFAS, which holds promise for in-situ groundwater treatment applications.

Tetra Tech provides a wide range of professional services relating to the characterization and remediation of contaminants in soil, groundwater, surface water, and wastewater. We provide cutting edge bench and pilot scale innovative technologies, such as plasma, electron beam and sonolysis technologies. Our clients vary in size and scope from private individuals and commercial/industrial clients, to small local public agencies, to national governments and large multinational corporations.

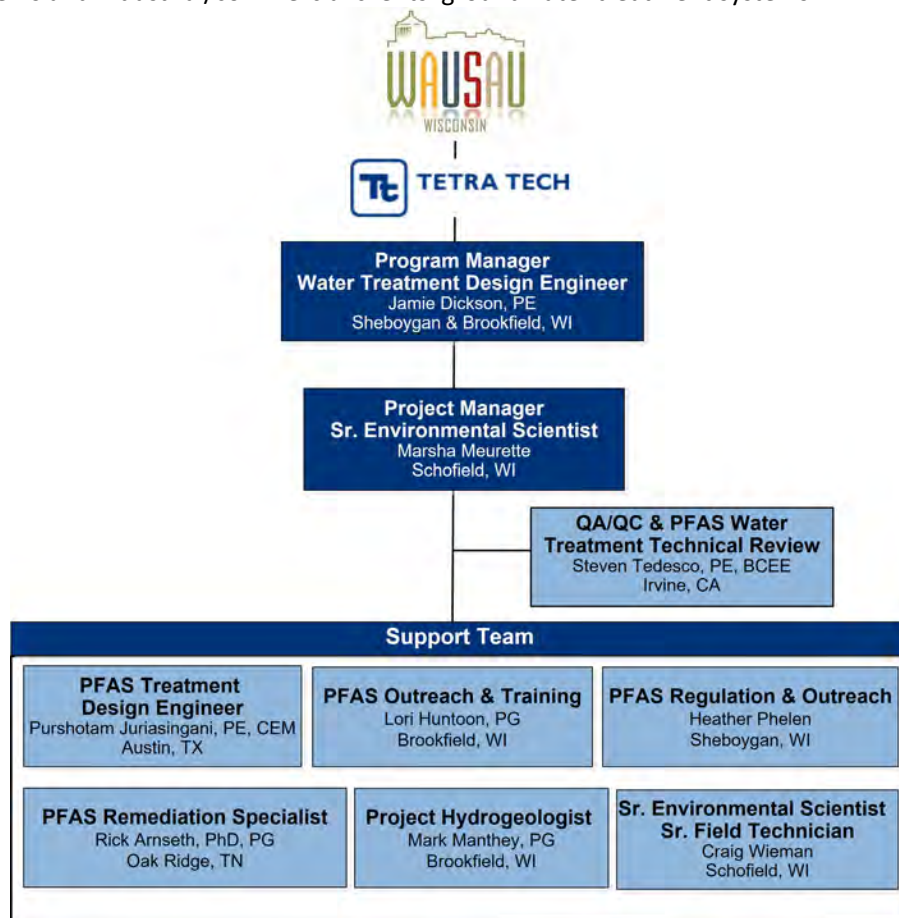
Tetra Tech is well versed in providing groundwater assessment, forensic analysis (fingerprinting), groundwater remediation, and water treatment solutions, particularly with those technologies commonly used to remove PFAS from water supplies (e.g. ion exchange, granular activated carbon, and reverse osmosis). We have provided planning, permitting, design, bidding assistance, construction, startup, testing, and operation of groundwater extraction systems and water treatment plants. Over the past 50 years, we have developed a specialized set of technical skills that position us to compete effectively for groundwater, surface water, and wastewater treatment projects.

PROPOSED PROJECT TEAM FOR THE CITY OF WAUSAU

Tetra Tech will bring together a team with direct relevant expertise in the State of Wisconsin and strong experience in the evaluation and design of PFAS remediation treatment systems. Tetra Tech plans to leverage the success, knowledge, lessons learned, and tools developed from the extensive list of PFAS remediation programs that we have completed for municipal and Federal utility DWTF systems and industrial/commercial clients' groundwater treatment systems.

Our team will be led by **Mr. James (Jamie) Dickson** and **Ms. Marsha Meurette**, both of whom are located in Wisconsin and have extensive experience collaborating with other consulting firms, working effectively with the WDNR, and with the investigation and remediation of traditional & emerging contaminants. **Mr. James (Jamie) Dickson, PE, Principal-in-Charge/Program**

Manager is a Professional Engineer licensed in 10 states with almost three decades of experience working on similar projects. He is the Operations Manager of the Brookfield, Wisconsin office as well as maintaining an office in Sheboygan, WI, and has experience working on projects involving the treatment of emerging contaminants for federal and state agencies including the WDNR, ACE (Army Corps of Engineers), Air Force Civil Engineer Center, and industrial/commercial clients.



Mr. Dickson will be supported by **Ms. Marsha Meurette, Senior Environmental Scientist/Project Manager** who brings over 27 years of experience in environmental and industrial hygiene consulting, regulatory interfacing, and budget management. Ms. Meurette is located in the Schofield, WI office, and in addition to project management and regulatory interfacing, she will be the general point of contact for the City of Wausau, Donohue and Becher Hoppe.

Mr. Dickson and Ms. Meurette will be supported by the following Subject Matter Experts (SMEs):

Steven Tedesco, PE, BCEE; Purshotam K. Juriasingani, PE, CEM, STS; Lori Huntoon, PG; and Heather Phelan.

These SME leads are experienced in PFAS regulations, investigations, treatment system evaluation and testing, and developing innovative, customized treatment systems for the remediation of PFAS impacting municipal water supply wells. Tetra Tech has experienced staff that are familiar with the City of Wausau's hydrogeologic conditions and has knowledge and experience working with the State of Wisconsin regulations, the WDNR and DHS.

Additional members involved with PFAS & emerging contaminant investigations, sampling, and remediation include: **Rick Arnseth, PhD, PG; Mark Manthey, PG; and Craig Wieman.**

Resumes for the project team are included in Appendix A.

Additional personnel can be brought onto the project team as project resource requirements dictate.

JAMIE DICKSON, PE, PROGRAM MANAGER / Principal-in-Charge and Technical Lead

Mr. Dickson is a Principal Engineer and Operations Manager of the Tetra Tech Brookfield office, with more than 30 years of experience working with large equipment refurbishment, piping systems, electrical, and system controls including supervisory control and data acquisition (SCADA). His experience includes process design, mechanical systems, control system instrumentations, control narratives and interlocks, electrical system design, hydraulic calculations, and other front-end engineering designs. He has a strong track record of integrating environmental regulations and policies with industrial, institutional, and commercial business objectives and has served as an effective advocate for his clients under various regulatory programs. He has worked extensively with the USACE, US NAVY, USEPA, and WDNR on several projects.

Mr. Dickson has worked on design and operations of projects treating volatile organic compounds (VOCs) and emerging contaminants in drinking water aquifers of Michigan, Ohio, New Jersey, New York, and Washington State. He is well known as an effective communicator on a variety of subjects relating to the remediation of traditional and emerging contaminants including PFAS and 1,4-dioxane. He has worked with and has a working relationship with many remediations treatment technology vendors for emerging contaminants including APT Water, Emerging Contaminant Technology 2 (ECT2), Groundwater Treatment Technology (GWTT), ORIN Remediation Technologies, Pacific Coast Carbon, Calgon Carbon, and Evoqua. His expertise includes the design and construction of treatment systems and plant facilities, and he is the principal design engineer for PFAS and 1,4-dioxane treatment in groundwater treatment plants/systems including drinking water aquifers. Expertise includes municipal and industrial water and wastewater treatment systems, liquid phase granular activated carbon (GAC), filtration, one use ion exchange resins (IX), regenerable ion exchange resins (IXR), treatment with multimedia filters (MMF), and advanced oxidation processes (AOP). His hands-on experience includes treatment systems with simple and complex piping configurations.

MARSHA MEURETTE, PROJECT MANAGER / Investigation Lead and Local Presence

Ms. Meurette is a Senior Environmental Scientist and Project Manager located in our Schofield, WI Office, and has over 27 years of experience working in the environmental and industrial hygiene consulting field for public and private clients. She has worked extensively on projects relating to traditional contaminants such as petroleum compounds, VOCs, semi-VOCs, heavy metals, solvents, and radioactive waste, as well as asbestos, lead-based paint, & mold, and maintains awareness of emerging contaminant regulatory changes and assessment practices. Project experience includes conducting subsurface explorations, monitoring well installation oversight, soil sample screening and collection, water and waste compliance sampling, monitoring well development, groundwater & surface water sample collection, active remedial system monitoring and maintenance, analytical result interpretation, and report preparation for clients and regulatory agencies. She is also well-versed in workplace exposure assessments for various contaminants of concern, site safety plan development, and has served as site safety officer.

She manages all aspects of projects, from providing proposals and cost estimates, to project execution and oversight of both Tetra Tech personnel and subcontractors, as well as report preparation, regulatory interfacing, and project budget management. She also provides project management, field assistance & expertise to internal Tetra Tech projects. Responsibilities include direction to project teams in order to ensure that projects and tasks are performed following established policies and procedural requirements. Her role in this project involves coordination with the program manager and directing the project team in achieving project objectives.

STEVEN TEDESCO, PE, BCEE – Treatment Technologies for Emerging Contaminants

Mr. Tedesco has over 38 years of experience in environmental consulting and project management. He is experienced in the planning, analysis, design, and construction of water supply, water treatment, and water distribution and collection systems. He is an expert in the advanced water and wastewater field, including desalination, Title 22, microfiltration, reverse osmosis, ultraviolet treatment, nanofiltration, and waste disposal projects. Mr. Tedesco has led membrane system design teams and managed the complete design and construction of membrane desalination projects and membrane filtration plants.

His extensive knowledge base includes quality assurance and quality control (QA/QC) of large water treatment systems, discrete treatment technologies, and associated equipment. He has direct experience in the planning and leading teams responsible for the mobilization, installation, operation, and repair at project locations nationally of technologies including IX, mixed media, particulate filtration, and granular activated carbon.

Mr. Tedesco works closely with project managers and clients to ensure that expectations are met or exceeded. He oversees all aspects of the field service process to ensure that cost-effectiveness, constructability, quality, and safety requirements are attained through the project completion/hand-off. He manages resources and material both internal and external to meet system start-up and operational performance requirements.

PURSHOTAM JURIASINGANI, PE, CEM, STS – Treatment Technologies for Emerging Contaminants

Mr. Juriasingani has over 23 years of experience in environmental programs and project management. He is a subject matter expert focusing primarily on the treatment of emerging contaminants like PFAS compounds and 1,4-Dioxane. Mr. Juriasingani has managed PFAS program consisting of PFOS/PFOA data tracking and analysis, development of drinking water protection studies, developing life-cycle assessments of different treatment technologies, and preparing cost & performance reports of several PFOS/PFOA treatment systems installed across several active US Air Force (USAF), Base Realignment and Closure (BRAC), and Air National Guard installations.

Mr. Juriasingani leads the initiative to develop proof-of-concept treatment technologies and processes for PFAS compounds in groundwater, soil, and surface water. He has experience with several innovative remedial processes and technologies for the treatment of conventional and emerging contaminants in soil, groundwater, and sediments. He has extensive experience with thermal, biological, chemical, and water treatment technologies. He has expertise in engineering management that brings together the technological problem-solving techniques of engineering and the organizational, administrative, and planning abilities of management to oversee complex projects from conception to completion. He is an expert in creating a cost-effective multi-component remedial strategy for complex sites with high risk, variable geology, and persistent sources.

LORI HUNTOON, PG, . - Emerging Contaminants, Outreach and Training

Ms. Huntoon brings over 30 years of professional experience in environmental compliance, including oversight of large multi-faceted programs. She has significant experience with technical program oversight and comprehensive reporting, facilitation/negotiation, public outreach, and training. She has presented environmental regulatory requirements and serves as an expert witness. She has extensive knowledge of the behavior of contaminants in various media including the sources, occurrence, distribution, fate, and transport of PFAS in groundwater. Her technical PFAS experience includes regulatory negotiation, industry and community training, and sustainable environmental solutions. She organizes and facilitates technical committees such as the internal Tetra Tech PFAS Workgroup for the Midwest; thereby organizing the expertise of some of the local leading PFAS practitioners to provide sound, engineering, and science-based guidance. She brings seven years of regulatory oversight and program administration experience as Chief of the Wisconsin Department of Commerce Environmental and Regulatory Services Division - Technical Section of the

Wisconsin Petroleum Cleanup Fund [PECFA (Petroleum Environmental Cleanup Fund Award)] with the Wisconsin Department of Commerce.

She has conducted PFAS training for staff, stakeholders (municipalities and pueblos), regulatory personnel and Department of Energy staff, including the detection of constituents and appropriate sampling protocols. In addition, she recently prepared a strategic action plan focused on decision-making prior to initiating site activities. This PFAS Action Plan was utilized during a recent site wide PFAS groundwater sampling event managed by Ms. Huntoon for the legacy contamination cleanup site at the Los Alamos National Laboratory. In addition, Ms. Huntoon was significantly involved in the City of Wausau Superfund Site investigation activities on behalf of the City of Wausau and provided oversight during the installation and development of City Well #8.

HEATHER PHELAN – PFAS Regulation and Outreach

Ms. Phelan has over 15 years of experience in environmental programs, including oversight of groundwater, sediment, and soil sampling programs. She brings strong experience in the elements required for the assessment of emerging contaminants, including PFAS. She has organized and facilitated technical committees and facilitated meetings regarding PFAS, including the internal Tetra Tech PFAS Workgroup for the Midwest, thereby organizing the expertise of some of the local leading PFAS practitioners to provide sound, engineering, and science-based guidance. Ms. Phelan has served as co-chair of the Wisconsin Chapter of the Solid Waste Association of North America PFAS Regulatory Subcommittee and has also been an active participant with the Public Outreach Subcommittee.

UNDERSTANDING OF THE REQUIRED SCOPE OF SERVICES

Tetra Tech understands that voluntary testing of the six water supply wells in the City of Wausau detected PFAS in all the wells, with perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) having combined concentrations ranging from 24 to 33 ppt, exceeding the DHS recommended level of 20 ppt. The total organic carbon (TOC) in all the wells, apart from one (Well 9), is above the median TOC concentration in surface water (3.5 mg/L). These concentrations indicate that PFAS and TOC are not effectively treated by the existing drinking water treatment facility (DWTF). Exposure to PFAS by the route of drinking water may occur if the source of the water supply has been contaminated by a PFAS source such as a manufacturer with processes that currently use, or historically used PFAS, wastewater treatment facilities, landfills, other disposal areas, and/or firefighter training facilities.

The existing DWTF has been determined to be outdated, with filters and media greater than 50 years, and the facility's controls are also greater than 25 years. The current DWTF site has a lack of additional space for expansion and further development which will be required for future treatment, including the remedy for the emerging contaminant. On March 26, 2019, the Common Council of the City of Wausau approved the construction of a new water treatment plant at 700 Bugbee Avenue to replace the existing water treatment plant currently located at 1701 North River Drive. The DWTF is currently under construction and is anticipated to be commissioned in the third quarter of 2022.

The new system consists of an aeration step followed by oxidations, coagulation, settling and filtration steps. The polish step will use an anion exchange system; specifically, the Thermax Tulsion A-72 MP Special Grade Ion Exchange Resin. This resin will be used to remove any residual dissolved natural organic matter (TOC) and color. Since there are data gaps in the efficiency of the resin in removing TOC in PFAS-contaminated water, Donohue & Associates and Becher Hoppe are in the process of conducting a pilot study to collect enough data to determine the potential limitations of the resin in PFAS removal. The pilot study includes the installation and operation of three pilot test columns in three treatment scenarios. In train 1, the first and second columns were filled with the Tulsion A-72 MP Thermax resin and ECT2 SORBIX PURE Ion Exchange Resin, respectively. Train 2 has Tulsion A-72 MP Thermax resin in one column and GAC in another column. Train 3 has only ECT2 SORBIX PURE Ion in one column. To expedite the results of the pilot study, the testing equipment or columns were connected to the existing drinking water treatment facility.



In soliciting the assistance of engineers with PFAS experience, the Wausau Water Works Commission hopes to add value to the ongoing treatment pilot study, close any data gaps remaining, and work toward a final resolution for adequately treating PFAS contaminated water. They have identified the need for a consulting firm with broad PFAS expertise to collaborate with Donohue & Associates and Becher Hoppe to present the best options in removing PFAS from drinking water and to provide guidance on additional testing in exploring those options, if necessary.

We understand that there are currently no PFAS treatment/removal systems installed in Wisconsin for drinking water supply systems, and the City of Wausau is likely to be the first municipality to treat for and remove PFAS from a public drinking water supply in the State. Tetra Tech has brought together a team with direct relevant expertise in the State of Wisconsin and solid experience with the evaluation and design of PFAS remediation treatment systems for municipal drinking water. We plan to leverage the success, knowledge, lessons learned, and tools that we have developed from other PFAS remediation programs that we have completed for municipal utility companies, municipalities, and commercial/industrial clients, to help the City of Wausau, and their subcontractors, achieve the goal of removing PFAS from the drinking water supply while also maintaining other water quality parameters required of municipal drinking water supply utilities.

TETRA TECH'S PROPOSED TECHNICAL APPROACH

Tetra Tech engineers have carefully reviewed the scope presented in the SOQ (Statement of Qualifications) and understand the types of services the City of Wausau and the Wausau Water Works Commission are requesting. The SOQ request intends to have engineering firms explain their capability and experience related to PFAS research, removal, treatment, and implementation of such processes in drinking water, groundwater, and wastewater facilities.

Our proposed approach will focus on the most pressing issues concerning the quality of drinking water for the citizens of Wausau. Tetra Tech has reviewed the system design available for the new water treatment plant and has proposed the following approach to address the needs of the City.

Description of the new system: The City of Wausau has begun the construction of a new DWTF that will replace the existing treatment system. The new facility consists of two air strippers, two aerators, two peroxidation basins, two flocculation tanks, two clarifiers, two backwash reclaim tanks, five gravity filters, two filtered tanks, anion exchange tank, process waste tank, two clear wells, sanitary pump station, and several pumps. The new treatment facility will be operated by six production wells, with two of the wells (3 and 6) impacted by VOCs from the Wausau Superfund site. During the operation of the facility groundwater from production wells (#7, #9, #10, and #11) will be conveyed to the two aerators while the VOC-impacted groundwater from production wells #3 and #6 will be conveyed through the two air strippers in lieu of the aerators.



Problems: The City of Wausau and Wausau Water Works conducted voluntary testing of all municipal water supply wells for PFAS in 2019 and 2022. The analytical results were between 23 and 48 ppt; indicating the concentrations are below the USEPA Health Advisory Level of 70 ppt, but greater than the DHS recommended level of 20 ppt that has been proposed. PFAS in the drinking water from the production wells was obtained from an aquifer impacted by PFAS from sources that currently unknown.

The new system will become operational in August 2022 or later with the goal of producing approximately 3,500 gpm of PFAS-free potable water. Several processes involved in potable water production would be affected if PFAS-impacted water from the production wells is not treated before traversing through system components. First, the coagulation, flocculation, and filtered solids will be impacted if PFAS is not intercepted before the system's initial operations. Secondly, while the anthracite layer in the filter beds will aid in removing some amount of PFAS from the water through adsorption, this layer will ultimately become PFAS saturated with time and may release PFAS during the backwash cycle. The released PFAS will impair the backwash water conveyed to the sanitary sewer and, ultimately, to the publicly owned treatment works.

Based on the review of system drawings, we discovered that the discharge of the two city wells (wells #3 and #6) through air stripping towers at given flow rates, and at designated periods, is mandated for the remediation of the VOCs from the Wausau Superfund site. Based on this information, the design plan shows a separate stream from these two wells must go through the air stripping tower proposed. The flow from the other four wells will be combined and directed to the inlet aerators with a significantly lower lift.

Solution: There are several approaches currently used in the removal of PFAS from municipal DWTF or systems globally; it is understood that the approach or system proposed for the City of Wausau's DWTF must meet the **National Science Foundation's (NSF) requirements**, which at the current time limits treatment directly to the use of IX or GAC with proper disinfection and flushing processes. Based on the current configuration of the new DWTF at Wausau and the city's water quality data, **we would likely propose using cation ion exchange (IX) resins (positively charged ion exchange resins) in a lead/lag/spare configuration** for the removal of PFAS from source groundwater from the

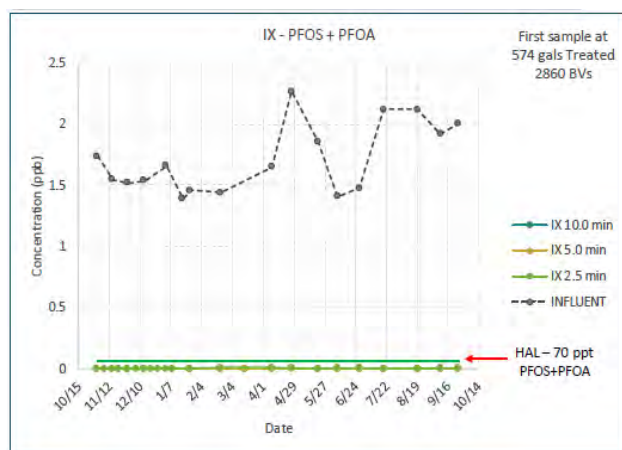
production wells prior to the conveyance of this water through aerators or air strippers. However results from the pilot study may provide additional data to refine the proposed treatment method.

Why use IX Resin instead of GAC? IX resins are highly porous, polymeric materials that are acidic or basic, and are insoluble in water (hydrophobic). IX resins are well known and established in treating or removing several contaminants in groundwater and potable water. IX resins act like tiny powerful magnets that attract and hold the contaminated materials from passing through the water system. IX resins are either negatively charged anion exchange resins for removing positively charged contaminants including metals, or positively charged cation exchange resins for removing negatively charged contaminants including PFAS. The cation exchange resins effectively remove PFAS from water because of the negatively charged structure of the hydrophilic head of most PFAS compounds becoming attached to the cation of the resin, due to opposite charge attraction, as well as the secondary removal mechanism by adsorption of the hydrophobic tail of PFAS molecules to the resin. These complementary properties increase the PFAS removal capacity of ion exchange resins when compared to strictly adsorptive media such as granular activated carbon (GAC).

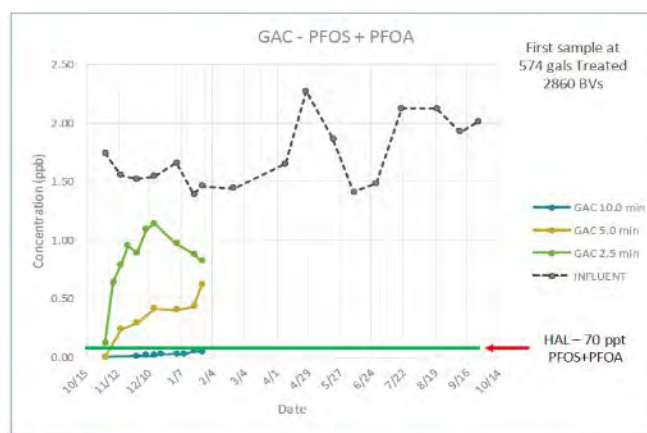
GAC has also been shown to be effective in removing PFAS from drinking water when used in a flow-through filter mode after particulates and TOC have already been removed. GAC would also require the lead/lag/spare configuration similar to the IX system to ensure treated PFAS concentrations remain below detection. Recent studies have shown that GAC works well on longer-chain PFAS (PFOA and PFOS); however, shorter chain PFAS including perfluorobutanesulfonic acid (PFBS) and perfluorobutyrate (PFBA) do not adsorb as well. Secondly, adsorption of PFAS by GAC is not instantaneous; therefore, a longer hydraulic retention time (residence time) is required for the adsorption of PFAS. Additionally, the presence of certain contaminants in groundwater, including nitrate, may pose a challenge in using GAC for drinking water PFAS treatment. Lastly, using GAC could be useful in removing PFAS and VOCs from the inlet stream of the system; however, this would affect the original design of the facility by rendering the air stripping towers redundant.

Other advantages of IX resin is the higher capacity of total PFAS removal compared to GAC and the shorter contact time required. IX resin has a higher capacity for total PFAS removal since IX treats 10x – 20x the number of bed volumes (BV) as GAC, depending on inlet water quality and treated water targets. This translates to less spent media change-outs of the lead vessels, reducing operating costs. IX resin can **remove single PFAS species, as well as simultaneously remove multiple short- and long-chain PFAS species to non-detect levels including PFOA, PFOS, PFNA, PFBS, PFBA, PFHxA, PFHxS, and PFHpA.**

The IX resin has a shorter empty bed contact time (EBCT) than GAC, usually less than 10 minutes, while GAC requires significantly more than 10 minutes. It is typical for the GAC vessel size to be 5-6 times larger than IX vessels to achieve the same effectiveness. Although elevated concentrations of organic matter in groundwater can affect the effectiveness of certain IX resins in removing PFAS, the average concentration of TOC in groundwater in Wausau should not affect the resin used. The resin is anticipated to last for approximately 2 years before a change out would be required. The graphs below show a comparison between GAC and IX resin in removing PFAS.



IX Resin is nondetect after 171,000 BV's or 34,300 gals Treated (2.5 mins EBCT)



GAC Breaks 50ppt at 13,000 BV or 10,400 gals Treated (10 mins EBCT)

Approach: Based on the current configuration of the new DWTF, Tetra Tech would likely propose the installation of two separate IX systems using single-use PFAS-selective positively charged cation exchange resins (non-regenerable) for treating PFAS-impacted groundwater from the production well before it gets to the facility inlets. The resin proposed would likely be the **ECT2 SORBIX PURE Ion Exchange Resin**, which is up to **20 times more** efficient in the treatment of PFAS than GAC. This resin has been used effectively in treating billions of liters of PFAS-contaminated water to concentrations below drinking water standards, with more sustainable and cost-effective treatment solutions. The resin has an EBCT of 2.5 to 5 minutes per vessel and is currently one of the resins included in Donahue’s treatment pilot study design. Results of the current pilot study will help provide additional data to either confirm the use of this type of IX resin.



One smaller system (1,100 to 1,400 gpm) would likely be adequate to remove the PFAS concentrations from wells #3 and #6, while letting the VOCs pass through to the air strippers for treatment. This system would be configured in a lead/lag vessel and a spare set for operations during change out, with two sets of IX vessels with a lead/lag configurable manifold to redirect flow. This will allow for sampling between the active vessels to monitor PFAS contaminant breakthrough and providing water with PFAS concentrations below detection to the DWTP to avoid contamination of the new system. The current detection limits for PFAS compounds are 5 ppt. If concentrations are detected between the lead and lag vessels, the alternate set of vessels would be placed in service while the change out of the spent vessel resin is arranged and conducted. Upon completion of resin replacement the former lead vessel with the new resin will then become the lag (polish) vessel by reconfiguring the flow through the manifold. In this way, the former lag vessel with resin that was previously exposed to some level of PFAS is now in the lead vessel position. This process will ensure that the polished vessel contains virgin resin material without any prior PFAS exposure. During the change-out process, the spent resin would be containerized for disposal, and the vessel will be flushed and disinfected following NSF requirements. The new NSF-certified resin will be placed in the sanitized vessel and backflushed with clean-finished water to sort the resin bed and provide the flushing required. The set will then be available for backup use once the other set exhibits PFAS breakthrough. There currently are few disposal options for spent resin. It can be dried and shipped to a landfill in the western US with low rainfall, or incinerated at a high temperature to destroy PFAS. Additionally, for the smaller system treating just wells #3 & #6, a booster pump would likely be needed to overcome the head loss across the IX vessels and ensure that the minimum flows required are met.

A similar but larger system could be installed on the feed line from the other four production wells (#7, #9, #10, and #11). Depending on demand, this system would need to treat between 2,650 to 4,850 gpm of groundwater. This system would be similar to the smaller system outlined for wells #3 & #6, but would either have larger vessels or more sets of similar vessels in parallel to meet the required retention time and the required throughput (amount of water passing through the system). If flow through the vessels is too fast, the retention or binding of PFAS to the resin will be minimal and PFAS will break through prematurely. Groundwater flow through the resin vessels would need to be controlled to ensure the flow range for PFAS removal by the resin is met. Flow below the low-end loading rate will result in the channeling of flow causing excessive contact with some resin and no contact with other sections of the resin within the vessel, resulting in inefficient resin use and/or premature breakthrough. The vessels will need to be adequately sized, or multiple vessel sets configured as primary and secondary may need to be utilized. This would allow lower flows to pass through the primary resin set and the secondary resin set would be added if flows exceed the single unit capacity. Both sets would have the lead/lag/spare set configuration discussed in the smaller system. In this case the secondary lead vessel may not require change for four or more years depending on the use of the secondary set. This preliminary approach would likely ensure the production of potable water for consumption by the City of Wausau without the need for further treatment of waste downstream of the facility, the existing system would not have PFAS impacts above the DHS levels, and the equipment procured for the DWTF will function as intended. Based on the existing water chemistry and pilot study design, the pilot study results should confirm the beneficial use of the ECT2 SORBIX PURE IX resin for PFAS treatment and provide breakthrough estimates.

OUR SUBSTANTIAL PFAS QUALIFICATIONS

Our industry-leading scientists, technicians, engineers, and public outreach specialists provide research and development, water quality characterization, and design of demonstration, remediation, and municipal-scale treatment solutions to mitigate risks to communities.

Tetra Tech is well qualified to provide a wide range of services related to the assessment and treatment of PFAS. We have extensive experience throughout Wisconsin conducting site investigations, sampling drinking water, installing treatment systems that can remove PFAS from water and other matrices, and managing public relations and community outreach issues related to PFAS.

With these capabilities, we are able to provide value for our clients in many ways, including:

- Source identification and expert testimony to defend our clients from offsite sources.
- Efficient and effective site characterization.
- Proactive negotiations and advocacy based on a strong knowledge of regulations and agencies.
- Identify and proactively manage risks and uncertainties to avoid unforeseen negative outcomes.
- Identification of optimal remedial approaches to decrease the total life cycle cost to closure.

Tetra Tech is extremely well positioned to support PFAS projects for our clients based on our:

- Global network of world-class PFAS experts and practitioners with extensive experience and deep expertise to support PFAS programs across the globe.
- A wealth of knowledge derived from successfully implementing over \$120 M in PFAS projects for our clients around the globe
- Global PFAS thought leadership with active participation in developing innovative characterization, analytical and treatment technologies
- Multi-disciplined teams that can provide support across the full life-cycle of PFAS projects including: characterization, fingerprinting, fate and transport modeling, conceptual site model development, remedial technology evaluation, and remedial implementation.

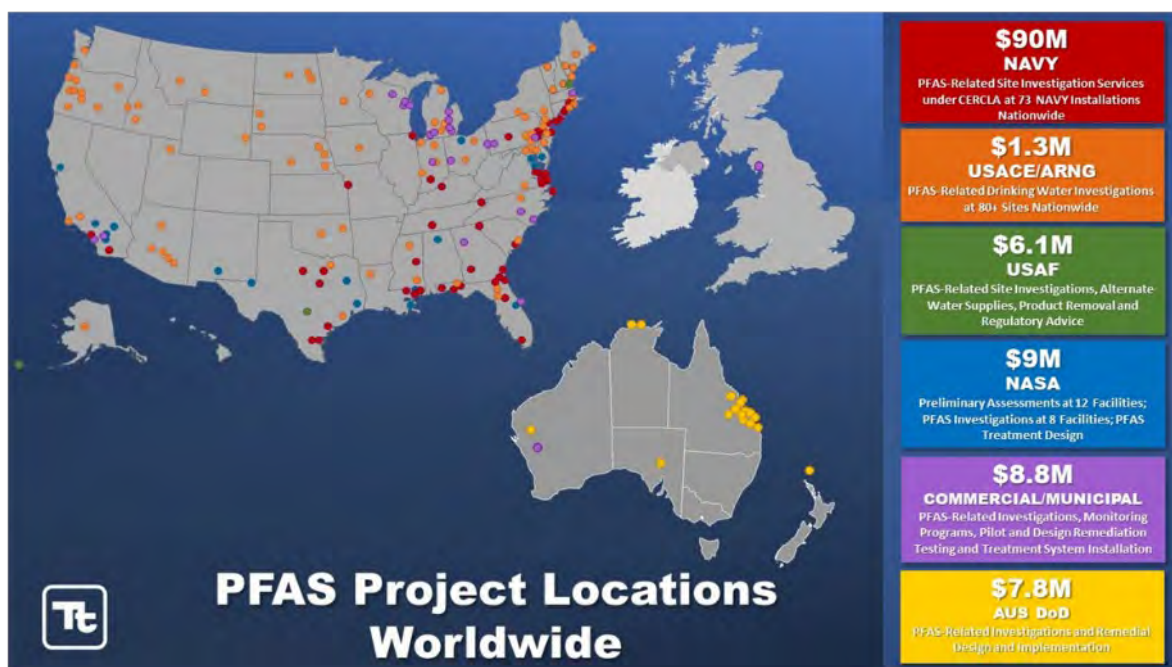
Our team's detailed knowledge of the most current industry standards for both design and operations and the "best value" solutions to sustainably maintain those standards will enable us to exceed the project requirements efficiently and effectively for the City of Wausau drinking water supply system. In addition, we will be able to draw on Tetra Tech's broad experience in designing & implementing drinking water & wastewater treatment facilities, including various disinfection methods and corrosion control technologies.

GLOBAL PFAS PROJECT FOOTPRINT

Our projects include complex programs for commercial, state, and federal clients in the United States and across the globe in addition to the six projects in California, summarized above. For example, successful solutions are being provided for a municipality in the US State of Ohio. The sampling was not limited to a single event or location but was expanded to include investigation of more than 700 sampling locations across the State during 2020. We used our deep bench of PFAS-trained field staff to maintain consistency among field teams while also operating in a COVID-safe manner. The work was completed safely and efficiently with of the highest levels of quality, resulting in a satisfied client who has requested additional PFAS support. A large privately-owned commercial client based in the United States is

faced with multiple locations with PFAS concerns in several media, including sludge, leachate, surface water and groundwater.

Our footprint of PFAS projects and revenue (in US dollars) is presented below and includes projects in the United States, United Kingdom, and Australia.



We support our clients in all aspects of development of conceptual site models, stake holder engagement, fate and transport modeling, source identification and bench scale testing, resulting in financial savings through consistent and innovative approaches as well as reputational protection by proactive measures.

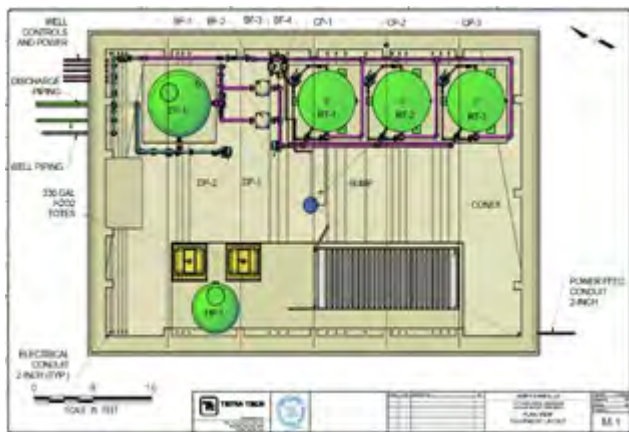
SELECTED TETRA TECH RELEVANT PROJECT EXPERIENCE

Tetra Tech has worked on several PFAS and other contaminant treatment projects in Wisconsin as well as throughout the United States and internationally. **Based on our performance and innovative approach to PFAS treatment, Tetra Tech was awarded the 2021 Environmental Business Journal's Project Merit Award for designing a first-of-its-kind IX exchange plant to treat PFAS in groundwater in California, the results of which restored drinking water supply for 12 production wells that had previously been taken out of service.**

The summaries below provide a selection of our relevant projects involving PFAS and emerging contaminants. Additional details regarding our expertise with design and implementation of water treatment systems involving PFAS are included in Appendix B.

EXPERIENCE WITH WDNR IN WISCONSIN INCLUDING TRADITIONAL AND EMERGING CONTAMINANTS**Treatment System for Emerging Contaminants, Confidential Client, Cottage Grove, WI**

Tetra Tech was contracted by a confidential client to construct a groundwater treatment system for the treatment of emerging contaminant 1,4-dioxane and other traditional contaminants.



The treatment system is a sequential batch reactor that utilizes an advanced oxidation process of ozone-activated hydrogen peroxide in treating contaminated groundwater pumped from two extractions wells that have a combined flow of 95 gallons per minute (gpm). The treated water will be discharged into a freshwater manmade pond via a combined storm sewer manhole. The treated groundwater will be characterized, treated, and analyzed before it is discharged into the pond. In order to meet the requirements of the General Permit, the treatment system retention time to theoretically treat 1,4-dioxane and other VOCs was calculated and the tank size was tripled to ensure all contaminants would be mineralized below discharge requirements. The

design calculations package and full-scale design were submitted to WDNR with the Notice of Intent filing to receive approval for the discharge. The permit and design package were approved by the WDNR last year. This project is currently at the construction phase and is anticipated to be completed in 2023. The estimated cost of design and construction was \$1.7M.

General PFAS Assessments Completed in Wisconsin in Conjunction with WDNR

In general, Tetra Tech has conducted several PFAS assessments including soil, groundwater, and leachate investigations for various clients across the state. Site activities were negotiated with, and work plans, standard procedures & protocols, and results were reviewed by the WDNR. Tetra Tech developed a plan for follow-up activities at selected sites. WDNR Project Managers have been on-site during sampling activities to observe PFAS sampling protocols.

Investigation and Regulatory Negotiation, Former Wausau Motor Service, City of Wausau, WI

Tetra Tech conducted environmental investigations and regulatory negotiation on behalf of the City of Wausau from 1995 to 2018 to acquire a WDNR Conditional Closure for a redevelopment site. Site contaminants included multiple constituents at concentrations in excess of regulatory standards.

Site Assessment for Building Expansion, Former Point Lube Property, City of Wausau, WI

Tetra Tech assisted the City of Wausau with a site assessment and subsurface soil sampling associated with the proposed site (now current) for the City of Wausau Fire Department Building expansion.

EXPERIENCE WITH WATER TREATMENT SYSTEMS**Moses Lake Wellfield Contamination Superfund Site, South Plume Groundwater Extraction Treatment and Reinjection system, Moses Lake, WA**

The Moses Lake Wellfield Contamination is located within and beyond the northwestern region of the City of Moses Lake, Washington and encompasses approximately 15 square miles. The site includes the Grant County International Airport and surrounding area (formerly the Larson Air Force Base), Port of Moses Lake, commercial facilities, and residences. Industrial activities associated with the aircraft industry and the former operations of the U.S. Air Force at the site resulted in soil and groundwater contamination.



Tetra Tech was subcontracted by FPM-CTI Joint Venture, LLC to help design, construct, and operate a new groundwater extraction and treatment system to treat contaminants. The system includes groundwater extraction from five wells installed in the core of the plume; equalization of the extracted groundwater; filtration of the water through lead/lag vessels; treatment of the water through liquid phase GAC, and the treated water discharge into one of two infiltration galleries.



Tetra Tech also managed the engineering aspects of construction with the installation of controls and remote access support being provided by the design team. Tetra Tech operated the system for required performance testing and managed the controls contractor to address issues encountered during the initial shakedown testing (30 days). This project began in 2019 and is currently ongoing. The estimated total cost was approximately \$5.2M.

Assessment and Treatment Evaluation of PFAS in Five Water Supply Wells, City of Downey, CA

The City of Downey found that they had five existing water supply wells with PFOA and PFOS concentrations higher than the new California Response Levels set in February 2020. Tetra Tech was hired to perform a study to determine the best means for the City to continue operating the wells. Alternative treatment options considered included isolating certain zones in the wells that contained PFAS, blending PFAS contaminated water with other City well water, using IX or GAC wellhead treatment, and/or piping PFAS contaminated water to a central location for treatment were analyzed. The scope of work for this project included:

- Analyzing the water quality in the wells.
- Reviewing the well screen data to determine if well modifications can solve the PFAS issue.
- Developing options for treating PFAS at the Wellhead.
- Developing options for treating PFAS at a central location.
- Determining if IX or GAC treatment should be used.
- Developing capital and operations cost estimates for the project.



This project was completed in 2021 and the cost of construction was \$4M. Considerations explored during the planning and execution of the project included limitations due to the size of the well sites and the location of the well sites within a highly developed urban area. A detailed analysis of capital and operating costs of the plant were prepared, and funds solicited based on the findings of this study.

Investigation and Remedy Evaluation for PFAS-Impacted Drinking Water, Irvine Ranch Water District, CA

Well ET-1 was developed to increase the utilization of the Irvine Subbasin through recovery and treatment of VOC-impaired groundwater. The contaminated groundwater was remediated, and the treated water was used for non-potable purposes. Water extracted from the VOC plume was treated using GAC and air stripping technologies.

The scope of work for this project included:

- Analyzing the water quality in the wells.
- Developing three treatment options for the PFAS in Well ET-1.
- Developing three treatment options for Wells ET-1 and 78 if PFAS was found in those wells.
- Determining if IX or GAC treatment should be used.
- Developing capital and operations costs for drinking water production based on the treatment options.

This project was completed in 2021 and the cost of construction was \$4M. Below are some of the key summaries of the project:

- i. The site had VOCs and elevated concentrations of PFAS.
- ii. The existing operating site has a small footprint.
- iii. Treated water was used for irrigation and industrial purposes.

EXAMPLES OF PFAS TREATMENT SYSTEMS COMPLETED BY TETRA TECH

The Orange County Water District selected Tetra Tech as one of the engineering firms for the PFAS Treatment Systems On-Call Design Contract. Projects include the design of PFAS systems for the District's groundwater producers. The project team prepared the Engineer's Report and the Operating Plan for the State of California Division of Drinking Water (DDW) for each of the projects below; these projects involved a pilot study to determine the type of remedial options to use. This project was completed in 2021 and the cost of construction was \$30M. Innovative technical approaches used during the project include:

- i. Performing detailed operational analysis of IX and GAC usage for the rapid small-scale column tests and the pilot study data.
- ii. Performing detailed wells analysis to determine how to maximize well production after adding IX and GAC systems.
- iii. Using early submittal process to obtain DDW approvals in less than 5 months from the start of the design.

Tetra Tech is currently completing multiple projects for the Water District, including the following:

Fast Track Design of a Wellhead Filtration/Treatment Plant for PFAS, Orange County Water District, CA

Tetra Tech completed a fast-tracked design of a wellhead filtration/treatment plant in late March 2020 for the Orange County Water District. The proposed site contained an existing well and disinfection system at a former Kimberly Clark site in an industrial section of Fullerton. Located on a very small site with a single well, this facility is designed to produce 3,000 gpm of water using an IX system with a bag filter pre-treatment, and a new chemical feed system for disinfection.

Due to the extremely small footprint of the site, IX treatment was selected. Using 12-foot diameter vessels, Tetra Tech designed a facility that allowed ample access for all equipment and room to service the existing well in the future. All design and permitting was completed in only 5 months, allowing the project to go to bid in late August 2020. The treatment system was designed using two IX trains operating in a lead/lag configuration. PFAS is monitored between lead and lag vessels on a quarterly basis. Once either PFOA or PFOS is measured above a certain threshold, the monitoring is changed to monthly. A trigger level directs the operator to order and schedule a media changeout.

Serrano Water District Well #5 and #9 (Completed Design), Orange County Water District, CA

This project consists of a 3,000 gallon per minute (gpm) IX system with a bag filter pre-treatment, a 3,000 gpm booster pump station, and a new chemical feed system for disinfection.

Fullerton Main Plant PFAS Water Treatment Plant, Orange County Water District, CA

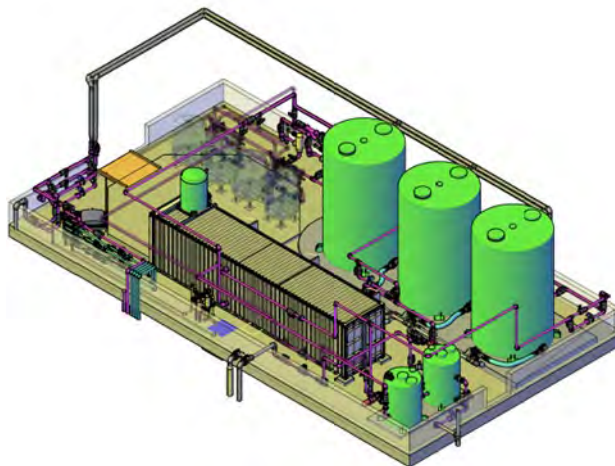
This plant will treat groundwater from six onsite wells with a total capacity of 10,100 gpm. PFOS, PFOA, and VOCs will be removed using 6 to 12 ft diameter, 40,000-pound GAC vessels that will discharge treated water into an existing forebay, then pump the water into the distribution system. The remaining wells will be treated with an IX system consisting of 8 vessels and bag filters for pre-treatment.

Yorba Linda Water District Headquarters Plant, Orange County Water District, CA

This plant will treat water from 10 wells with a total capacity of 17,400 gpm. An IX System consisting of 11 pairs of lead/lag vessels (22 vessels total), bag filter pre-treatment, booster pump station, and a new onsite generation system for disinfection of water using chlorine. An extensive analysis of the site improvements was completed to get the system on the existing site.

Treatment System Redesign for Emerging Contaminants, Naval Air Station, Whidbey Island, WA

An existing remediation system installed at Area 6 of Naval Air Station Whidbey Island for the removal and treatment of CVOCs has been operational for over 20 years. The system consisted of multiple groundwater extraction wells pumped via a common manifold to an equalization tank. Water from the Equalization was pumped and treated by an air stripping tower based on the contaminants of concern at the time. The discharge from the system re-infiltrates via overland flow to an adjacent wetland. The discovery of emerging contaminant 1,4-dioxane exceedances in groundwater, which are not removed by air stripping, and a new 1,4-dioxane plume from the historic discharge infiltration area have emerged. As a result, a new system to treat 1,4-dioxane and VOCs was required. Tetra Tech was contracted to support the design team for the US Navy Remediation Project. The system design consists of a continuous flow advanced oxidation process (AOP) treatment to mineralize VOCs and 1,4-Dioxane. During the initial design phase, a second emerging contaminant became apparent and was incorporated into the final design as a contingency. PFAS pretreatment design was added to the AOP system design. This pretreatment system consists of a lead/lag/spare set of single-use ion exchange resin vessels. The system hydraulic modeling includes additional pump sizing on variable frequency drives to provide a full range of potential flows needed for the PFAS pretreatment. The 100% design for the project was completed in March 2022 and the has moved into the construction contractor procurement phase by the US Navy.



APPENDIX A: RESUMES OF KEY PERSONNEL

EXPERIENCE SUMMARY

Specializing in Multidisciplinary Engineering Design and Construction, Mr. Dickson has over 30 years of experience as a Process Engineer, working with large equipment refurbishment, piping systems, electrical, and system controls including SCADA. His experience includes process design, mechanical systems, control system instrumentations, control narratives and interlocks, electrical system design, hydraulic calculations, and other front-end engineering designs. Mr. Dickson has project experience with automotive companies, municipalities, and federal agencies.

Mr. Dickson is licensed in 10 states including Michigan and will serve as Principal Engineer for the project overseeing all technical disciplines.

RELEVANT EXPERIENCE

Ground Water Extraction, Treatment and WPDES Discharge Design, WDNR Permitting and Coordination for Emerging Contaminant, Confidential Client, Cottage Grove, Wisconsin (2020-Present). Designer of a shallow plume treatment system for remediating traditional CVOCs and emerging contaminant 1,4-dioxane. The identification of emerging contaminants resulted in identifying a treatment technology capable of removing both CVOCs and 1,4-dioxane. To expedite both the design and implementations literature was used to identify an oversized sequential batch reactor advanced oxidation process (AOP) system that can treat all COCs at the site. To evaluate the potential for sludge management, the installed extraction well water was used to pilot solid generation on-site by sparging air at different hydrogen peroxide doses in graduated cylinders. No significant accumulation was noted in any case which was tied into the final design submitted for WDNR review and WIPDES Permit application and approval. The system commission will be used to develop minimum treatment times, chemical dosing, and objective for final operations before the initial discharge begins. The final system construction is ongoing.

Naval Air Station Whidbey Island (NASWI) Area 6, South Groundwater Extraction Treatment and Reinjection (GETR) System Design and Construction Oversight and Designed Retrofit of the Existing GETR System to Treat Emerging Contaminants including 1,4-Dioxane and PFAS, Oak Harbor, Washington (2017-Present). Design Lead for one-half of a joint venture working with an intercompany, interdisciplinary team to design a groundwater extraction system and associated instrumentation and controls with equalization followed by filtration and advanced oxidation consisting of Ozone activated hydrogen peroxide in a multi-stage reactor (HiPOX) with discharge to a gravity piping system discharging to an upgradient wetland. The design is to address 1,4-dioxane from an existing groundwater pump and treat consisting of equalization and air stripping for the western plume that did not remove the emerging contaminant 1,4-dioxane prior to re-injection. The initial design now was for the south plume to address 1,4-dioxane and residual vinyl chloride outside the western plume plant's capture zone. This system has been constructed with the potential for PFAS mitigation incorporated and is currently operating. A 100% design for the western plume retrofit system

EDUCATION

B.S., Environmental Engineering, Michigan Technological University, 1995

NEC-3386 (Nuclear Propulsion Plant Mechanical Operator and Engineering Laboratory Technician)

REGISTRATIONS/ AFFILIATIONS

American Chemical Society
ITRC PFAS Group Member

TRAINING/CERTIFICATIONS

Licensed Professional Engineer: Michigan (6201050612), Wisconsin (39086), Ohio (72517), Pennsylvania (075030), Missouri (2007032423), West Virginia (017637), South Carolina (26489), Washington (46759), New York (089100), Utah (990329-2202),

USACE CQM-C Training
MDEQ Certified Wastewater Treatment Plant Operator for Industrial/Commercial Classifications A-2b, A-2d and B-1b

40-Hour and 8-Hour HAZWOPER Refresher, 29 CFR 1910.120(e)(8) OSHA, 1996-2020
HAZWOPER Supervisor Training

OFFICE

Brookfield, Wisconsin

YEARS OF EXPERIENCE

30

including equipment and pump sizing and accommodations for the addition of PFAS ion-exchange pre-treatment was incorporated in the final design completed in March 2022.

Moses Lake Wellfield Contamination Superfund Site, South Plume Groundwater Extraction Treatment, and Reinjection (GETR) system, Moses Lake, Washington (2019-present). Design Lead Engineer for a Design/Build Contract for USACE under USEPA. Prepared Design with a multi-company interdisciplinary team of a GETR system which included groundwater extraction, equalization, filtration, liquid phase activated carbon (LGAC) treatment, with discharge into one of two infiltration galleries. Managed the engineering aspects of construction with the installation including controls and remote access support being provided by the design team. Operated the system for required performance testing and managed the controls contractor to address issues encountered during the initial shakedown testing (30 days). Began the proof of operability period operations and maintenance including initial bag filter changeover and troubleshooting of various alarms and functions.

Fried Industries Superfund Site, Groundwater Extraction and Treatment System, East Brunswick, New Jersey (2009-2011). Senior Process Engineer for the construction support and initial start-up, testing (commissioning), and initial O&M for a groundwater extraction and treatment system of a Metals and CVOC groundwater plume utilizing equalization tanks, metal removal skids, and liquid granular activated carbon (LGAC) carbon vessels with backwash system. Included development of Initial Testing and Startup Plans, initial equipment testing and controls calibrations, preparation of initial O&M Manual management, and direction of project operators throughout the initial year of operations. Managed to stay within initial operation budget with substitution changes in condition resulting in severe system fouling by system optimization and process changes.

Milwaukee Metropolitan Sewerage District Jones Island Water Reclamation Facility, Effluent Pumping System, Milwaukee, Wisconsin (2010 – 2017). Project manager and Design Engineer for the reconditioning of four 90,300 gallons per minute vertical propeller pumps. Evaluation, planning, design, and structural evaluation of an innovative alternative pumping system including four 32-inch submersible horizontal propeller pumps integrated into two water-tight stop gate structures using the existing stop log channel. Electrical, instrumentation, and controls evaluation for new horizontal pump system and existing effluent pumps. Work included the installation of innovative stop log dams, each with two 32-inch horizontal propeller pumps, to increase low to medium flow capacity and efficiency for Jones Island Water Reclamation Facility Effluent Pump Station. Provided construction submittal review for the reverse engineering of existing pumps, changing over the oil filed lubrication system with a biodegradable automatic grease system to increase reliability and longevity of pump bearings. Guided the pump testing of existing pumps before modification and the commissioning of the reconditioning pumps to release for service.

Hudson River Alternative Water Supply for Waterford and Halfmoon New York (2014-2020). Process engineer for the repair and maintenance of the alternative water supply pipeline from Troy, NY Reservoir to feed potable water to the communities of Waterford NY, and Halfmoon NY. The system was installed by USEPA to provide a source of clean drinking water during Hudson River PCB dredging operations for communities that historically intake water from the Hudson River and treat it for distribution. Replaced two flow meters that had failed or were failing for the water feed to Halfmoon Water Treatment Plant. The work included the installation of new electrical and control conduit to the two control valve vaults, replacement of existing meters with new supported versions, updating the instrument controllers with supported versions, and reprogramming the PLC for automated flow control that has been lost since the existing meters malfunctioned. Perform oversight of routine maintenance issues performed by the control valve vendor, and coordinate improvements and other repairs as needed.

Chapaton Retention Treatment Basin, Wet Weather Pump Refurbishment Project, Macomb County, Michigan (2008-2013). Design engineer and technical lead for the complete removal, refurbishment, and reinstallation of three 72-inch variable flow pumps driven by 4800 V 2750 HP motor each capable of pumping 230,000 GPM. Each of the three pumps is located in a pump station in St. Clair Shores, MI, extending to 40 feet below the ground surface in a concrete wet well. The three pumps were refurbished one after the other with the first approaching substantial completion. This included several large lifts of the 32-ton motor and other pump parts for loading and transportation to repair facilities. Reviewed and approved loading calculations for large equipment component lifting and staging at the facility and on the treatment basin deck. Motor inspection, asbestos abatement, complete rewind, and enhancements were reviewed and approved at the motor repair shop. Mechanical tolerances replacement parts and other modifications were reviewed and approved at the pump repair shop. Reviewed and approved electrical, controls, new hydraulic system, and pump modifications to improve reliability and efficiency of the pumps in the future.

EXPERIENCE SUMMARY

Ms. Meurette is a senior environmental scientist / industrial hygiene technician and project manager with over 27 years of experience in the environmental and industrial hygiene consulting field. She manages all aspects of projects from providing cost estimates & proposals to project execution and reporting, with oversight of both Tetra Tech and subcontractor employees, as well as regulatory interfacing and project budget management. She also provides project management assistance on other projects for additional private and public sector clients.

Environmental responsibilities include conducting subsurface explorations involving soil boring and monitoring well installation oversight, soil sample screening and collection, water and waste compliance sampling, monitoring well development, groundwater sample collection, active remedial system monitoring and maintenance, analytical result interpretation and report preparation for clients and regulatory agencies, and conducting Phase I environmental site assessments (ESAs) in accordance with ASTM E1527-05 and EPA's All Appropriate Inquiry (AII).

Industrial hygiene responsibilities include conducting worker exposure assessments, performing surveys for asbestos-containing materials (ACM), performing inspections and risk assessments for lead-based paint (LBP) at residential and commercial/industrial sites, monitoring asbestos removal and industrial lead removal projects, conducting mold assessments and collecting samples for mold investigations, interpreting analytical results as they relate to federal, state, and/or local standards, and reporting to regulatory agencies and clients. Ms. Meurette is proficient in the use of the various standard environmental and industrial hygiene field survey and assessment equipment and skilled at data interpretation. She is proficient in the use of the Microsoft suite of software applications to generate electronic deliverables, and also has experience using AutoCAD® to produce diagrams and figures in association with environmental reporting, and with ArcGIS software to generate orthophoto figures.

EDUCATION

BS, Water Resources,
University of Wisconsin-
Stevens Point, 1992

REGISTRATIONS/ CERTIFICATIONS

Lead Inspector/Risk Assessor: WI
 Asbestos Contractor/Supervisor:
 WI, MI
 Asbestos Inspector: WI, IL, IA
 40-Hour / 8-Hour HAZWOPER

OFFICE

Schofield, Wisconsin

YEARS OF EXPERIENCE

27

YEARS WITHIN TETRA TECH

27

EXPERIENCE

Environmental Site Investigations

Contaminant Release Impact Evaluations, Wisconsin. Environmental Scientist responsible for managing and conducting subsurface investigations to evaluate soil and groundwater impacts from contaminant spills and/or underground storage tank releases on residential, small business, commercial, and industrial properties throughout the state. Duties included procuring subcontractors to perform remediation, remediation oversight, regulatory contact/compliance, and associated project report preparation.

Drycleaning Facility Subsurface Investigation, Central Wisconsin. Project Manager/Project Scientist for a subsurface investigation to define the degree and extent of contamination from petroleum-related compounds and drycleaning solvents. Developed a sampling plan, collected soil and groundwater samples and prepared reports for Wisconsin Department of Natural Resources (WDNR) and the client.

Radioactive Waste-Impacted Site Remedial Investigation/Baseline Risk Assessment, Niagara Falls, New York. Environmental Scientist/On-site Health and Safety Officer for a remedial investigation/baseline risk assessment for a site impacted by high- and low-activity radioactive waste from uranium extraction related to the Manhattan Project and chemical impact from TNT manufacturing processes during World War II. Work conducted at this Formerly Utilized Sites Remedial Action Program site for the Buffalo District US Army Corps of Engineers. Assisted with subsurface field investigation activities, including installation of soil borings and groundwater monitoring wells; development, purging, sampling and slug testing wells; collecting soil, sediment and groundwater samples; and downhole gamma logging of subsurface radioactive contamination. Also served as one of the on-site health and safety officers, responsible for implementation of the site Health and Safety Plan (HASP).

Anthrax Sampling, Washington DC. Environmental Scientist responsible for implementing EPA-generated sampling plans within various government buildings to identify the presence of anthrax. Conducted anthrax dust wipe, swab, vacuum and air sampling in modified Level C. Provided outside support during chlorine dioxide gassing events. Conducted post-gassing damage analysis visual inspections and reported results to EPA.

Indoor Air Quality Assessments / Exposure Assessments

Employee Exposure Assessments, Wisconsin. Industrial Hygiene Technician/Project Manager in conjunction with a Tt CIH responsible for overseeing and conducting employee exposure assessments for public and private clients including various industries such as paper mills, chemical plants, food processors, non-metallic mines, auto parts, for numerous parameters such as particulates, metals, acid gases, volatiles, noise, etc. Develop and implement personal breathing zone and general area air sampling strategies, evaluate work task protocols, assess work environments, interpret sampling results in comparison to regulatory standards, and prepare summary reports including recommendations.

Asbestos Inspection and Abatement

ACM Inspections Prior to Demolition, Wisconsin. As a state certified asbestos inspector, inspect residential and commercial properties for ACMs prior to demolition for municipal redevelopment, highway expansion projects, and public and private sector clients. Perform surveys in accordance with US Environmental Protection Agency (EPA)-National Emission Standards for Hazardous Air Pollutants (NESHAPS). Inspect and bulk sample suspect ACMs, interpret analytical results, and develop a written report of results.

Asbestos Removal Observation and Air Monitoring, Wisconsin. As a state certified asbestos supervisor, conduct air monitoring for asbestos and on-site analysis using phase-contrast microscopy in accordance with NIOSH 582 methodology. Observe removal activities to ensure compliance with federal, state, and local regulations and project design specifications, and preparation a final documentation report. Sites include government buildings, schools, commercial buildings, insurance companies, paper mills, food processing facilities, power utilities.

Environmental Site Assessments

Phase I ESAs, Wisconsin. As Environmental Scientist, review historical site information, regulatory records and physical setting data; conduct a site reconnaissance; and develop a report detailing results and recommendations for private sector clients.

Regulatory Compliance

Bulk Fuel Storage & Loading Terminals, Wisconsin. As Environmental Scientist and Project Manager, coordinate water and waste sampling to characterize various waste streams for appropriate transport & disposal in accordance with RCRA requirements, coordinate effluent sampling for WPDES discharge permit compliance and system effectiveness, and coordinate water sampling for secondary containment WPDES discharge permit compliance. Also assist with SWPPP and SPCC plan preparation and revisions

EXPERIENCE SUMMARY

Mr. Steve Tedesco is experienced in the planning, analysis, design, and construction of water supply, water treatment, and water distribution. Specialties include water system master planning, water treatment plant design, construction management, and Design-Build delivery methods. He has extensive design experience in water and wastewater treatment, including Desalination, Membrane Filtration (MF), Reverse Osmosis (RO), Ultraviolet Treatment (UV), Nanofiltration, Granular Activated Carbon (GAC), Ion Exchange (IX), and waste disposal projects.

Relevant experience includes complete project management from design through construction on design reports, capital improvement planning, final design, drawings, specifications, contract documents, permitting, bidding, construction of both water and wastewater facilities, and start-up services.

Steve Tedesco will provide quality assurance and quality control management for this project.

RELEVANT EXPERIENCE

PFAS On-Call Contract, Orange County Water District, California (2021). Project Manager for IX and GAC treatment for PFOS and PFOA design for 18 affected wells in the Main Orange County Basin. The project included design, estimating of capital and operating costs, coordinating with vessel suppliers, and construction management for the following projects:

- Serrano Water District – 4.3 million gallons per day of treatment for two production wells
- Yorba Linda Water District – 25.0 million gallons per day of treatment for 10 production wells
- Fullerton Kim 1A – 4.0 million gallons per day treatment for one production well
- Fullerton Main Plant – 12.0 million gallons per day of treatment for five production wells

PFAS Study for Wells ET-1, ET-2 & 78, Irvine Ranch Water District, Irvine, California (2021). Principal-in-Charge for a study to determine the options to add PFAS treatment to an operating VOC air stripper project. Well ET-1 operates at 2.0 million gallons per day through a tray air stripper that discharges into a small wet well with a single booster pump station. The existing plant is located on a small lot with limited space. The project included an analysis of water quality, options for IX or GAC treatment, and analysis of adding wells ET-2 and ET-78 to the project if they become affected by PFAS. He was responsible for the preparation of the capital and operations and maintenance costs.

PFAS Study for 5 Wells, City of Downey, California (2021). Project Manager for a study to determine the options to add PFAS treatment to five existing wells in Downey affected by PFOS & PFOA. The study included analysis of water quality, siting study, comparison of IX and GAC treatment, evaluation of piping wells to a central location for treatment, capital cost estimates, operations, and maintenance estimates, and lifecycle cost analysis. The report was used as an attachment to the City of Downey's funding application to the Water Replenishment District.

EDUCATION

BS, Civil Engineering,
Polytechnic Institute of New

REGISTRATIONS/ AFFILIATIONS

American Chemical Society
ITRC PFAS Group Member

TRAINING/CERTIFICATIONS

Licensed Professional Engineer:
California, No. 39261
40-Hour and 8-Hour
HAZWOPER Refresher, 29
CFR 1910.120(e)(8) OSHA,

OFFICE

Irvine, California

YEARS OF EXPERIENCE

40

Huntington Park Well 15, Water Replenishment District of Southern California, City of Huntington Park, California (2019). Project Manager for the preliminary design, final design, construction management, and construction services to upgrade the Wellhead Treatment system at Huntington Park Well 15. The design included removing the existing air stripping units at Well 15 and replace with a liquid phase GAC treatment system to remove contamination, particularly volatile organic compounds from the well.

Burbank Operable Unit Plant Upgrade Design Services, Lockheed Martin Corporation, Burbank, California (2019 - present). Quality Assurance and Quality Control Manager. Tetra Tech is preparing the design package for planned upgrades at the Burbank Operable Unit groundwater treatment plant. The upgrades shall consist of providing additional liquid-phase GAC treatment capacity with approximately 1,500 gallons per minute of increased capacity, new motorized valves to control flow to the existing liquid-phase granular activated carbon vessels, advanced oxidation process treatment to address 1,4-dioxane contamination from the Burbank Operable Unit extraction wells and North Hollywood Operable Unit extraction wells, upgrades to the SCADA system and automation of the plant to integrate flow from the North Hollywood Operable Unit wells, along with alarm upgrades to the vapor phase granular activated carbon regeneration process compressors, boilers, and liquid phase GAC system controls; variable frequency drives on existing extraction well motors; modifications to the air stripper blower motors; and new piping connections to new treatment equipment as described in this report to bypass the existing air stripper and vapor phase granular activated carbon systems, as needed.

Groundwater Treatment Plant Modifications GAC for Methyl tert-butyl ether (MTBE) Removal, San Juan Capistrano, California (2012). Project Manager for the modification to the Groundwater Treatment Plant to remove the MTBE found in the feed water. The 5.3 million gallons per day system includes eight 10-feet diameter GAC vessels with feed, backwash, and effluent piping.

Richardson Treatment Plant, Lockheed Martin Corporation, Loma Linda, CA. 2010. Project Manager for the IX/GAC treatment system designed to remove TCE and Perchlorate from well-feed water. The treatment plant is supplied by one on-site and one off-site newly drilled groundwater well located in the City of Loma Linda. The total flow rate treated is 4,800 gpm. The design included pretreatment and post-treatment bag filtration, treated water storage break tank, product water booster pump station, backwash pumping system, backwash waste storage tank, and pumping system, backwash waste treatment system, and chlorination system. Initial engineering work included the preparation of a Basis of Design Report, hydraulic analysis, chemical feed systems, structural and electrical calculations. Filter vessels included a (5-12' diameter) pair for GAC and a (3-12' diameter) pair for IX equipment. Treated water is conveyed via the booster pumps to two separate pressure zones within the City of Loma Linda. The electrical design included a system compatible with City's SCADA system.

Purshotam K. Juriasingani, PE, CEM

Subject Matter Expert-Emerging Contaminants/ Engineering Program Manager

EXPERIENCE SUMMARY

Mr. Juriasingani has 24 years of professional experience in environmental program and project management, opportunity capture and proposal management, and remediation technology innovation, design, and implementation. He is a Registered Professional Engineer and has a M.S. in Environmental Engineering and B.S. in Civil Engineering from The University of Tennessee, Knoxville TN.

Mr. Juriasingani is a subject matter expert (SME) focusing primarily on treatment of emerging contaminants like PFAS compounds and 1,4-Dioxane. Mr. Juriasingani has managed the PFAS program consisting of PFOS/PFOA data tracking and analysis, development of drinking water protection studies, developing life-cycle assessments of different treatment technologies, and preparing cost & performance reports of several PFOS/PFOA treatment systems installed across several active USAF, BRAC, and ANG installations. Mr. Juriasingani leads the initiative to develop proof-of-concept treatment technologies and processes for PFAS compounds in groundwater, soil, and surface water.

Mr. Juriasingani has experience with several innovative remedial processes/technologies for the treatment of conventional and emerging contaminants in soil, groundwater, and sediments. He has extensive experience with thermal, biological, chemical, and water treatment technologies. He has expertise in engineering management that brings together the technological problem-solving techniques of engineering and the organizational, administrative, and planning abilities of management in order to oversee complex projects from conception to completion. He is an expert in creating cost-effective multi-component remedial strategy for complex sites with high risk, variable geology, and persistent sources.

Mr. Juriasingani has proficiency with ISO 9000/9001 Quality Management System and has led the initiative for developing and implementing Quality Control Program based on standard quality management principles.

RELEVANT EXPERIENCE

Tetra Tech, Inc, Austin TX **Subject Matter Expert-Emerging Contaminants/ Engineering Program Manager, 2019-Present**

Technology Development Program

Program Lead for Research and Development of innovative PFAS treatment technologies for groundwater, soil, and surface water. The program includes collaborating with universities to demonstrate the efficacy of proof-of concept technologies for PFAS treatment at the PFAS contaminated sites, participating as a principal investigator or co-performer in the development of technologies funded by DOD's funding organizations including SERDP/ESTCP, and participating as a member of the ITRC PFAS team to assist in the development of technical resources related to PFAS regulations, fate and transport, and treatment.

EDUCATION

Master of Science, Environmental Engineering and Bachelor of Science, Civil Engineering; University of Tennessee, Knoxville, TN. 1996

Engineering Degree, Civil Engineering; The Institution of Engineers (India), India. 1992

AREA OF EXPERTISE

Subject Matter Expert-Emerging Contaminant

Remediation Technology Design, Implementation, Innovation, and Development

Complex Site Strategy

Data Analysis and Management

REGISTRATIONS/ CERTIFICATIONS

Professional Engineer, TX, MT

Certified Energy Manager

Safety Trained Supervisor

TRAINING

OSHA 1910.120 40-Hour HAZWOPER Training

OSHA 1910.120 8-Hour Annual Refresher Training

OSHA 1910.120(e)(4) 8-Hour Management and Supervisor Training Program

OSHA 1910 and 1926 30-hour Construction Outreach Training

AFFILIATIONS

Society of American Military Engineers

OFFICE

Austin, TX

YEARS OF EXPERIENCE

25

NASA Wallops Flight Facility, VA; Laboratory and Field PFAS Treatability Studies;; 2020-Present

Subject Matter Expert and Task Manager for conducting the following PFAS laboratory and field treatability studies at various contaminated sites at Wallops Flight Facility. The results of these studies will assist in determining full scale remedial solutions for these sites. The laboratory studies include: Simulating soil washing technique to determine the effectiveness of using various washing solutions for removing PFAS compounds from soil; testing six adsorbents and determining its effectiveness in mitigating PFAS contamination from groundwater to surface water migration pathway; determining the efficacy of using electron beam technology to destroy PFAS compounds in soil and aqueous IDW at the National Institute for Electron Beam Research facility, and; testing ultrasound technology for treating PFAS contaminated soil and groundwater IDW. The field studies include column testing of PFAS contaminated WWTP effluent and FFTA groundwater using ion exchange resins and granular activate carbon and testing mitigation of PFAS contaminated groundwater at the seep area in the FFTA by installing a capture structure and using the effective adsorbent determined during the laboratory study.

Confidential DOD Client, Pennsylvania, PFAS Pilot Tests and Full Scale Design; 2019-Present

Hangar 680 and Site 5 Pilot Tests: Subject Matter Expert and Task Manager for managing and overseeing the project team for conducting field pilot tests at two sites for the treatment of PFAS compounds using regenerable and one time use ion exchange resins. The treatment train also includes other treatment units including GAC and plasma to meet the following overall objectives: determine whether the ion exchange technology can alone meet the PFOS/PFOA treatment goals established by EPA's health advisory (HA) level of 70 parts per trillion (ppt) and develop breakthrough curves for the fourteen PFAS compounds included in EPA Method 537; compare treated effluent concentrations against the discharge criteria for the parameters established in the Pennsylvania Department of Environmental Protection NPDES permit and determine if the treated water can be discharged to the Outfall below the discharge limits; evaluate the plasma technology to treat the still bottoms generated during the ion exchange regeneration process to minimize the disposal of PFAS waste, and; determine system parameters to design full scale system and identify operational constraints for implementing a full-scale system.

Groundwater Extraction and Treatment System Designs: Design Manager to lead the design of a centralized 500-gpm groundwater extraction and treatment system to treat PFAS contaminated groundwater from Hangar 680 and Site 5. The treatment system is being designed based on the results of the pilot tests conducted at these sites. Groundwater from each of the sites would be transferred to a pump station located within the vicinity of the wellfields which would then be transferred to existing building for treatment.

Former Naval Air Warfare Center, Warminster, Pennsylvania; Groundwater Extraction and Treatment System (GWETS) Optimization; 2019-Present

Subject Matter Expert and Task Manager for evaluation and recommendation of the options for modification/optimization of the existing VOC treatment system to include treatment of Chromium (VI) and per- and polyfluoroalkyl substances (PFAS) present in the influent water. The task includes preparing an optimization report documenting the findings of the optimization study, evaluation of the remedial action objectives, remedial action effectiveness, and cost efficiency for potential GWETS modifications.

Confidential DOD Client, Maine; Design/Installation of Point of Entry Treatment Systems; 2020-Present

Subject Matter Expert and Task Manager for conducting a Time-Critical Removal Action (TCRA) under the Comprehensive Long-term Environmental Action (CERCLA) in Maine. The TCRA is initiated to provide a more sustainable and feasible option to mitigate the identified exposure to PFAS in groundwater used by residences with private drinking water wells with sampling results exceeding the USEPA lifetime health advisory. The tasks include public outreach, evaluation of existing data, Ion Exchange system design and installation, post-installation performance monitoring, and operations and maintenance for the recommended treatment system.

SCIENTIFIC/TECHNICAL PUBLICATIONS

- Use of Advanced Techniques to Maximize Amendment Delivery in Challenging Geologies; Bioremediation & Sustainable Environmental Technologies Conference, May 18-21, 2015, Miami, FL
- Bioremediation of Source Zone and Migrated Plumes; Bioremediation & Sustainable Environmental Technologies Conference, May 18-21, 2015, Miami, FL

EXPERIENCE SUMMARY

Ms. Huntoon brings over 25 years of professional experience in environmental compliance, including oversight of large multi-faceted environmental programs, over 2 decades of program and personnel management and 7 years of regulatory oversight. Her technical experience includes assessment of emerging contaminants including PFAS, design and management of complex groundwater monitoring networks, completion of groundwater and soil contamination investigation and remediation programs, oversight of thorough environmental assessments, environmental drilling technology, groundwater supply programs, regulatory negotiation, industry and community training, and sustainable solutions.

Most recently, Ms. Huntoon served as the Project Manager of the Groundwater Management Program for the Department of Energy Legacy Contamination Cleanup Program at the Los Alamos National Laboratory (LANL) in New Mexico, providing program oversight for groundwater sampling and reporting at more than 200 locations for the evaluation of legacy contamination associated with nuclear weapons development and government research.

She brings seven years of regulatory oversight and program administration experience as Chief of the Technical Section of the Wisconsin Petroleum Cleanup Fund (PECFA) with the Wisconsin Department of Commerce.

Her relevant knowledge includes USEPA programs (CERCLA/SARA, NEPA, RCRA, UST/LUST), corporate environmental compliance (ISO14000), and NEPA permitting. Project contaminants involve a variety of chemicals including chlorinated solvents, explosives (DNT), metals, petroleum hydrocarbons, pesticides/herbicides, PCBs, and radionuclides.

Ms. Huntoon has significant experience with technical program oversight and comprehensive reporting, facilitation/negotiation, public outreach, and training. She has presented on environmental drilling methods, regulatory requirements, and hydrogeology, and served as an expert witness in cases involving applicability of soil and groundwater regulatory limits and subsurface classification.

ENVIRONMENTAL PROGRAM ASSISTANCE TO MUNICIPALITIES

United States Environmental Protection Agency, Washington DC.

Participated as a member of a Site Optimization Review Team and conducted site reviews for Superfund sites located in Minnesota and Oklahoma, including meetings with municipalities and EPA. Tasks included onsite evaluations, review of extensive documentation, meetings with regulatory agencies, assessment of remedial actions, and preparation of optimization review reports.

City of Wausau Superfund Site, Wausau, Wisconsin. Project Hydrogeologist for field investigations including long-term aquifer pump tests to delineate the nature and extent of groundwater and soil contamination, and the influence of the Wausau Municipal Well Field on transport of contaminants beneath the Wisconsin River. Drilling technology included dual-tube reverse circulation drilling, which allowed the use of vertical sampling at multiple depths to more adequately determine contaminant source locations. Completed extensive investigation for

EDUCATION

B.S., Geology, University of Wisconsin - Platteville 1985

AREA OF EXPERTISE

Emerging Contaminants
 Environmental Drilling
 Expert Witness/Litigation
 Grant Reporting and Oversight
 Groundwater Network Design
 Regulatory Negotiation

REGISTRATIONS/ AFFILIATION

Professional Geologist WI #8

TRAINING/CERTIFICATIONS

Baroid Mud School, Houston, TX
 Certified Groundwater Professional, National Ground Water Association
 Drilling Technology, Staples Technical Institute, MN
 OSHA 30-Hour Construction Outreach Training
 OSHA 40-Hour Hazardous Waste Operation & Emergency Response Training (1986) and Annual Refresher Training

DIVISION

Midwest

YEARS OF EXPERIENCE

25+

YEARS WITHIN FIRM

5

identification of potentially responsible parties, evaluation and sampling of extensive monitoring well network. Findings were presented to USEPA/Region V and discussed in public hearings.

City of Wausau Municipal Water Supply Wellfield, Wausau, Wisconsin. Project Hydrogeologist managing field investigations for siting of municipal water supply wells. Drilling technology included dual-tube reverse circulation drilling which, as a new technology at the time, required negotiation of a variance from the WDNR.

City of Janesville Planning Department, Janesville, Wisconsin. Completed Phase I Environmental Site Assessments for several properties to fulfill due diligence requirements prior to property transfer. In addition, assisted with completion of tasks associated with closeout of the City of Janesville USEPA Brownfields Area-Wide Planning Grant, including reporting of data in the ACRES database, preparation and submittal of multiple forms, and a final report to USEPA.

City of Janesville Planning Department, Janesville, Wisconsin. Provided technical review of documents related to the General Motors facilities in Janesville, Wisconsin, including substantial Work Plans and Site Investigation Reports, to identify any discrepancies and determine whether further assessment may be warranted. Prepared a Technical Memorandum for the City including recommendations for the sampling of soil, groundwater, and river sediments.

City of Madison Municipal Water Supply, Madison, Wisconsin. Teamed with a computer modelling specialist to provide thorough assessments of potential sources of VOC contamination impacting two municipal water supply wells. Project resulted in confirmation of potential sources not previously identified.

City of Freeport, Galena Avenue Corridor, Freeport, Illinois. Project Manager for area-wide corridor assessment associated with municipal brownfield redevelopment project. Included Phase I evaluation of historic dry cleaners, gasoline service stations, and other sources of underground storage tanks.

State of Wisconsin Emergency Management, Columbia/Dane/Rock/Sauk Counties, Wisconsin. Program Manager for preparation of county-wide Hazardous Material Commodity Flow Studies for four counties in Wisconsin. Field study and data collection was conducted to determine the types of chemicals transported through counties, general timeframes, and transportation methods to assist Emergency Management personnel with emergency shelter planning.

Sheboygan River & Harbor Superfund Site, Sheboygan, Wisconsin. Project Hydrogeologist for field investigations including collection of sediment borings and installation of groundwater monitoring wells from a barge within the harbor to delineate the nature and extent of contamination, and the influence of transport of contaminants from the Sheboygan River. Completed extensive investigation for identification of potentially responsible parties, and geologic evaluation. Findings were presented to USEPA/Region V and discussed in public hearings.

EXPERT WITNESS & LITIGATION SUPPORT

Wheeler, Van Sickle & Anderson, S.C, on behalf of Friends of Sturgeon Bay Waterfront, Wisconsin. Provided technical assistance and served as an expert regarding the subsurface characterization of public trust land located in Sturgeon Bay, Wisconsin. Produced an expert report and provided testimony at the two-day trial in addition to a follow-up regulatory review, which resulted in a judgement in favor of the client group.

Wheeler, Van Sickle & Anderson, SC, on behalf of Confidential Client, Madison, Wisconsin. Provided technical assistance and served as an expert for site characterization and assessment of a proposed sand and gravel pit located adjacent to a wetland in southern Wisconsin. Produced an expert report and affidavit regarding hydrogeologic implications of proposed quarry activities. Provided testimony at appeal hearing with Dane County Zoning Committee. Conditional Use Permit was successfully denied upon appeal.

Bell, Gierhart & Moore, S.C on behalf of Confidential Client, Wisconsin. Provided technical assistance and served as an expert for an appeal with the State of Wisconsin regarding a Wisconsin Pollutant Discharge Elimination System (WPDES) permit; specifically, the question of the regulatory agency's legal authority to apply regulations to mixed waste at an industrial outfall.

Confidential Client, Madison, Wisconsin. On behalf of a law firm's client, evaluated the environmental setting and geologic/hydrogeologic characteristics of a parcel of land to determine the impact of highway construction on drainage of the property, to assess potential effects to the property from an adjacent quarry, and to evaluate the potential return of the site to pre-construction use as an agricultural operation.

EXPERIENCE SUMMARY

Ms. Phelan has 14 years of experience as an environmental geoscientist specializing in fluvial sediment remediation investigations. Her primary role has been investigation task lead, with 10 years managing sampling programs. Responsibilities include providing technical expertise to management and clients, scheduling, sediment core collection, and characterization of sediment. Ms. Phelan assists with the development of work and quality plans; standard operating procedures; and reports. She is an effective communicator coordinating and building a positive rapport with clients, third party and agency oversight, as well as subcontractors.

Additionally, Ms. Phelan has strong data management skills including interpretation of analytical and spatial data and development of datasets for simple retrieval and tracking purposes to streamline processes and assist in efficient and effective decision making.

RELEVANT EXPERIENCE

PFAS Groundwater Task Lead, October 2020—Present

Confidential Client, Wisconsin

Task lead for groundwater sampling at local facility. Collaborated on developing plans and procedures for the site and responsible for successful implementation to avoid cross-contamination.

Sediment Investigation Task Lead, October 2019—Present

Equinor, Empire Wind 1 and 2, New York, NY

Sediment investigation task lead to support cable installation for two offshore wind farms. Tasks included development of sampling, quality, and HSE plans; client, agency, and subcontractor coordination; procurement; and supported contracting. Execution of the sediment investigation as field manager including managing staff and subcontractors. Value of this task approximately \$2M.

Sediment Technical Lead, 2019—Present

Orsted, Bay State Wind Offshore Wind Farm, MA

Sediment technical lead supporting project management team in development of the Sediment Sampling and Analysis Plan and Construction and Operations (COP) Survey Plan for the Bay State Wind Offshore Wind Farm under Commercial Lease OCS-A 0500. Project received industry first SAP approval in June 2017.

Sediment Investigation Task Lead, Spring 2021

LePetomane Trust, Colgate Creek, Baltimore, MD

Sediment investigation task lead to support in-channel remediation of Colgate Creek. Tasks included development of sampling, quality, and HSE plans; client, agency, and subcontractor coordination; procurement; invoicing, and supported contracting. Execution of the sediment investigation as field manager including managing staff and subcontractors.

EDUCATION

BA, Geology and Chemistry,
Lawrence University, 2007

REGISTRATIONS/ CERTIFICATIONS

30-Hour OSHA Construction
Management Training; 2015

40-Hour OSHA Hazardous
Waste Health and Safety
Training; 2007

Boating Skills and Seamanship;
US Coast Guard; 2009

Construction Quality
Management; USACE; 2016

CPR and Wilderness First Aid
Training; 2021

CPR, First Aid, and AED
Training; 2021

Environmental and Safety
Supervisor (ESS); 2015

Introduction to Incident
Command; FEMA; 2013

Waste Management Training;
2021

SafeGulf, 2021 (1997)

AFFILIATIONS

Wisconsin Ground Water
Association

National Ground Water
Association

Federation of Environmental
Technologists

OFFICE

Schofield, Wisconsin

YEARS OF EXPERIENCE

14

YEARS WITHIN TETRA TECH

14

Sampling Technical Task Lead, April 2017-Present**Lower Passaic River, Operable Unit 2, Pre-Design Sediment Investigation, NJ**

Technical lead to support pre-design investigation of the lower 8.3 miles of the Passaic River. Responsible for development of sampling, quality, and HSE plans; client, agency, and subcontractor coordination; procurement; and invoicing. Execution of the field investigation as sample custodian and core processing manager. Tasks included managing more than 10,000 samples; coordination with five laboratories; shipping coordination; quality control; and data evaluation.

Field and Technical Support Team Lead, May 2013–December 2019**Enbridge Energy Pipeline Integrity Group, Superior and Great Lakes Regions**

This is a geohazard assessment project investigating conditions where oil pipelines intersect with water bodies and slopes. The program aims to identify instability in soil and other site conditions at slope pipeline intersections and bank and riverbed erosion at river and pipeline intersections to prevent future pipeline ruptures. Ms. Phelan is a field team lead responsible for background and field data collection and processing. Desktop responsibilities included background data collection including soil identification, surficial and bedrock geology, and watershed data; GIS data analysis; evaluation of water crossing erosion potential and slope stability; assessment of incoming field data and writing technical documents including memorandums and yearly summaries. Field responsibilities included leading crew(s), geophysical data collection, and GPS operation. This field program is ongoing. The thorough data collection and in-depth data analysis has earned the team ongoing monitoring.

Field Coordinator, March 2015–Present**Equitrans Mountain Valley Pipeline, Virginia and West Virginia**

Wetland delineations and waterbody characterizations were conducted for the Mountain Valley Pipeline (MVP) project, a natural gas pipeline system that spans approximately 301 miles from northwestern West Virginia to southern Virginia – and as an interstate pipeline will be regulated by the Federal Energy Regulatory Commission (FERC). Wetland delineations were performed on a proposed 300 foot corridor that included soil characterization, plant identification, and GPS mapping. Responsibilities included field and right of way coordination, determining where crews would be working based on landowner access, and updating management and client of field progress.

Project Manager, January 2016–2018**Arconic, Elliott Ditch, Lafayette, IN**

Responsible for developing plans including QAPP, Health and Safety Plan, and Field Sampling Plan. She is responsible for managing budgets, invoicing, and costing proposals.

Quality Control Manager and ESS, November 2014–March 2015**Lockheed Martin, Middle River, MD**

First phase of a sediment dredging project on the Chesapeake Bay where Ms. Phelan was responsible for ensuring contractor removed PCB contaminated sediment to the remedial action level outlined in the Record of Decision. Tasks included core logging and sampling; coordination with the lab; assessment of incoming data; and communication and coordination with the Agencies and client. Additional tasks included weighing and manifesting disposal trucks; wipe sampling; supporting on-site health and safety manager; documenting site activities, and turbidity monitoring.

Emergency Preparedness Trainer, October 2014**Mt. Sinai Hospital, NY**

Present hospital personnel with training on how to appropriately don and doff personnel protective equipment when coming in contact with Ebola patients. Responsible for maintaining records and determining whether or not personnel understand the material and are able to safely provide patient care.

**EXPERIENCE SUMMARY**

Dr. Arnseth has more than 30 years of experience in environmental restoration, geochemistry, and hydrogeology, including the past 24 years in consulting positions. He has managed firm fixed price and cost-reimbursable contracts and performance-based contracts (PBC) technical tasks including the full range of CERCLA and RCRA plan and report preparation, implementation of multi million-dollar field investigation and analysis efforts (soil, sediment, surface water, groundwater), remediation, and site closures. He holds professional geologist registrations in Florida and Virginia.

In addition, he has extensive experience evaluating geochemical data, specifically in surface water and groundwater systems, to support water quality determinations, human health and ecological risk assessments and for developing innovative remediation strategies. Dr. Arnseth has specific experience in the characterization and remediation of volatile organic compounds, explosives, perchlorate, emerging contaminants (e.g., PFAS, 1,4-dioxane) and metals (including radionuclides) in soil, surface water, sediments and groundwater. Dr. Arnseth and colleagues are testing innovative remedial technologies to address emerging contaminants (e.g., PFAS)

RELEVANT EXPERIENCE**PFAS Remediation Technology Development Research – Multiple Funding Sources (July 2016 – present)**

Dr. Arnseth and colleagues within Tetra Tech have reviewed a broad range of possible in situ remedial technologies applicable to PFASs. Tetra Tech provided internal funding to support bench-scale testing of an aggressive advanced oxidation destruction approach beginning in the summer of 2016. In addition, Tetra Tech is collaborating with academic institutions in the US and Australia (e.g., University of New South Wales, New Jersey Institute of Technology, Yale University, Clarkson University) seeking funds to explore possible microbial defluorination enzymes and various electrochemical destruction techniques and their applications to remediation.

Navy Comprehensive Long-Term Environmental Action Navy; Multiple Navy Sites with PFAS (August 2020 - present)

Dr. Arnseth is the technical lead for several remedial investigations focused on PFAS compounds in groundwater and surface water. Dr. Arnseth supports design and implementation of the supplemental PFAS RIs at Meridian (MS) Naval Air Station sites. Dr. Arnseth also leads the data interpretation and reporting on surface water PFAS investigations at the Naval Air Station Joint Reserve Base (NAS-JRB) Willow Grove (PA). Dr. Arnseth also supports planning for supplemental RIs at Naval Surface Warfare Center Crane (IN) and Marine Corps Recruit Base Parris Island (SC). Dr. Arnseth leads a group of technical colleagues designing PFAS sampling and analysis plans for groundwater, soil, biosolids and surface water at multiple Navy and Marine Corps properties (e.g., Calverton, Jacksonville, Meridian, Albany).

EDUCATION

PhD, Geological Sciences,
Northwestern University,
Evanston, Illinois, 1983
MS, Geological Sciences,
Northwestern University,
Evanston, Illinois, 1980
BA, Chemistry, Gustavus
Adolphus College, Saint
Peter, Minnesota, 1975

AREA OF EXPERTISE

Geochemistry
Remediation
Site Characterization

**REGISTRATIONS/
AFFILIATIONS/
CLEARANCES**

2002, Certified Professional
Geologist, Virginia (License
No. 1526)
1989, Professional
Geologist, Florida (License
No. PG359)
DOD Top Secret - Active

**TRAINING/
CERTIFICATIONS**

2007, OSHA 40-
HAZWOPER Training (29
CFR 1910.120) and annual
refreshers
2013 - current, Project
Management Professional
(PMP) (Certificate No.
1597733)

OFFICE

Oak Ridge, TN

YEARS OF EXPERIENCE

34

Navy Comprehensive Long-Term Environmental Action Navy (CLEAN); Bethpage Naval Weapons Industrial Reserve Plant (NWIRP) (December 2018 – December 2020)

Dr. Arnseth evaluated data from a comprehensive groundwater sampling campaign at the site. Geochemical analysis of the data included identification of relationships between locations with elevated Radium-226/Radium-228 activity and geochemical measurements (e.g., pH, ionic strength, dissolved oxygen, redox). The evaluation confirmed the predicted relationship between dissolved radium concentrations and major geochemical parameters (e.g., pH) at this Navy site. The results were presented to community stakeholders as part of a legal agreement between the Navy and the community. Additional data analysis will be presented in a CERCLA Site Inspection Report.

Former Nebraska Ordnance Plant (FNOP) Source Area Investigation and Remedy Evaluations, Kansas City Corps of Engineers; (August 2018 – July 2020)

Dr. Arnseth is supporting design and data interpretation for a high-resolution site characterization study to locate remaining source areas for VOCs (TCE) and explosives (RDX) at the FNOP, a Formerly Used Defense Site (FUDS). Detailed evaluation of existing data were used to design a flexible plan for fieldwork utilizing drive point technologies and field laboratory capabilities to define discrete source zones, transport paths and associated hydraulic and geochemical characteristics.

Cyanide Remediation in Groundwater – former Continental Motors Site, Mobile, Alabama, Continental Motors, Inc. (November 2016 – present)

Dr. Arnseth has reviewed quarterly and annual groundwater monitoring reports to evaluate remedial action progress since implementation. The results of the reviews have been shared with the client along with suggestions for alternative approaches to the remediation. Injected oxidants have been poorly distributed within the clay-rich subsurface soils. Acidic pH conditions limit the effectiveness of the implemented remedy. Thermally enhanced hydrolysis has been proposed as an alternative, in conjunction with planned building demolition actions, but will require a focused treatability test.

Contaminant Transport Groundwater Model Development, Former Nebraska Ordnance Plant, U.S. Army Corps of Engineers – Kansas City District; U.S. Environmental Protection Agency (USEPA) Region 7; Mead, Nebraska (February 2013–September 2015)

As project manager, Dr. Arnseth directed a team of groundwater modeling experts in modification and upgrade of a rudimentary groundwater flow and transport model for the FUDS Program. The goal of the upgrade was to develop and test contaminant transport scenarios for the co-mingled TCE and RDX plumes at the site. Ultimately, the result of the model scenario runs will be used to negotiate financial responsibilities among PRPs. Tasks included historical data review, conceptual model development, groundwater model input scenarios, model runs and reporting.

Groundwater Remediation, Horse Pasture Site PBC, Robins Air Force Base (AFB), U.S. Air Force, USEPA Region 4, CERCLA/RCRA Robins AFB; Houston County, Georgia (2003–2011)

As groundwater remediation lead, Dr. Arnseth supervised this GFPR contract requiring regulatory closure on the Horse Pasture site at Robins AFB. Closure required excavation of groundwater contamination source areas, soil stabilization and screening, off-site soil disposal, and groundwater remediation. Dr. Arnseth was responsible for developing the groundwater remediation approach, which involved in situ oxidation of chlorinated organics in the primary source areas. He also designed the sampling program for MNA following active source area remediation.

EXPERIENCE SUMMARY

Mr. Manthey has 32 years of professional experience as a project manager and hydrogeologist. His experience includes managing and performing Phase I and Phase II environmental site assessments, site investigations and remedial actions including operation, maintenance and monitoring of groundwater remediation systems for industrial, municipal and state agency clients; 2-dimensional and 3-dimensional groundwater flow modeling; setting up project databases used in Geographic Information System (GIS) software; using GIS software to evaluate and map groundwater elevation data, groundwater chemistry data and soil chemistry data; producing report-quality figures using GIS software; conducting aquifer tests and dual soil vapor/groundwater extraction pilot tests; underground storage tank (UST) removal oversight and assessment; installation of groundwater monitor wells, groundwater extraction wells, water supply wells, dual soil vapor/groundwater extraction wells, and soil and bedrock borings; collection of air, soil gas, soil, surface water, groundwater, and sediment samples for various laboratory analyses; well development; evaluation of air, soil gas, surface water, groundwater, soil and sediment sample analytical data; hydraulic conductivity testing and data analysis; logging soil and bedrock samples; evaluating borehole geophysical logs; preparing work plans, monitoring plans, site health and safety plans, and reports for Phase I and Phase II environmental site assessments, Remedial Investigation/Feasibility Studies and UST closure assessments, and preparing proposals and cost estimates for environmental investigations and remedial actions.

RELEVANT EXPERIENCE

PCE Investigation and Remedial Action, Quad/Graphics, Inc., Pewaukee, Wisconsin. Project manager and hydrogeologist for a site investigation and remedial action at the Quad/Graphics Pewaukee facility. The Wisconsin DNR requested Quad/Graphics conduct a site investigation of the Pewaukee facility to determine whether the property was a potential source of tetrachloroethene (PCE) impacts discovered in several private water supply wells by the DNR in a residential subdivision east of the Pewaukee facility. A phased site investigation of the property and surrounding area that included the collection of groundwater samples from 27 private water supply wells, the installation and sampling of 16 bedrock monitor wells, the installation and sampling of nine Solinst CMT system multilevel monitoring wells, the sampling of three Solinst CMT system multilevel monitoring wells installed by the DNR on a property between the Pewaukee facility and the subdivision, the collection of soil samples from 23 GeoProbe® soil borings, and the collection of surface soil samples was conducted by Tetra Tech. The site investigation identified an area of PCE-impacted soil and groundwater on the north end of the Pewaukee facility. Site investigation activities also included performing a vapor intrusion assessment in the residential subdivision (Hill N'Dale subdivision) located east of the Pewaukee facility, which included collecting sub-slab soil gas samples from the sump pump basins of 16 homes. Sub-slab vapor mitigation systems were installed in eight of the homes based on the results of the sub-slab soil gas testing. An interim groundwater remediation system designed by Tetra Tech consisting of groundwater extraction from two extraction wells located within the area of soil and groundwater impacts and on-site treatment of the impacted groundwater using granular activated carbon vessels began operation in September 2007. A step discharge test and 48-hour constant-rate pump test was performed on one of the extraction wells to determine aquifer properties and aid in the design of the interim

EDUCATION

M.S. Geosciences, University of Wisconsin-Milwaukee, 1989

B.S. Geosciences, University of Wisconsin-Milwaukee, 1985

AREA OF EXPERTISE

Hydrogeology

REGISTRATIONS/ AFFILIATIONS

State of Wisconsin Professional Geologist #034

Missouri Professional Geologist #2016027589

TRAINING/CERTIFICATIONS

OSHA 40-hour Hazardous Waste Health & Safety Course (29CFR 1910.120)

OSHA 8-hour Annual Updates

OSHA 8-hour General Site Work and Supervisor Refresher

American Red Cross Standard First Aid/CPR

Project Management Training – Level 2, Tetra Tech, 2006

OFFICE

Brookfield, Wisconsin

YEARS OF EXPERIENCE

32

YEARS WITH TETRA TECH

30

groundwater remediation system. Quad/Graphics has also voluntarily connected most of the affected residences that were not on municipal water to the municipal water supply and installed a replacement water supply and a whole-house carbon treatment system for the two affected residences that are not able to be connected to municipal water at this time. The interim groundwater remediation system was approved as the long-term remedial action for the PCE impacts by the Wisconsin DNR as recommended by Tetra Tech. Current activities include semi-annual groundwater sampling from site monitor wells and former and existing private water supply wells located in the subdivision, collecting indoor air samples from the homes with sub-slab vapor mitigation systems to document the effectiveness of the systems, preparing progress reports, and operating, maintaining and sampling the groundwater remediation system.

Operation, Maintenance & Monitoring (OM&M) Portfolio, Confidential Client, Nationwide. Project manager for five of 38 nationwide remedial action sites. Tasks performed included remedial system operation and maintenance, groundwater and system monitoring, and preparation of progress reports and discharge monitoring reports. Responsibilities included providing notifications to the appropriate on-site personnel prior to the start of field work, and scheduling of Tetra Tech field staff to perform the field work, which included groundwater monitoring, surface water sampling and groundwater treatment system sampling and maintenance, review of analytical data, report writing and preparation of discharge monitoring reports.

RCRA Facility Investigation and Hydraulic Barrier System Operation, Maintenance, Monitoring, and Reporting, Hydrite Chemical Company, Cottage Grove, Wisconsin. Project Manager and hydrogeologist for a RCRA facility investigation and groundwater remedial action at a chemical manufacturing and solvent reclamation facility with extensive off-site chlorinated VOCs and ketones groundwater impacts, including dense non-aqueous phase liquids (DNAPL). Developed a GIS database for the site using the SiteGIS and MapInfo computer software packages. Work included setting up database files that contained well construction information for the site monitor wells, groundwater elevation data and groundwater chemistry data obtained from the site monitor wells and surface water chemistry data collected from surface water bodies within the study area. Updated and expanded an existing numerical three-dimensional groundwater flow model of the site that was used to estimate local and regional flow paths and identify potential migration pathways for the contaminant plume. The model was also used to determine the location and optimal pumping rates of extraction wells (hydraulic barrier system) that are used to prevent the downgradient migration of highly impacted groundwater coming off the DNAPL source area in a permeable fractured bedrock horizon. Responsible for managing the operation, maintenance, and monitoring program for the hydraulic barrier system, which was brought on-line in October 2003, and preparing the monthly discharge monitoring reports for the barrier system. Additional responsibilities include adding new data to the GIS database files, and making recommendations for future field activities to better define the extent of groundwater impacts. Sediment samples have also been collected as part of the investigation. Additional activities included assisting University of Waterloo and University of Guelph graduate students in conducting field work for various research projects at the site, interpretation of borehole geophysical logs and logging bedrock cores obtained from bedrock borings installed within the footprint of the contaminant plume; conducting an investigation to define the extent of DNAPL in the permeable fractured bedrock horizon; pumping of DNAPL from recovery wells installed in the permeable bedrock zone; performing a 24-hour aquifer test on the permeable bedrock horizon in which the DNAPL occurs; installing dedicated pneumatic submersible pumps in monitor wells on the quarterly sampling schedule; implementing the low-flow sampling method as part of the groundwater monitoring program for the site; installing and developing a new Westbay System multi-level monitoring well in the deep bedrock zones beneath the contaminant plume. On-going project activities include operating, maintaining and monitoring the hydraulic barrier system, preparing and submitting the monthly discharge monitoring reports for the hydraulic barrier system, assisting the University Consortium for Field Focused Groundwater Contamination Research in the field work they conduct at the site, managing the quarterly groundwater monitoring program and preparing quarterly progress report.

Remedial Alternatives Analysis and Groundwater Flow Modeling, Wisconsin Department of Natural Resources, Rhinelander, Wisconsin. Evaluated the existing remedial action activities and evaluated supplemental remedial alternatives for a closed municipal landfill in northern Wisconsin. Developed a regional two-dimensional analytic element groundwater flow model of the area surrounding the landfill. The data from the two-dimensional model was used to establish reasonable boundary conditions for an existing three-dimensional groundwater flow model of the landfill developed by the responsible parties (RPs). The three-dimensional model was used to evaluate the effectiveness of the groundwater pump-and-treat system implemented on the south side of the landfill by the RPs.

EXPERIENCE SUMMARY

Mr. Wieman has over 35 years of experience in the environmental consulting business. Tasks and duties include performance and project management of environmental assessments, including comprehensive development feasibility studies; wetland (401/404 permits including Alternatives Analysis) erosion control, storm water, construction permitting, and environmental critical issues analysis. National Environmental Policy Act-based reporting; Phase I environmental site assessments (ESAs) conducted in accordance with ASTM:E1527-05 and EPA's All Appropriate Inquiry (AI); Phase II and geotechnical subsurface investigations; installation oversight of soil and groundwater monitoring and remediation systems (including feasibility assessment for implementation of in-situ and ex-situ treatment techniques); soil, sediment, water, and air sampling; limited asbestos-containing materials surveys; asbestos abatement oversight including NIOSH 582 fiber counting; hazardous conditions air monitoring; site health and safety plan (HASP) preparation and site safety officer; bid procurement, subcontractor coordination and oversight, proposal and cost estimate preparation; project scheduling; permit procurement, and routine required reporting and interfacing with regulatory agencies and clients. Field work is commonly performed in hazardous environments requiring up to Level B protection.

AIR QUALITY MONITORING / FIELD OVERSIGHT/HAZARDOUS MATERIALS SAMPLING SR. ENVIRONMENTAL SCIENTIST. (2000-PRESENT)

Wisconsin. Performed air quality monitoring during loading rack and piping system upgrades at petroleum terminals and pipeline corridors including compound specific sampling, field documentation, and site safety coordination. Duties also included excavation oversight, subcontractor coordination, field sample collection, and associated project reporting.

Michigan. Implemented outdoor air quality monitoring program during removal of coal tar waste for a state of Michigan environmental remediation contractor. Monitoring included sample collection employing Summa® air canisters for volatiles, PUF/XAD high-volume sampling for semi-volatiles and real-time air monitoring for personnel protection.

Washington D.C. Performed air sampling for anthrax utilizing cellulose and sheep's blood agar sampling media employing high volume pumps and Anderson samplers. Performed air monitoring in Level B personal protective equipment for fugitive and captive chlorine dioxide (ClO₂) levels in conjunction with decontamination procedures for anthrax abatement.

EDUCATION

BS, Resource Management (Soil Science), University of Wisconsin-Stevens Point, 1984

REGISTRATIONS/ CERTIFICATIONS

Asbestos Contractor/ Supervisor: Wisconsin and Michigan (ACS-3414, 1996, A47853, 2015)

Petroleum Environmental Cleanup Fund Act Program Consultant: Wisconsin (#41724, 1996)

CN e RAILS SAFE System Badge – Contractor (2010 to current date)

NIOSH 582 Sampling and Evaluating Airborne Asbestos Dust Asbestos Fiber Counting (1997)

40-Hour/8-Hour HAZWOPER

AFFILIATIONS

Wisconsin Ground Water Association

Federation of Environmental Technologists

OFFICE

Schofield, Wisconsin

YEARS OF EXPERIENCE

35

YEARS WITHIN TETRA TECH

35

Questa, New Mexico. Performed asbestos abatement subcontractor oversight and coordination, pre-and post-work area inspections, equipment maintenance and calibration, asbestos fiber air monitoring, and final air clearance sampling with associated microscopy. Work was performed as part of the decommissioning and demolition of a former molybdenum mine located in Northern New Mexico.

New Orleans, Louisiana. Member of the U.S. Environmental Protection Agency (EPA) Superfund Technical Assistance Response Team assembled to address environmental impacts from Hurricane Katrina and flooding from re-breach of levees after Hurricane Rita. Sampled flood water and canals during and after dewatering of flooded areas including discharge outfalls into the surrounding bayou or lower lying areas, primarily during ongoing oil recovery. Tested water for municipal potable water supply treatment plants to ensure adequate chlorination as they were being brought back on-line. Sampled sediment for residual contaminants to establish baseline data in and around New Orleans to facilitate neighborhood re-occupancy.

ENVIRONMENTAL SITE INVESTIGATIONS/REMEDATION

Contaminant Release Impact Evaluations As Senior Environmental Scientist, manage and conduct subsurface investigations to evaluate soil and groundwater impacts from contaminant spills and/or underground storage tank (UST) releases on residential, small business, commercial, and industrial properties throughout the state. Duties included procuring subcontractors to perform initial subsurface assessment, remediation oversight, regulatory contact/compliance, and associated project report preparation. (1986 to present)

Radioactive Waste-Impacted Site Remedial Investigation/Baseline Risk Assessment, Niagara Falls, New York. Environmental Scientist for a remedial investigation/baseline risk assessment for a site impacted by high- and low-activity radioactive waste from uranium extraction related to the Manhattan Project and chemical impact from TNT manufacturing processes during World War II. Work conducted at this Formerly Utilized Sites Remedial Action Program site for the Buffalo District, U.S. Army Corps of Engineers (USACE). Assisted with subsurface field investigation activities, including installation of soil borings and groundwater monitoring wells; development, purging, sampling, and slug testing wells; collecting soil, sediment, and groundwater samples; and downhole gamma logging of subsurface radioactive contamination. Served as one of the on-site health and safety officers, responsible for implementation of the site HASP. (1999 to 2003)

REMEDIAL INVESTIGATION / FEASIBILITY STUDY

PCB Dredging Project – Fox River, WI. Performed pre- and post dredging sample collection including in-situ sediment delineation as part of a field sampling crew obtaining data/verification of residual PCB contaminants for proposed and completed dredge areas. Duties include utilization of sediment sampling equipment, procurement, decontamination, and maintenance of sampling equipment, and commandeering the sampling boat. (2009-2010; 2012)

Feasibility of Applied Remedial Techniques, Wisconsin. As Senior Environmental Scientist, conducted fieldwork to obtain data to determine the feasibility of impacted soil excavation including on-site in-situ and/or ex-situ remediation of impacted media. Feasibility included pilot testing for soil vapor extraction, pump testing for groundwater sparge and/or groundwater pump-and-treat systems, (1989 to present).

Ammonium Perchlorate Sediment Sampling – NERT Site, Henderson NV. Performed sediment sampling in settlement ponds for a decommissioned rocket fuel booster facility. Duties included equipment procurement, sampling technique thickness verification/evaluation, sediment and crystallized materials sampling with a variety of techniques, hazardous materials shipping preparation, and extensive personal and equipment decontamination. Sampling was performed to mitigate explosion hazard and materials contact.

Development Feasibility Assessment/Site Evaluation, Kane, Lake, and McHenry Counties, Illinois. Project Manager responsible for performing, managing, and providing oversight for comprehensive pre-development assessments of properties ranging from 9 to 500 plus acres for potential residential development. Assessment includes natural resource inventory and management planning, wetland delineation permit procurement.

APPENDIX B: DETAILED PROJECT DESCRIPTIONS FOR PFAS TREATMENT PROJECTS

OCWD PFAS On-Call Design Contract

ORANGE COUNTY, CALIFORNIA



owner:

Orange County Water District
Chris Olsen, PE
714.378.3232

schedule:

2020 - 2021 (Design)

value:

\$30M (construction)

key staff:

Steve Tedesco, PE, BCEE
Project Manager

Tom Epperson, PE
QA/QC

James Christopher, PE, BCEE
QA/QC

Kara Buttacavoli, PE
Project Team Lead

Amanda Taylor, PE
Process Engineer

Crisna Raymond, PE
Project Engineer

Victor Ramirez, PE, SE
Structural Engineer

Mazen Kassar, PE
Electrical Engineer

Astrid Fleischer, PE I&C
Engineer

The OCWD selected Tetra Tech as one of the Engineering Firms to design PFAS Systems for their groundwater producers. Tetra Tech is currently working on the following four projects:

- ▶ **Serrano Water District Well #5 and #9** (Completed Design) – This project consists of a 3,000 GPM IX System with a bag filter pre-treatment, 3,000 GPM Booster Pump Station and new chemical feed system for disinfection. Estimated Const. Cost - \$6.2M.
- ▶ **Kimberley Well 1A** (Completed Design) – Located on a very small site with a single well this facility is designed to produce 3,000 GPM using an IX System with a bag filter pre-treatment and new chemical feed system for disinfection. Estimated Const. Cost - \$3.7M.
- ▶ **Fullerton Main Plant** – The Fullerton Main Plant will treat six (6) onsite wells with a total capacity of 10,100 GPM. PFOS, PFOA and VOCs will be removed using 6 to 12 ft diameter, 40,000 lb. GAC vessels that will discharge into an existing forebay then pumped into the distribution system. The remaining wells will be treated with an IX system consisting of 8 vessels and bag filters for pre-treatment. Estimated Const. Cost - \$26.5M.
- ▶ **Yorba Linda Water District Headquarters Plant** (Completed Design) – This system will treat water from 10 wells with a total capacity of 17,400 GPM. An IX System consisting of 11 pairs of Lead/ Lag Vessels (22 vessels total), bag filter pre-treatment, Booster Pump Station, and new Onsite Generation System for chlorine disinfection. In order to get the system on the existing site an extensive analysis of the site improvements was completed. Estimated Const. Cost - \$32.5M.

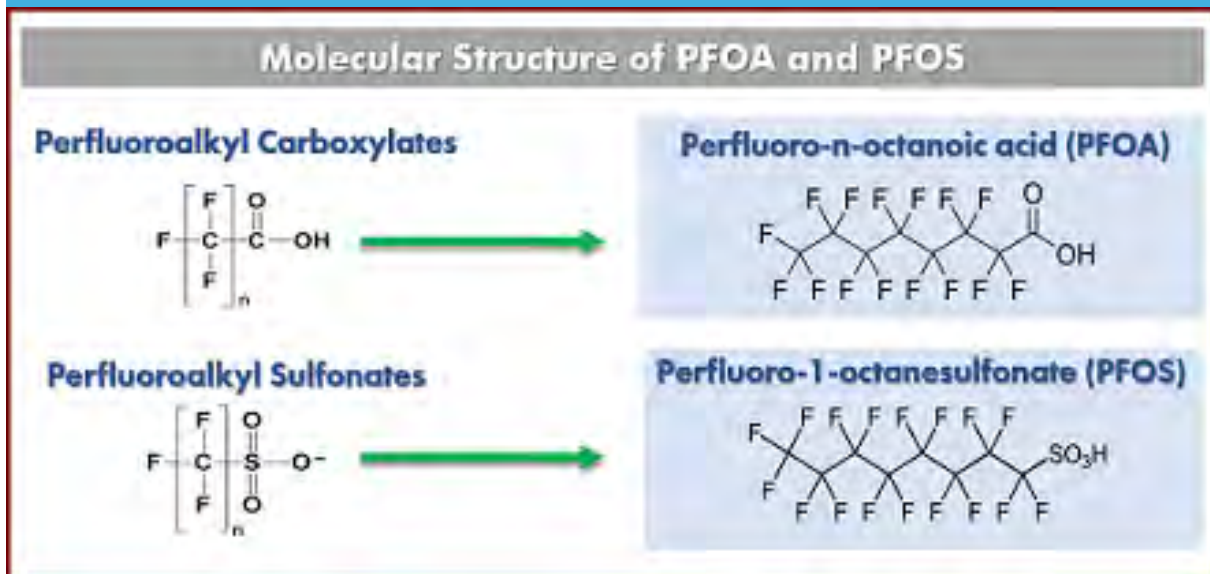
The Tetra Tech team prepared the Engineer's Report and Operating Plan for the State of California Division of Drinking Water (DDW) for each of the projects.

Innovation

- *Performed detailed operational analysis of IX and GAC usage from both RSCCT and Pilot Data.*
- *Used early submittal process to obtain DDW approvals in less than 5 months from start of the design.*
- *Performed details wells analysis to determine how to maximize well production after adding IX and GAC systems.*

PFAS Study for Five Wells

DOWNEY, CALIFORNIA



owner:

City of Downey
 Dan Mueller, PE
 562.904.7110

schedule:

2020 - 2021

value:

\$4M (construction)

key staff:

Steve Tedesco, PE, BCEE
 Principal in Charge
 Kara Buttacavoli, PE
 Project Engineer
 Amanda Taylor, PE
 Process Engineer
 Crisna Raymond, PE
 Project Engineer
 Victor Ramirez, PE, SE
 Structural Engineer
 Eric Yuen, PE, SE
 Structural Engineer
 Mazen Kassar, PE
 Electrical Engineer
 Nicole Han, PE
 Electrical Engineer

The City of Downey found that they had five existing groundwater wells in their system that had PFOA and PFAS higher than the new California Response Levels (RL) set in February 2020. Tetra Tech was hired to review perform a study to determine the best means for the City to continue to operate the wells.

Alternatives were analyzed including isolating certain zones in the wells that contained PFAS, blending PFAS contaminated water with other City well water, using IX or GAC wellhead treatment and/or piping PFAS contaminated water to a central location for treatment.

The scope of work of the project includes:

- ▶ Analyze Project Water Quality
- ▶ Review Well Screen Data to determine if well modifications can solve the PFAS issue
- ▶ Develop options for treating the PFAS at the Wellhead
- ▶ Develop option for treating PFAS at a Central Location
- ▶ Determine if IX or GAC treatment should be used
- ▶ Develop capital and operations cost estimates

Innovation

- *Well sites are within a highly developed urban area.*
- *All existing well sites are on very small sites.*
- *Detailed analysis of Capital and Operating Costs.*
- *Study used to supplement funding application.*

Well ET-1 PFAS Study

IRVINE, CALIFORNIA



owner:

Irvine Ranch Water District
Rich Mori, PE
949.453.5571

schedule:

2020 - 2021

value:

\$4M (construction)

key staff:

Steve Tedesco, PE, BCEE
Principal in Charge

Kara Buttacavoli, PE
Project Engineer

Amanda Taylor, PE
Process Engineer

Victor Ramirez, PE, SE
Structural Engineer

Mazen Kassar, PE
Electrical Engineer

ET-1 was developed to increase utilization of the Irvine Subbasin through recovery and treatment of VOC- impaired, poor-quality groundwater. The project cleans up the contaminated VOCs, with the treated water used for non- potable purposes. Water extracted from inside the VOC plume is treated using granular activated carbon and air stripping technologies. The scope of work of the project includes:

- ▶ Analyze Project Water Quality
- ▶ Develop three options for treating the PFAS discovered at ET-1
- ▶ Develop three option to include wells ET-1 and 78 into the project if PFAS is found at those wells
- ▶ Determine if IX or GAC treatment should be used
- ▶ Develop capital and operations cost

Innovation

- Site with VOCs and very High PFAS and PFOA levels.
- Existing Operating Site with small footprint.
- Treated water will be used in the non-potable distribution system for irrigation and industrial uses.



PLUME CHARACTERIZATION, GROUNDWATER MODELING, AND TREATMENT DESIGN AND CONSTRUCTION

An aerospace company operated a rocket testing facility between the mid-1950s and mid-1970s in the Bunker Hill Basin. The Basin encompasses an area of approximately 120 square miles in the upper Santa Ana Valley. Tetra Tech has managed this project for our client for over 25 years and the project has encompassed all aspects of a project life cycle from characterization, to remediation, to operations and maintenance.

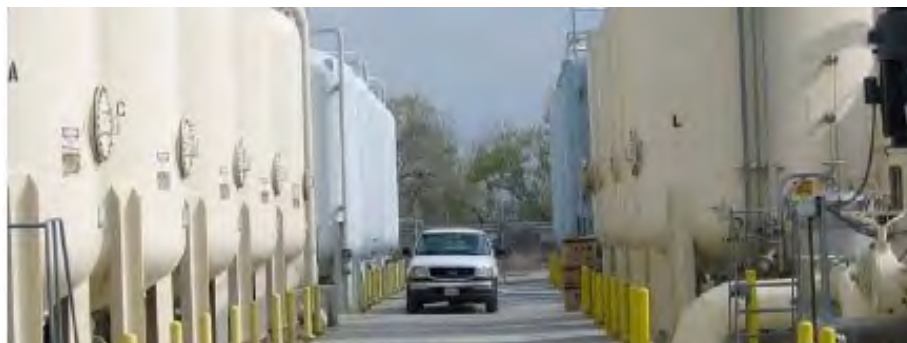
Work elements have included characterization of the vertical and horizontal extent of a 10-mile long 3-mile wide solvent and perchlorate plume, construction of a 3-dimensional fate and transport groundwater model that encompasses the majority of the Bunker Hill Groundwater Basin, and design and treatment of potable production wells to remove volatile organic compounds (VOCs) and perchlorate. The treatment systems are capable of treating over 20,000 gpm for potable supply for four water purveyors in the Basin that removes VOC, perchlorate and PFAS in delivered water. Key elements of work related to plume characterization, 3D groundwater modeling, information management, and design/build treatment facilities to remove VOCs, perchlorate and PFAS are provided below.

Plume Characterization: Since 1994, Tetra Tech has performed a variety of tasks to characterize the extent of the perchlorate, TCE, and emergent compounds including PFAS. Since 1996, Tetra Tech has installed 15 multiport (Westbay) monitoring wells with up to 10 ports each at depths to 1,100 feet below ground surface (bgs). Since project inception, Tetra Tech has sampled over 200 wells and has collected over 50,000 groundwater samples. Samples are analyzed for VOCs, perchlorate and emergent compounds including PFAS compounds, 1,4-dioxane, 1,2,3-trichloropropane (TCP), dibromochloropropane (DBCP) radionuclides, and stable isotopes. Data generated from the groundwater sampling program is entered into the project data base and is used to refine the Conceptual Site Model and update the 3D flow and transport groundwater model.

3D Fate and Transport Groundwater Modeling: Analytical results from plume characterization activities described above are used to build the Bunker Hill Basin groundwater model. The model contains six layers, includes over 650 wells and/or monitoring points, and extends across a 100 mi² area. The groundwater model is used to evaluate contaminant migration over time through the Basin. The model predicts contaminant impacts at municipal production wells. The groundwater flow model in conjunction with the water system blend model are used to predict the timing, the magnitude of impact, the need for treatment, the duration of treatment, when the treatment can be suspended, and the associated costs. Model predictions typically run for 20 years; however, in certain applications model predictions have been extended to over 50 years.

Treatment Plant Design & Build: Tetra Tech has designed and built several regional and stand-alone treatment plants to remove PFAS, VOCs, and perchlorate for potable supply. Treatment includes removal of TCE by granulated activated carbon (GAC) and removal of perchlorate by ion exchange (IX). PFAS is removed using both GAC and IX treatment. To date, the combined treatment capacity exceeds 20,000 gpm. The treatment plants remove VOCs, perchlorate, PFAS compounds, TCP, DBCP to potable standards.

Information Management: The Tetra Tech team developed a user-friendly project database that stores analytical, water level, production, well construction data, collected by Tetra Tech and others in the Basin. The existing database houses over 3 million project-specific records. The project database allows project team members access to up to date project-related data wherever there is an internet connection.



Response to Request for Qualifications

Prepared for

City of Wausau

Wausau Water Works

Prepared by



March 25, 2022

March 25, 2022

Mr. Eric Lindman, P.E.
City of Wausau – Director of Public Works and Utilities
407 Grant Street
Wausau, Wisconsin 54403

Re: Statement of Qualifications for Perfluorinated Compounds Treatment and Removal from Drinking Water

Dear Mr. Lindman:

The Wausau Water Works (WWW) is seeking engineering services for expertise related to treatment technologies for treatment and removal of per- and polyfluoroalkyl substances (PFAS) in the City of Wausau's drinking water. The WWW's objective is to treat the drinking water to levels where PFAS are below the Wisconsin Department of Health Services recommended health advisory levels prior to of the treated water distribution.

Geosyntec Consultants, Inc. (Geosyntec) has reviewed and understands the Request for Professional Engineering Qualifications and Scope of Services (RFQ) and is confident we provide the subject matter expertise the WWW is seeking. Geosyntec's qualifications align well with the City's preferred experience, including:

- ✓ Geosyntec designed and is constructing a state-of-the-art treatment system in Wisconsin specifically to remove PFAS from groundwater
 - o Only PFAS-specific groundwater treatment system in Wisconsin, based on a search of the WDNR Bureau for Remediation and Redevelopment Tracking System (BRRTS) database
 - o Prepared and received all approvals from the Wisconsin Department of Natural Resources (WDNR) to construct and operate the system
 - o Completed bench-scale tests and evaluated technologies to design the most effective treatment system
- ✓ Geosyntec designed and constructed municipal and private water drinking water treatment systems to remove PFAS from drinking water supplies across the United States
- ✓ Geosyntec prepared a PFAS technology evaluation overview and presented the technologies in a workshop with our client
- ✓ Geosyntec has a strong PFAS-centered practice and has internationally recognized subject matter experts that will be available to the WWW
- ✓ Geosyntec participates in research and development of emerging and novel technologies in conjunction with:
 - o The Strategic Environmental Research and Development Program (SERDP)
 - o The Environmental Security Technology Certification Program (ESTCP)

-
- o The Technology Advisory Council (TAC), which is Geosyntec's internally funded research program

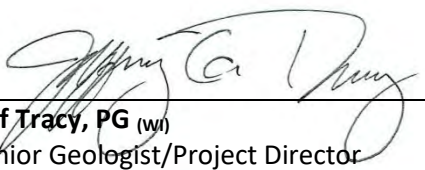
Geosyntec, which has been providing similar services to clients in Wisconsin and the United States for over thirty-five years, assembled a team of experienced engineers, hydrogeologists, and subject matter experts familiar with current and emerging PFAS treatment technologies, PFAS fate and transport, water and wastewater treatment system design, and waste management to assist the WWW in accomplishing the project goals. Geosyntec experts have an in-depth knowledge of existing and proposed drinking water quality standards and regulations at the local, state, and federal level. Our practitioners are well-versed in water treatment for potable use, specifically in the latest technologies for effectively treating PFAS and other emerging contaminants of concern, as described further in the attached qualifications package. Geosyntec's team will provide the national expert capabilities, local experience, and staff commitment to meet WWW's objectives for the duration of the project. WWW will benefit from our team's multi-faceted strengths, including:

- **Project Understanding** - We have extensive experience performing similar work scopes and delivering cost-effective solutions for our clients in WI and around the world, including optimizing plans for fast-paced, state-driven projects related to PFAS and other emerging contaminants of concern.
- **Expert Staff** - The key staff selected for this project are experts in their fields. In addition, the subject matter experts identified in this proposal are thought leaders in the field of PFAS occurrence and treatment who will assist WWW to navigate the developing technology and regulatory requirements, and are the only staff with experience gaining approval from regulators for a system to treat PFAS in Wisconsin's groundwater.
- **Project Team Availability** - We are committed to the full availability of our key staff for the project duration. We understand that time is of the essence and will maintain constant, effective communication with WWW to keep you informed throughout the project.

We appreciate the opportunity to provide WWW with our qualifications. Geosyntec's Water Treatment Leader, Balaji Seshasayee, PE_(OR), and Jeff Tracy, Geosyntec's Wisconsin Regulatory Leader are ready to answer your questions/comments, and to provide further details on Geosyntec's advanced capabilities.

Sincerely,

Geosyntec Consultants, Inc.

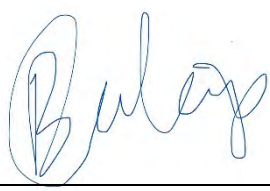


Jeff Tracy, PG_(WI)

Senior Geologist/Project Director

Direct: 414-918-7481

E-mail: JTracy@Geosyntec.com

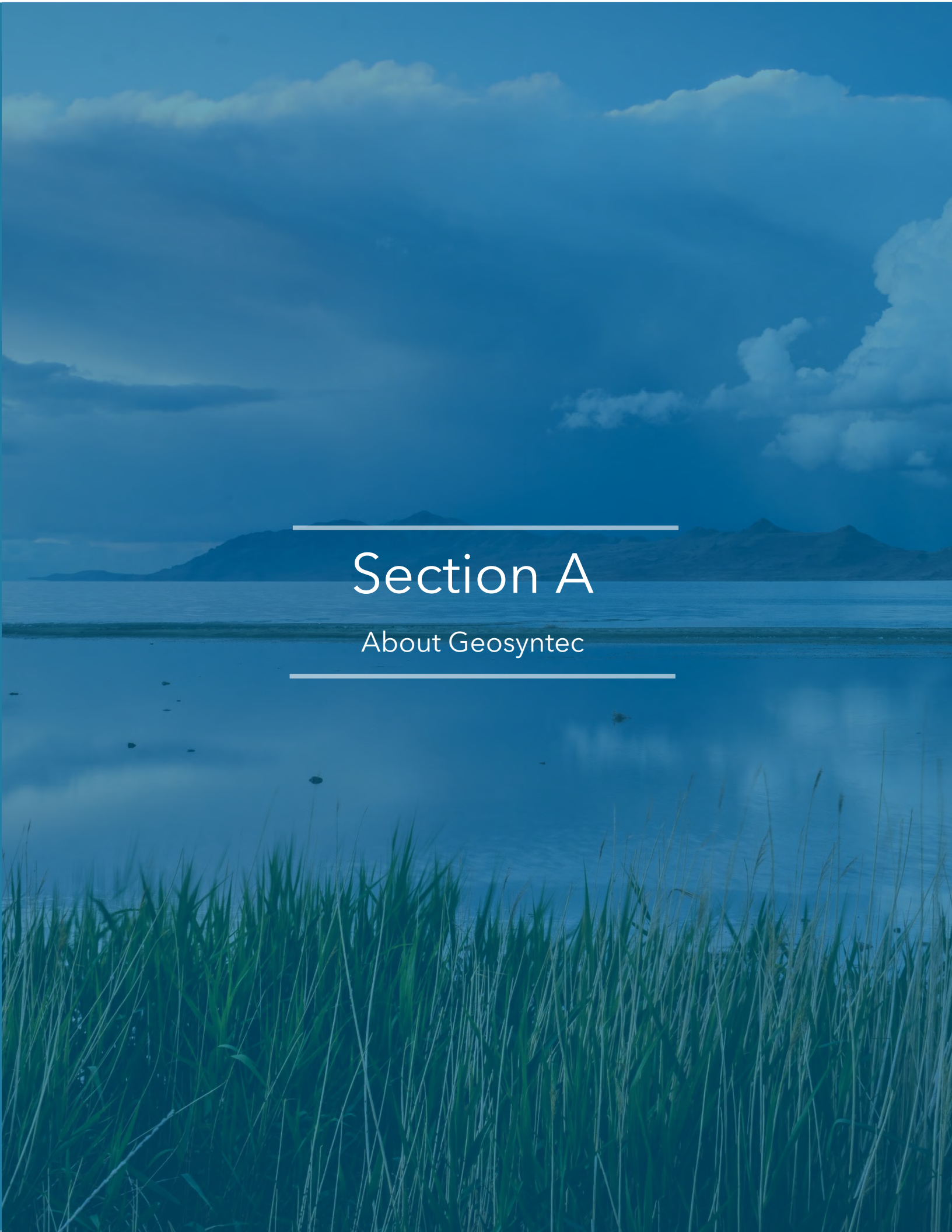


Balaji Seshasayee, PE_(OR)

Senior Engineer/Project Team Lead

Direct: 312-416-3941

E-mail: BSeshasayee@Geosyntec.com



Section A

About Geosyntec

About Geosyntec

Geosyntec Consultants, Inc. (Geosyntec) is an employee owned, top-tier environmental consulting and engineering firm that works with public and private sector clients to address complex problems involving the environment, natural resources, and civil infrastructure. We deliver solutions with a combined staff of more than 1,700 engineers, scientists, and related technical and project support personnel. We serve our clients from more than 90 offices in the United States, Canada, the United Kingdom, Ireland, Sweden, Australia, and the United Arab Emirates.

Geosyntec's engineers, geologists, scientists, technical professionals, and project support staff are highly skilled and well recognized technical experts with unprecedented experience in water treatment, process engineering, per- and polyfluoroalkyl substances (PFAS) and other emerging contaminants, hydrogeology, and environmental issues in Wisconsin and throughout the U.S.

Geosyntec is a practice-centered business, meaning we draw on subject matter experts across the company, not just locally. The proposed primary point of contact for supporting WWW is Jeff Tracy who is located in Geosyntec's Milwaukee, Wisconsin, office. Mr. Tracy is familiar with the regulatory processes (permitting, planning) and the current state of proposed PFAS-related regulations in Wisconsin. Balaji Seshasayee is a subject matter expert in treating PFAS in both water supply and wastewater systems resides in Geosyntec's Chicago, Illinois office. Dr. Rula Deeb is an internationally recognized subject matter expert in PFAS fate and transport and treatment technologies, is Geosyntec's PFAS practice lead and is located in California. Dr. Mary Ensich, also in the Milwaukee office, is a subject matter expert in destructive PFAS technologies. Kirk Craig is an expert in designing water treatment systems, developing cost estimates, and constructability estimates. Each of these practitioners were instrumental in designing, constructing, permitting and obtaining WDNR approvals in the only PFAS-specific groundwater treatment system in Wisconsin. Dr. Amini is an expert in design and construction of municipal water treatment systems and his expertise will assist the team in ensuring appropriate technologies for the WWW.

PFAS Services and Capabilities

PFAS represent a very challenging family of contaminants given that: (i) most PFAS constituents cannot be detected using conventional analytical techniques, (ii) they are nearly ubiquitous contaminants that tend to be detected at very low concentrations, and (iii) by virtue of their backbone of carbon-fluorine bonds, they, as a class, are very recalcitrant to most typically employed environmental remediation approaches. Remedial options that may address one PFAS constituent may not work for others, and only partial treatment may be achievable. Due to the relative dearth of analytical methods and diversity of PFAS, by-products of treatment may not be detected thus severely complicating the ability to assess their relative risk. Risk-based standards for PFAS in soil and water are extremely low in some states.

PFAS Core Services



For these reasons, the investigation, management and treatment of PFAS requires an innovative, adaptable, and experienced team, actively involved in (not just aware of) current research, and capable of developing and optimizing new approaches in response to regulatory updates and technological advances.

Geosyntec is an international leader in developing, testing, and implementing conventional and innovative treatment technologies for emerging contaminants, including PFAS. We are helping our clients in the municipal, federal, and industrial sectors respond to ever-evolving PFAS regulations and treatment requirements. The Geosyntec team has extensive experience in treating PFAS-impacted water and are knowledgeable about the regulatory process in Wisconsin, which provides the team with a local understanding of the unique challenges and issues WWW faces.

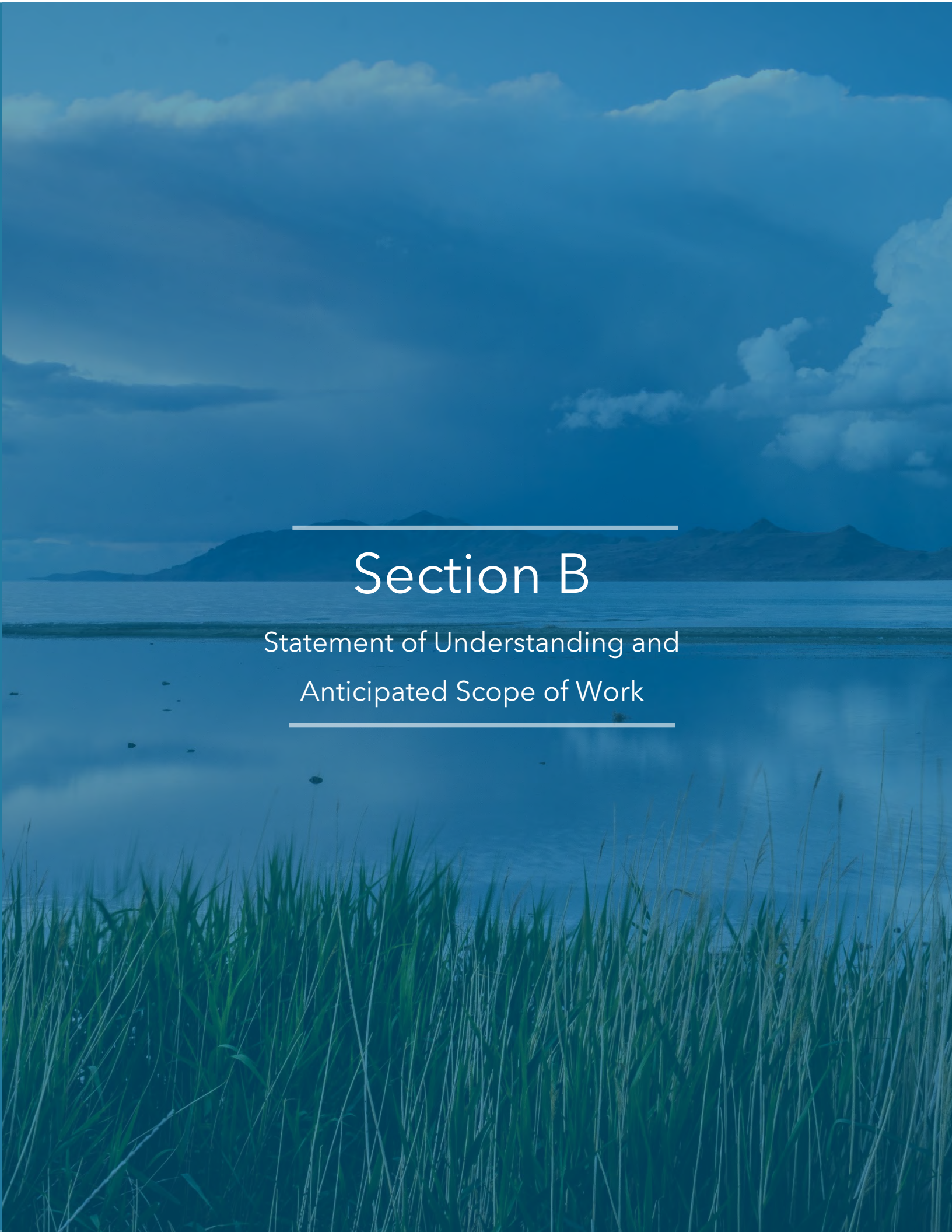
Recognized Leaders in Water Treatment

Geosyntec's focus is in working with municipalities, districts, agencies, and private sector businesses to identify and implement efficient innovative solutions. Geosyntec provides a wide range of expert services in the areas of water treatment, include planning and implementation, such as feasibility evaluation, in-house treatability testing, technology evaluation, engineering analysis and cost estimating, engineering design, permitting support, bid support, and construction management services.

Specifically, Geosyntec has assisted multiple municipalities in navigating the regulatory and planning aspects related to PFAS treatment in response to detection in treated water and evolving regulatory standards, similar to WWW's scope of work in this Request for Qualification (RFQ). The work Geosyntec performed for other municipalities included, but was not limited to, conceptual feasibility and technology evaluation, treatment process selection and siting, system modeling, cost estimations, bench and pilot testing, treatment system design, procurement, and construction management services. Project descriptions are presented in Section E. Experience and References.

Geosyntec understands and is experienced in a variety of PFAS treatment technologies, which vary in treatment effectiveness, stage of development, waste generation, and costs. Geosyntec has direct design and implementation experience with technologies that are relatively mature and being implemented in full scale, such as granular activated carbon (GAC) and ion exchange (IX), and is a recognized leader in researching, testing, and improving technologies in various development stages, including emerging novel destructive technologies.

The following sections of this SOQ are structured to address the anticipated scope of work and qualifications described in Section IV, WWW Goals and Description of Deliverables, of the RFQ.



Section B

Statement of Understanding and
Anticipated Scope of Work

Statement of Understanding

The Wausau Water Works (WWW) supplies potable water to its customers in the City of Wausau, Wisconsin. WWW serves potable water to a population of approximately 16,000 customers through its distribution network. WWW's main water supply is from six public drinking water supply wells that produce groundwater from shallow sand aquifers. The WWW water treatment facility currently treats and distributes approximately 4.2 million gallons of water per day, or 1.5 billion gallons of water annually. The WWW began construction of a new Drinking Water Treatment Facility in 2020 and expects the facility to be substantially complete in August 2022.

Per- and polyfluorinated-alkyl substances (PFAS) are a class of emerging contaminants that have been increasingly scrutinized by federal and state regulatory agencies. The United States Environmental Protection Agency (USEPA) and the Wisconsin Department of Health Services (WDHS) have issued health advisories for two PFAS compounds, perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA). The USEPA advisory for combined PFOA and PFOS is 70 nanograms per liter (ng/L); the WDHS advisory for combined PFOA and PFOS is 20 ng/L. Although the agencies issued health advisories for PFOA and PFOS, the USEPA and the WDNR have not established drinking water standards for either compound or any other PFAS.

The City of Wausau, at the request of the Wisconsin Department of Natural Resources (WDNR), collected water samples from each of the six operating water wells and analyzed the samples for 33 PFAS, including PFOA and PFOS. The combined PFOA and PFOS concentrations in the wells ranged between 23.77 ng/L and 35.3 ng/L, which are below the USEPA advisory levels, but above the WDHS health advisories. Although drinking water standards do not exist for PFAS, specifically, PFOA and PFOS, WWW is interested in evaluating long-term and cost-effective water treatment technologies to remove PFAS from its drinking water prior to distribution.

The primary goal of the WWW for this RFQ is to retain a “...consulting firm (Consultant) whose expertise in the field of PFAS will complement the Engineers’ (Donohue and Becher and Hoppe, added for clarity) expertise. The Consultant will be brought on board to provide broad PFAS expertise to assist WWW in determining, with the Engineers, the best PFAS removal/treatment options moving forward and provide guidance on additional testing to explore those options if necessary and warranted.”

For this particular project, Geosyntec understands WWW's needs for assistance in managing complex technical and fluid regulatory challenges with a clear path forward. Compliance and potential treatment requirements for PFAS add another complicating factor to WWW's operation that must be carefully considered. WWW relies on multiple groundwater wells and is in the process of constructing a complex water system to comply with federal and state regulations to provide high-quality drinking water to its customers. Geosyntec has the track record in delivering projects of similar regulatory and compliance complexity. Our engineers and scientists on the proposed team routinely work on water systems with multiple conventional and emerging contaminants (volatile organic compounds, 1,4-dioxane, PFAS, nitrate, perchlorate, to name a few) and complex treatment trains comprising GAC, IX, membrane filtration such as nanofiltration (NF) and reverse osmosis (RO), advanced oxidation and biological treatment, which are further demonstrated in the enclosed project descriptions. The project team includes seasoned professionals who assist clients in navigating through challenging constraints

to meet project goals daily. Working together, the Geosyntec team can develop the most cost-effective and practical solutions for WWW.

Anticipated Scope of Services

The WWW presented an anticipated scope of services that the Consultant will engage in. Our understanding is the final scope of services will be developed after WWW selects a Consultant. The proposed scope of work includes the following:

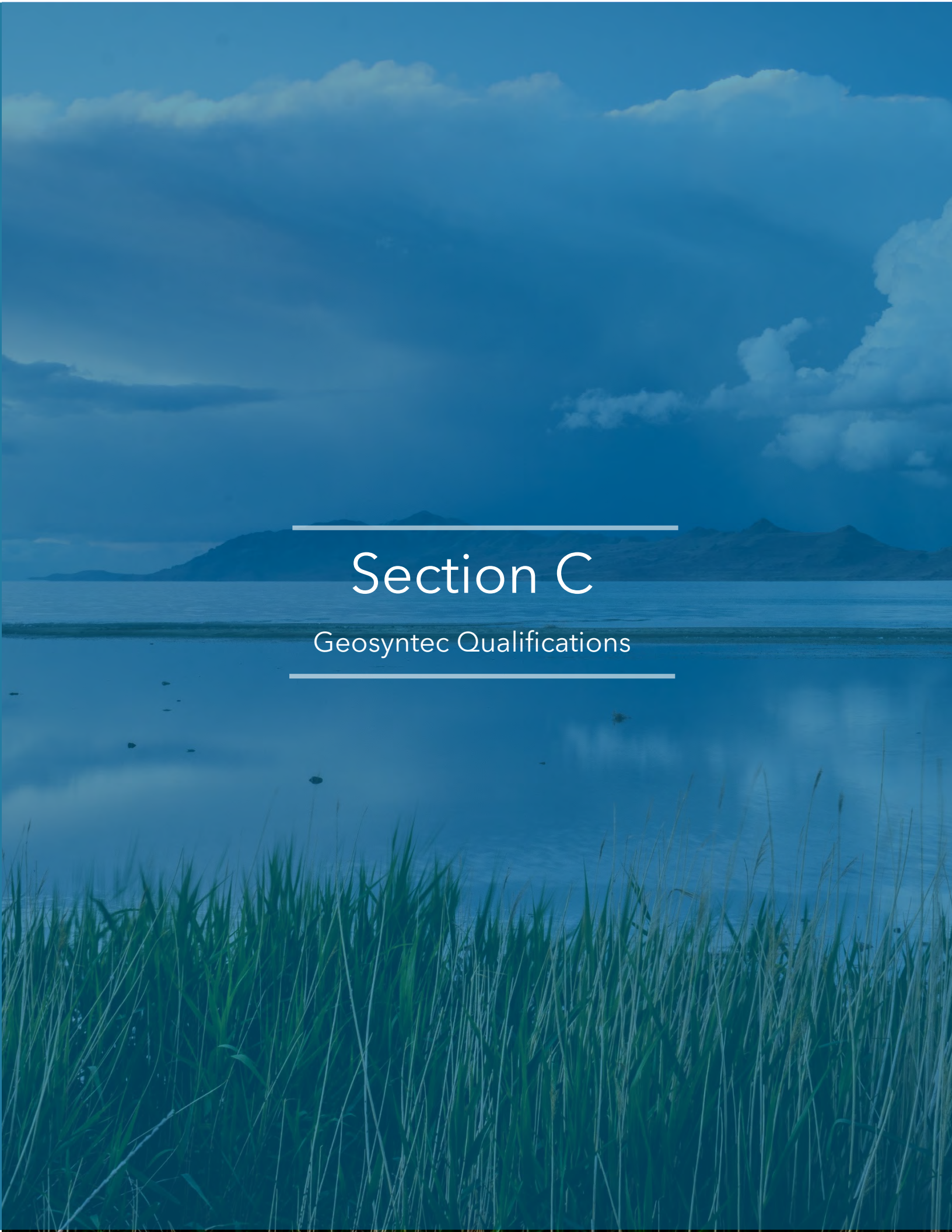
- Prepare a Technical Memorandum on best practices nationally for PFAS removal from groundwater and drinking water, emerging/novel treatment technologies, and their potential relevance to Wausau's water supply.
- Review data collected from pilot testing and other tests performed by Engineers in the investigation of PFAS treatment strategies.
- Provide recommendations for additional testing as needed.
- Perform peer review of project deliverables prepared by Engineers (drawings, technical memoranda, data analysis, and strategy recommendations).
- Work with Engineers and utility staff to support the development and presentation of recommendations and cost estimates for interim and permanent PFAS removal options to the WWW Commission.
- Participate in technical workshops with utility staff and Engineers.
- Remain available for participation (virtual or in-person) in monthly meetings with the WWW Commission.
- Review timelines and pilot testing results.
- Work with Engineers and utility staff for continuing the Pilot Study once the new treatment facility is fully operational.
- Review the water quality at the new treatment facility as part of the Pilot Study.

Geosyntec designed and is currently constructing a system to treat PFAS-impacted groundwater in Marinette, Wisconsin. As part of that project, Geosyntec completed an almost identical scope of services. Geosyntec reviewed another consultant's conceptual treatment system design to evaluate the potential effectiveness of the conceptual system and recommend revisions to increase the system performance. As part of this project, Geosyntec's services included the following:

- Reviewing data previously collected by others
- Completing a third party review of the consultants Remedial Action Design Report and recommending revisions to increase system performance

- Evaluating appropriate treatment technologies, including pretreatment and multiple rapid small scale column tests (RSSCT) for GAC and IX resin
- Developing and implementing several bench studies and reviewing results to optimize design
- Completing the treatment design
- Preparing permit applications and receiving appropriate permits
- Developing a precedent setting, unique discharge permit compliance document
- Preparing presentations and presenting to City of Marinette and other local stakeholders to obtain access approvals
- Developing cost estimates to construct the system and presenting the costs to Tyco's upper management
- Construct the system.
- Attend and lead regularly scheduled meetings to discuss technical, cost and schedule related issues with regulators and project stakeholders, as well as local residents.

On another project for a confidential client in the upper Midwest, Geosyntec prepared a soil and groundwater technology evaluation to address soil and groundwater impacted with PFAS. The technologies evaluated included mature technologies such as treatment with GAC, IX resin and RO, and emerging technologies such as permeable barriers around extraction wells, and several emerging destructive and separation technologies. The results of the technology evaluation were presented to the client during a "technology workshop" prepared by Geosyntec.



Section C

Geosyntec Qualifications

Geosyntec Qualifications

The WWW requests potential consultants demonstrate experience in specific areas (Section IV of the RFQ). The following section presents Geosyntec's experience and demonstrates our unique ability to assist WWW achieve their goals. The requested experience will be numbered and in bold text followed by Geosyntec's response in the following sections.

1. What is the consultant's experience in design of PFAS removal from groundwater? For both drinking water and groundwater remediation? With what types of removal systems do you have experience?

As stated earlier, we believe Geosyntec is the only consultant with experience in designing and constructing a system to specifically treat PFAS-impacted groundwater in Wisconsin. The key personnel described in this proposal are key team members for that project. The groundwater treatment system implemented in Marinette, Wisconsin, utilizes GAC and IX to treat the PFAS. The system also includes pre-treatment for iron, manganese, and total organic carbon (TOC) removal through chemical oxidation using sodium permanganate, and enhanced coagulation. The purpose of the pretreatment is to improve the performance of GAC and IX for PFAS treatment, and reduce the frequency of media changeouts.

Geosyntec is a leader in treating both drinking water and groundwater impacted with PFAS. Geosyntec understands and is experienced in a variety of PFAS treatment technologies, which vary in treatment effectiveness, stage of development, waste generation, and costs. Geosyntec has direct design and implementation experience with technologies that are relatively mature and being implemented in full scale, such as GAC, IX resin and RO. Each of these technologies are recognized as the current standards for treating water streams impacted with PFAS. Geosyntec is the recognized leader in researching, testing, and improving those in various development stages, including the emerging IX resins and novel destructive technologies.

Geosyntec's water and wastewater treatment experts provide our clients with access to a broad range of technical expertise and services related to water assessments, feasibility studies, engineering design, permitting, construction oversight, and pre- and post-construction monitoring and operations. We provide the following full range of water and wastewater consulting and engineering services that demonstrate our understanding of water treatment systems and our ability to interact with the WWW and its Engineers:



- *Waste Minimization*
- *Pilot & Treatability Studies*
- *Water & Wastewater Treatment Plant Design*
- *Corrective Action Plan Implementation*
- *Operations Assistance*
- *Wastewater Collection System Design*
- *Water Balance*
- *Hazardous Waste Management*
- *Hazardous Waste Management*
- *Water Distribution System Management*
- *Collection & Distribution System Studies*
- *Program & Project Management*
- *Construction Supervision and Inspection*
- *Permitting*

Geosyntec has the engineering experience and talent to provide complete water and wastewater treatment engineering services from concept design through detailed design, management of construction, and supervision of operation. We provide consulting, design, and turnkey engineering services on projects ranging from feasibility studies to the design and operations of multi-million-dollar facilities. Our extensive technological capabilities and applications experience provides clients with high-quality single-source engineering solutions to their diverse water and wastewater treatment problems and are well suited for the services being requested by the WWW. Our personnel have evaluated and, where appropriate, implemented appropriate treatment technologies.

The following table provides a focused list of Geosyntec's core process engineering treatment design practitioners that designed a system to treat PFAS-impacted water in Wisconsin. The table presents the core practitioners that will support the WWW and the technologies each practitioner has utilized on projects.

Geosyntec Process Engineering Practitioners for WWW Support

Name	Education	Yrs of Exp.	Licensure	Representative Treatment Technologies																	
				AOP	AS	CA	Chl	CL/S	C/F	CO	CP	DW/SH	Evap	FBR	FO/RO/UF	IX	MF/UF	MBR	MMF	pH	UVOx
Core Treatment Practitioners Anticipated to Contribute to WWW Support (Resumes in Appendix A)																					
Balaji Seshasayee	BS, MS	10	OR	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	
Kirk Craig	BS, MS	25	CO, AZ	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	
*Hamid Amini	BS, MS, PhD	15	CA	X	X		X			X		X	X		X	X		X	X	X	
Unit Operation Abbreviations																					
AOP = Advanced Oxidation Processes; AS = Air Stripping; CA = Carbon Adsorption; Chl = Chlorination; CL/S = Clarification/Settling; C/F = Coagulation and Flocculation; CO = Chemical Oxidation; CP = Chemical Precipitation; DW/SH = Dewatering and Solids Handling; Evap = Evaporators; FBR = Fluidized Bed Reactor; FO/RO/UF = Forward Osmosis/Reverse Osmosis/Ultrafiltration; IX = Ion Exchange; MF/NF = Microfiltration/Nanofiltration; MBR = Membrane Bioreactor; MMF = Multi-Media Filtration; pH = pH Adjustment; UVOx = Ultraviolet Oxidation																					
*Mr. Amini was not involved in the Wisconsin project.																					

2. Has the consultant worked with the WDNR on PFAS removal in drinking water or with PFAS removal for groundwater remediation?

The City of Wausau will be the first Wisconsin municipality to treat PFAS in its potable water supply. Therefore, Geosyntec and other consultants have not worked with the WDNR to remove PFAS from drinking water. Geosyntec, as far as we know, is the **only consultant** that has experience with the WDNR in designing a treatment system to remove PFAS from groundwater. Geosyntec designed a water treatment system based on a conceptual design from another consultant and is currently constructing the system in Marinette, Wisconsin; the construction is well underway and on schedule to begin operation in early summer 2022. Geosyntec worked with the WDNR to rapidly obtain all construction, design, and engineering approvals and permits; and obtain a discharge permit with a precedent setting compliance process. Geosyntec worked with the WDNR for phased approvals of the engineering design so construction could be started as early as possible before the full system was designed.

3. Does the consultant have experience in PFAS removal related to wastewater and biosolids (Class A or Class B)?

Geosyntec has performed PFAS Analysis in biosolids and wastewater at multiple wastewater treatment plants in Georgia and Michigan. As part of the PFAS evaluation, Geosyntec collected and evaluated PFAS data in

biosolids, influent wastewater, and treated effluent water for a municipal client across five of their water resource recovery facilities (WRRFs). Geosyntec further helped the client in decision-making to manage the disposition of their biosolids and effluent treated waters. Geosyntec routinely assists clients with management of liquid and solid waste and has experience managing both non-hazardous and hazardous wastes.

4. What is the consultant's experience in the field of fate and transport of PFAS?

As previously mentioned in Section A, PFAS represent a very challenging family of contaminants given that: (i) most PFAS constituents cannot be detected using conventional analytical techniques, (ii) they are nearly ubiquitous contaminants that tend to be detected at very low concentrations, and (iii) by virtue of their backbone of carbon-fluorine bonds, they, as a class, are very recalcitrant to most typically employed environmental remediation approaches. Remedial options that may address one PFAS constituent may not work for others, and only partial treatment may be achievable. Due to the relative dearth of analytical methods and diversity of PFAS, by-products of treatment may not be detected thus severely complicating the ability to assess their relative risk. Risk-based standards for PFAS in soil and water are extremely low in some states.

As mentioned earlier, Geosyntec is a practice-centered business and we have a nationwide PFAS practice group. Dr. Deeb leads the PFAS practice group and Mr. Seshasayee, Mr. Tracy, Mr. Craig, and Dr. Ensich are active members in the practice. Dr. Deeb is an internationally recognized PFAS expert in the matters of PFAS fate and transport. Her focus on emerging contaminants has promoted awareness and improved the understanding of the sources, occurrence, fate and transport, and behavior of these compounds (including perfluorinated compounds [PFCs], 1,4-dioxane, methyl tertiary butyl ether [MTBE] and other fuel oxygenates, perchlorate, n-nitrosodimethylamine [NDMA], endocrine disrupting chemicals [EDCs], pharmaceuticals and personal care products [PPCPs], in natural and treatment environments.

Additionally, each of the practice group members has experience with evaluating the fate and transport of PFAS either in the natural or treatment environments, or both. Understanding release and deposition mechanisms, and processes that affect chemical transformations and transport, are keys to developing appropriate and effective treatment systems.

5. What proven technologies and emerging technologies for PFAS treatment does the consultant have experience? Either experience in the lab, pilot testing, or testing through full scale temporary treatment of PFAS?

There are limited proven PFAS technologies to treat PFAS. The proven technologies for liquids consist of ex-situ treatment with GAC, IX resin, and RO and in-situ underground injection. Proven technologies for solids include soil removal with management at a licensed disposal facility. Solids may also be incinerated; however, The USEPA considers incineration to be a proven management technology for PFAS-impacted solids. The USEPA is beginning to demonstrate concerns related to air deposition of PFAS due to the potential for incomplete incineration. Geosyntec has extensive experience with the proven technologies identified.

Geosyntec is a leader in the research and development of emerging PFAS-treatment technologies. We receive research funding through the SERDP, ESTCP, and universities. In addition, Geosyntec funds its own research through our Technology Advisory Council (TAC) that was established to fund internal research and development projects. Examples of PFAS research we have been, or are currently engaged in, include the following:

- Demonstration of Smoldering Combustion Treatment of PFAS-impacted Investigation-Derived Waste, SERDP
- Smoldering Combustion Treatment of PFAS-Impacted Soil, SERDP
- Hydrothermal Treatment of PFAS (Columbia School of Mines, Geosyntec), SERDP
- Biochar-Amended Biofilters to Remove PFAS and Other Trace Organics from Stormwater (Geosyntec, Texas Tech, Stanford University), SERDP
- Validation of a UV/TiO₂ Activated Alkaline Media for Destruction of PFAS in Concentrated Liquid Waste Streams (Geosyntec, University of Missouri - Kansas City), SERDP
- Treatability Studies to Enhance PFAS Degradation Using Thermally-Enhanced Persulfate Oxidation (Geosyntec, University of California at Berkeley, Naval Facilities Engineering Command (NAVFAC) Expeditionary Warfare Center (EXWC)), ESTCP
- Development and Application of Injectable Fuels/Adjuncts for In Situ Treatment of PFAS and Co-contaminants in Source Areas by Smoldering Combustion, SERDP
- In-Situ Treatment of PFAS Using D-FAS Technology, SERDP

Descriptions of the emerging technology projects above are included in Appendix B. In addition, Geosyntec routinely partners with, and evaluates third-party vendors' emerging technologies for PFAS treatment.

6. What is the consultant's experience in design of drinking water and wastewater treatment facilities? Specifically, what is the experience in Drinking Water and Wastewater Treatment and working with state and federal regulators?

Geosyntec's water treatment experts have extensive experience with treatment methods for drinking water supply systems and actively participates in collaborative assessments of treatment technologies and management methods for PFAS in drinking water systems. Notable past PFAS project experience includes:

- City of Issaquah, Washington: Municipal water supply treatment using GAC
- Atlantic City Municipal Authority: Evaluation of GAC, IX resin and RO for municipal drinking water supply
- New England, Confidential Municipality: Design/permitting of a drinking water treatment system with GAC
- Water Resources Foundation: GAC, IX, RO, NF

A summary of drinking water system design projects is listed in the Table in Appendix C.

Geosyntec's processing engineering and treatment design professionals have extensive experience interfacing with regulators and the public. We routinely support our clients in regulatory and stakeholder education, outreach, and negotiation. Our success in regulatory liaison and approvals is built on our technical expertise, reputation, and credibility. This technical credibility and mutual respect extend to our relationships with USEPA and State regulators.



The vast majority of projects undertaken by Geosyntec have included public involvement, participation, and stakeholder input. We routinely work collaboratively with our clients to develop Public Outreach Programs specific to client and project needs. Our professionals are experienced in simplifying complex technical issues for presentation to the public in an easily understandable format. We have often transformed community situations that were initially extremely contentious; through our diligent and respectful outreach, we have addressed public concerns and educated citizens. Thus, we have opened new lines of communication and ultimately engendered trust.

7. What is the consultant's experience in corrosion control treatment (CCT) optimization? What methods/chemicals of CCT?

Geosyntec has practical experience developing a holistic approach to evaluating internal corrosion control in water systems. We focus on minimizing lead and copper release to drinking water for Lead and Copper Rule (LCR) compliance while enhancing overall distribution system water quality. In doing so, we incorporate all aspects of corrosion control, including desktop water quality analysis, treatment optimization, scale analysis, pilot-scale pipe loop testing, and design of treatment upgrades.

Corrosion control treatment strategies include pH/alkalinity adjustment and addition of a corrosion inhibitor. From our experience helping various water treatment systems implement or optimize corrosion inhibitors, we have gained a thorough understanding of corrosion inhibitor types, including the many proprietary product offerings, allowing us to efficiently assist utilities with corrosion inhibitor selection and implementation.

Geosyntec's experience optimizing corrosion control treatment includes desktop analysis, investigative tap sampling (sequential sampling), scale analysis, and pilot-scale studies. Consideration of internal corrosion control of other distribution system materials, including cast iron, galvanized iron, and asbestos cement pipe must also be considered to prevent unintended consequences.

8. What is consultants experience in drinking water disinfection using chloramines? What is experience with other disinfection methods?

Geosyntec has experience in drinking water disinfection with chlorine and practical experience with chloramine disinfection. Both chlorine and chloramine are accepted for public water systems. Chlorine remains the dominant disinfection method for public water systems, but in some systems disinfection byproducts (DBPs) can be an issue due to various reasons including things such as long branches with low numbers of users and deadend lines, with both increasing the water age and the potential formation of DBPs.

In many systems that have these concerns, chloramines is becoming more of the disinfectant of choice. Chloramine is less reactive than chlorine and remains in the water longer ensuring adequate disinfection. Another major benefit over chloramines is that they are less reactive with organics that may be present in the water, reducing the formation of DBPs. Chloramine brings additional concerns to the overall system that require evaluation prior to changing from chlorine in that it makes the water more corrosive to the system and

can lead to issues with lead. This is most generally addressed by increasing the concentration of corrosion inhibitors.

The solution for disinfection is dependent upon the specific system and needs to be addressed with an evaluation of the system as part of the treatment system design to determine the disinfection method and if chloramines are selected, close coordination of the design of the corrosion control and disinfection as they are extremely dependent upon each other.

9. What is the consultant's experience in managing PFAS generated waste including reactivation of spent carbon, single use resin, disposal of contact media and/or destruction?

Geosyntec provides operational oversight and management of multiple treatment systems for PFAS removal across the country. At one industrial facility in California, Geosyntec is responsible for the waste management program including tracking, sampling, reporting, maintaining manifests and profiles, and waste audits for waste generated from the treatment system including spent carbon, single use resin, sediment, and backflush waste. Geosyntec works closely with local and national transportation, storage, and disposal facilities (TSDFs) to manage wastes. At other sites, Geosyntec works with carbon vendors on profiling and custom reactivation (thermal reactivation) of spent carbon for reuse in the treatment system. Geosyntec has strong ongoing relationships with the major carbon and ion exchange vendors working on PFAS treatment. As an aside, Mr. Balaji Seshasayee formerly worked for Evoqua Water Technologies (Evoqua), a carbon and resin vendor, and has experience with managing spent carbon and resin from his time at Evoqua.



Section D

Key Personnel

Key Personnel

Team Organization

The Geosyntec Team presented below will be the Team that WWW will be collaborating with on a frequent basis. The selection of our Project Team was developed with a strong local lead as the WWW's Primary Point of Contact, Jeff Tracy, who will be responsible for bringing in subject matter experts based on WWW needs. WWW will benefit from our Subject Matter Experts (SMEs) team which includes experts in the PFAS regulatory processes, fate and transport, and treatment technologies. Our SMEs and staff are committed to being available to WWW to deliver on this project. Full resumes for key staff are included in Appendix A.

Key Personnel Bios

Balaji Seshasayee, PE

Senior Engineer | Chicago, Illinois | P: 312-416-3941

Water Treatment Process Lead



EDUCATION

- ◆ M.S., Public Policy, University of Chicago
- ◆ M.S., Civil & Environmental Engineering, Carnegie Mellon University, PA
- ◆ B.Tech., Chemical Engineering, Anna University, India

REGISTRATIONS

- ◆ Professional Engineer, Oregon

AREAS OF EXPERTISE

- ◆ Water/Wastewater Treatment
- ◆ Process Engineering and Design
- ◆ Technology Evaluation
- ◆ Groundwater Remediation

Mr. Seshasayee is experienced in treatment system design, treatability testing and oversight, project execution, operations support and troubleshooting. He is also knowledgeable in technology evaluation, process engineering and design, and engineering drawing and document creation for clients in a variety of industries. Mr. Seshasayee has designed several treatment systems at complex sites for emerging contaminants such PFAS and 1,4 dioxane for federal, industrial, and municipal clients. He has conducted and overseen several pilot and bench scale treatability studies to develop treatment designs. He has also designed multiple treatment systems for potable use for municipalities, focusing on removal of contaminants such as nitrate, uranium, hexavalent chromium, perchlorate and chlorinated organics from well water. **Mr. Seshasayee is the lead process design engineer for the Tyco Fire Technology Center PFAS groundwater treatment system in Marinette, Wisconsin.**

Rula Deeb, PhD, BCEEM, PMP

Senior Principal | Oakland, California | P: 510-285-2676

Subject Matter Expert PFAS



EDUCATION

- ◆ Ph.D., Civil & Environmental Engineering, UC Berkeley
- ◆ M.S., Civil & Environmental Engineering, UC Berkeley
- ◆ B.A., Chemistry & Mathematics Warren Wilson College

REGISTRATIONS & CERTIFICATIONS

- ◆ Board Certified Environmental Engineering Member
- ◆ Project Management Professional

AREAS OF EXPERTISE

- ◆ Emerging Contaminants Management
- ◆ Research & Development
- ◆ Due Diligence Assessments
- ◆ Geologic & Hydrogeologic Evaluations

Dr. Rula Deeb, BCEEM, PMP, is a Senior Principal at Geosyntec whose technical expertise includes the cross-media fate and transport of contaminants and the remediation of complex soil and groundwater sites impacted by non-aqueous phase liquids (NAPL). Her focus on emerging contaminants has promoted awareness and improved the understanding of the sources, occurrence, fate and transport, and behavior of these compounds (including PFAS, 1,4-dioxane, methyl tertiary butyl ether [MTBE] and other fuel oxygenates, perchlorate, n-nitrosodimethylamine [NDMA], endocrine disrupting chemicals [EDCs], pharmaceuticals and personal care products [PPCPs], in natural and treatment environments. Dr. Deeb's doctoral research focused on substrate interactions of gasoline aromatics and oxygenates. As a post-doctoral fellow, she developed and implemented research programs in collaboration with scientists and engineers at other universities, consulting firms, and the United States Air Force on the remediation of sites impacted with contaminant mixtures. **Dr. Deeb is the Technical Advisor for the Tyco Fire Technology PFAS groundwater treatment system in Marinette, Wisconsin.**

Kirk Craig, PE

Senior Principal | Phoenix, AZ | P: 480-544-7221

Treatment System Design and Construction



EDUCATION

- ◆ M.S., Environmental Science and Engineering, Colorado School of Mines
- ◆ B.S., Zoology, Undergraduate Environmental Engineering Studies, University of Florida

REGISTRATIONS & CERTIFICATIONS

- ◆ Professional Engineer, CO and AZ

AREAS OF EXPERTISE

- ◆ Groundwater Treatment System Design
- ◆ Emerging Contaminants (PFAS)
- ◆ Remediation Construction Management
- ◆ Environmental Permitting

Mr. Craig has over 25 years of professional consulting experience with a focus on providing technical and project management support to clients in the U.S. with the assessment and remediation of a variety of sites throughout the United States. His environmental engineering experience includes the design, construction, optimization, and operation of well over a 100 remedies using a variety of innovative and cutting-edge technologies. This includes notable experience treating various recalcitrant and emerging contaminants such as PFAS, 1,4-dioxane and perchlorate. Mr. Craig serves as Geosyntec's project director for the Davis Monthan and Cannon Air Force Bases (AFBs) PFAS investigations and provides senior-level engineering support for the PFAS investigation activities at the Nellis and Creech AFBs, as well as the Morris Air National Guard Base. **Mr. Craig is the Project Director for the Tyco Fire Technology Center groundwater PFAS treatment system in Marinette, Wisconsin.**

Hamid Amini, PhD, PE

Principal | Huntington Beach, California | P: 714-465-1261

Municipal Water System Treatment



EDUCATION

- ◆ Ph.D., Environmental Engineering, University of Central Florida
- ◆ M.S., Environmental Engineering, Iran University of Science & Technology
- ◆ B.S., Civil Engineering, Iran University of Science & Technology

REGISTRATIONS & CERTIFICATIONS

- ◆ Professional Engineer, California No. C85896
- ◆ 40-HR OSHA HAZWOPER

AREAS OF EXPERTISE

- ◆ Water/Wastewater Management Process Engineering
- ◆ Water/Wastewater Conveyance Systems
- ◆ Civil & Environmental Engineering
- ◆ Construction Management
- ◆ Renewable Energy Generation

Dr. Amini, PE is a Principal at Geosyntec with over 17 years of experience in design and construction of water and wastewater treatment systems. He has served as Project Director or Project Manager on several feasibility studies, treatability testing, design, and construction support/oversight of potable water, wastewater, and stormwater projects in the Western United States. Dr. Amini also has extensive experience in permitting support, compliance monitoring, energy sustainability studies, and construction quality assurance services.

Jeff Tracy, PG

Senior Geologist | Milwaukee, WI | P: 414-918-7481

Wisconsin Regulations



EDUCATION

- ◆ B.S., Geology, University of Wisconsin, Milwaukee

REGISTRATIONS & CERTIFICATIONS

- ◆ Professional Geologist, Wisconsin

AREAS OF EXPERTISE

- ◆ Groundwater Remediation
- ◆ Emerging Contaminants (PFAS)
- ◆ Environmental Portfolio and Project Management
- ◆ Wisconsin Regulations and Permitting

Mr. Tracy is a Licensed Professional Geologist with 30 years of experience in environmental project management, primarily in the practice of owner's representation for site and portfolio management; site closure strategy review and development; soil and groundwater quality investigation and remediation; spill response and management; vapor intrusion assessment; demolition planning and management; and brownfields redevelopment. Provided value added services for projects at oil refineries, railroad facilities, municipal sites, and a variety of manufacturing and commercial facilities. Mr. Tracy is well-versed in Wisconsin's regulatory climate, especially with regard to PFAS, and permitting processes, and an experience project manager. **Mr. Tracy is the Project Manager for the Tyco Fire Technology Center groundwater PFAS treatment system in Marinette, Wisconsin.**

Mary Enschede, PhD

Senior Staff Professional | Milwaukee, WI | P: 414-918-7493

PFAS Destructive Technologies



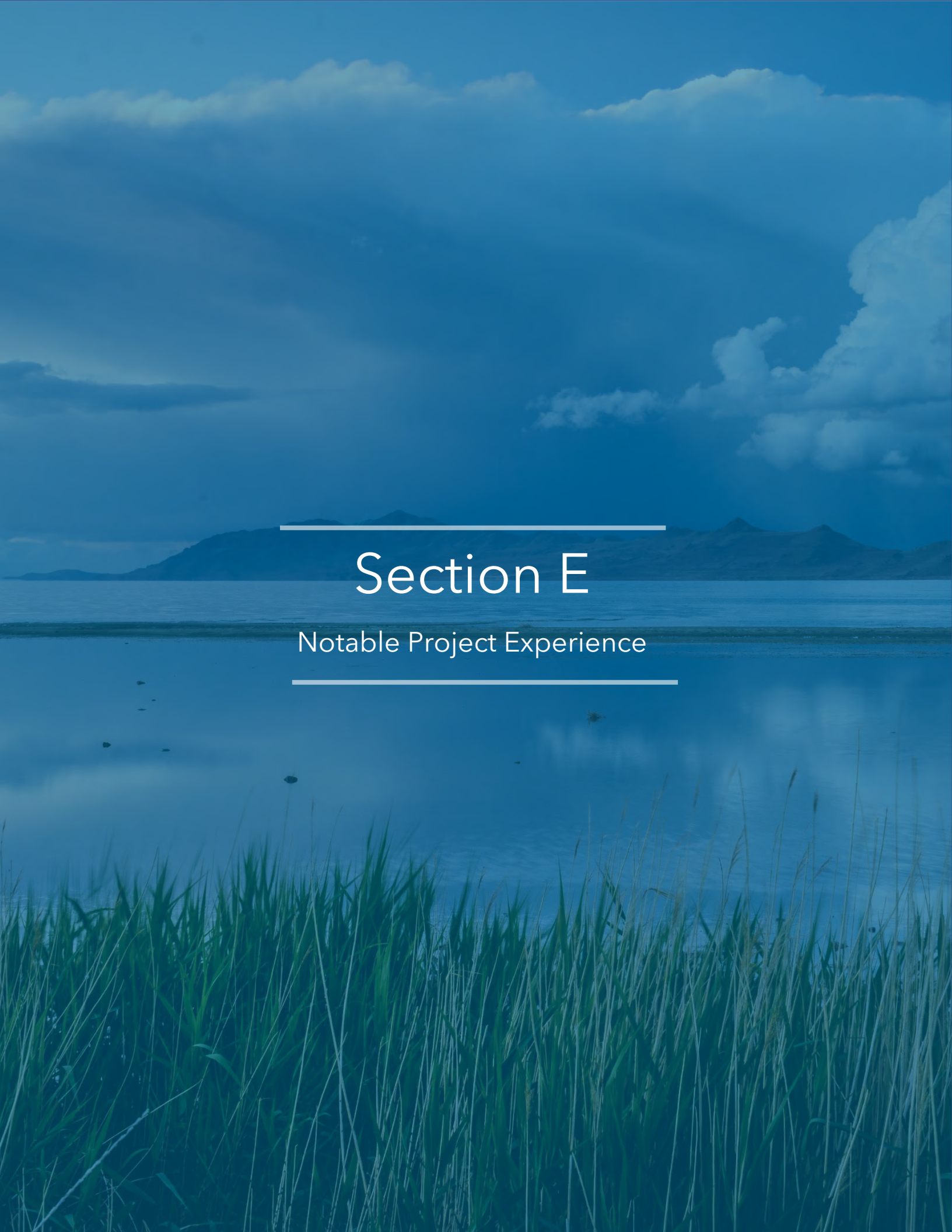
EDUCATION

- ◆ Ph.D., Chemical Engineering, Michigan State University
- ◆ B.S., Chemical Engineering, Michigan State University

AREAS OF EXPERTISE

- ◆ PFAS
- ◆ Electrochemical oxidation and sensing
- ◆ Environmental permitting

Dr. Enschede is a Senior Staff Professional with Geosyntec Consultants in the Milwaukee, Wisconsin office. Her expertise is in the mineralization of per- and polyfluoroalkyl substances (PFAS) using electrochemical destruction. She focused on PFAS presence in complex solutions such as landfill leachate or following a preconcentration method such as ion exchange. In addition, she has worked on biological and heavy metal sensing using electrochemical methods. Dr. Enschede is responsible for providing support on a variety of remediation services, focusing on PFAS projects in the Great Lakes Region. **Dr. Enschede is the Permit Manager and a technical resource for the Tyco Fire Technology Center groundwater PFAS treatment system in Marinette, Wisconsin.**



Section E

Notable Project Experience

Notable Project Experience

The projects included below illustrate our experience and qualifications in the areas of most interest to the WWW. They illustrate our experience in performing similar scopes of work related to conducting engineering alternative evaluations and implementing treatment systems for removal of PFAS and other contaminants, in Wisconsin and throughout the U.S. We approach each project with years of experience but at the same time with an understanding that each project has a unique set of circumstances and success factors. We strive to identify areas where innovation will lead to successful projects that save total project time and reduce short-term and/or long-term costs.

Groundwater Treatment for PFAS - Marinette, Wisconsin



CLIENT

Tyco Fire Products

SERVICES PROVIDED

- Treatment Technology Evaluation
- Bench Scale Testing
- Treatment System Design
- Regulatory Permitting and Approvals
- System Construction
- City Council, Regulatory Agencies & Stakeholders Interface

Tyco Fire Products (Tyco) operates an aqueous film forming foam research and development and a fire training facility in Marinette, Wisconsin. PFAS were detected in groundwater samples collected on and around the property. Groundwater discharges to a downgradient surface water drainage ditch. Tyco retained Geosyntec to design, construct, and commission a groundwater extraction and treatment system (GETS) to intercept groundwater before it discharges to the ditch, treat the captured water, and reintroduce the treated water to the ditch.

Geosyntec reviewed the conceptual design prepared by another consultant and determined the proposed treatment was appropriate, but additional pre-treatment would be required. Following the evaluation, Geosyntec designed the groundwater treatment system that consists of two parallel trains of six vessels (12 total) for GAC treatment followed by two vessels for ion exchange treatment. The system includes duplicate trains to minimize down-time during maintenance and optimize operational flexibility. Geosyntec designed the system and applied for and received approvals using a collaborative approach with the City and regulatory agencies. In particular, Geosyntec worked with the Wisconsin Department of Natural Resources to approve the design in phases so construction could begin before the design was complete. The system is currently under construction and will be operational in summer 2022.

Proposed team members for the WWW project, Balaji Seshasayee, Rula Deeb, Kirk Craig, Jeff Tracy, and Mary Ensich, are key members of this effort.

PFAS Municipal Drinking Water - Issaquah, Washington



CLIENT

City of Issaquah, Washington

SERVICES PROVIDED

- Wellfield Treatment Evaluation
- Monitoring Well Installation
- Groundwater Modeling
- City Council, Regulatory Agencies & Stakeholders Interface

The City of Issaquah is one of the first in the U.S. to initiate a treatment and source identification program in response to detections of PFAS in their wellfield. PFAS was found at high concentrations in a primary production well via EPA's 2012 UCMR-3 sampling program. The affected well was immediately taken off-line, but to maintain water supply during summer peaking, the City initiated a fast-track treatment and characterization program with extensive public outreach and notification. Geosyntec evaluated long-term water supply and treatment options and presented technical results and issues to stakeholders.

Geosyntec supported the City's engineering staff with an evaluation of long-term and short-term treatment alternatives. This included an assessment of pumping rates and water-levels in both the affected well and an adjacent unaffected well completed in a deeper aquifer. We found that the vertical gradients between the two wells were highly sensitive to their relative typical pumping cycles and rates. The City decided to install a skid-mounted GAC system, consisting of two 20,000-pound vessels capable of treating both the affected well and the adjacent deeper well. The initial response to install treatment was completed in six months through a transparent and collaborative approach with the City, affected stakeholders, and regulatory agencies led by Geosyntec. The City faced several difficult situations throughout the project, including a lowering of the advisory level for PFOS in 2016, in the midst of the treatment, and increasing PFAS levels in their deeper well. These situations were addressed clearly and consistently by Geosyntec, bringing a variety of resources to support the City as appropriate. The City and Geosyntec jointly presented this work at a national public works conference in 2019.

Design and Permitting PFAS Drinking Water Treatment System - New England



CLIENT

Confidential Municipality

SERVICES PROVIDED

- Drinking Water Treatment System Design and Permitting
- Construction Oversight
- Regulatory Negotiation

In early 2019, a municipality in New England detected PFAS in a public drinking water supply well above the USEPA Health Advisory of 70 parts per trillion (ppt). The town's Department of Public Works (DPW) subsequently shut down the impacted water supply well. Geosyntec was retained to design, permit, and oversee the construction of a one million gallon-per-day (MGD) treatment system to remove PFAS from the water supplied by the impacted well. Geosyntec fast-tracked the design and permitting of a GAC treatment system to remove PFAS from the water supplied by the well. We designed the treatment system in approximately three weeks, and a state permit for the system construction was approved approximately one week later. Geosyntec worked closely with a foundation contractor and various treatment system vendors to accelerate the construction schedule, optimizing the foundation configuration to reduce the time required to build the concrete formwork. Our design called for high-strength concrete so the foundation pad could support the 200-ton treatment system with just one week of curing time. This allowed system start-up to occur by early summer. The treatment system is reducing the concentrations of PFAS in the treated water to below the laboratory detection limit of 2 ppt. Our technical reputation and ability to work cooperatively with the stakeholders throughout the design and construction phases were critical to completing this project.

LPVCWD Groundwater Treatment System for Nitrate Removal - Baldwin Park, California



CLIENT

La Puente Valley County Water
District (LPVCWD)

SERVICES PROVIDED

- Groundwater Treatment
- Feasibility Study
- Technology Evaluation
- Blending Analysis
- Conceptual Cost Estimate
- Strategic Planning
- Funding Analysis
- Multi-Agency Coordination

LPVCWD operates a Groundwater Treatment Facility as part of the Baldwin Park Operable Unit within the San Gabriel Valley Superfund Site. While the Facility treats the groundwater for the removal of other analytes, including VOCs, perchlorate, and 1,4-dioxane. Treated groundwater is delivered to the drinking water distribution system for the public service area. With the nitrate concentration in the wells approaching its Maximum Contaminant Level (MCL), the client hired Geosyntec to evaluate viable treatment technologies for treatment of nitrate, including several types of ion exchange systems. Geosyntec developed evaluation criteria and a ranking system to assess the feasibility of each treatment technology's ability to consistently and efficiently remove nitrate. The treatment technologies were analyzed for operational complexity, financial feasibility, and other evaluation criteria. A blending model was developed in collaboration with LPVCWD and the ion exchange vendors to assess the operating conditions (e.g., flowrate) for the treatment system. Geosyntec provided preliminary cost estimate for procuring and constructing the nitrate treatment system, and potential operation and maintenance costs. Geosyntec assessed potential loan and funding opportunities and streamlined the client's application process for the Drinking Water State Revolving Fund (DWSRF). Geosyntec coordinated with several agencies to identify permitting requirements and plan for the required permitting application processes. Geosyntec also prepared an integrated implementation schedule, including schedule for engineering design, permitting application processes, construction, and start-up and commissioning. Geosyntec is currently assisting LPVCWD with engineering design and permitting for the selected nitrate treatment alternative.



Appendix A

Key Personnel Resumes

BALAJI SESHASAYEE, P.E.

**groundwater remediation
industrial wastewater treatment
process engineering and design**

EDUCATION

Master's in Public Policy, University of Chicago, IL

M.S., Civil & Environmental Engineering, Carnegie Mellon University, PA

B.Tech., Chemical Engineering, Anna University, India

REGISTRATIONS

Professional Engineer: Oregon P.E. License No. 91635PE

CAREER SUMMARY

Mr. Seshasayee is an environmental engineer and a registered professional engineer in the state of Oregon, with more than ten years of experience in water/wastewater treatment. He is experienced in treatment system design, treatability testing and oversight, project execution, operations support and troubleshooting. He is also knowledgeable in technology evaluation, process engineering and design, and engineering drawing and document creation for clients in a variety of industries.

Mr. Seshasayee has designed several treatment systems at complex sites for emerging contaminants such as per- and polyfluoroalkyl substances (PFAS) and 1,4 dioxane for federal, industrial, and municipal clients. He has conducted and overseen several pilot and bench scale treatability studies to develop treatment designs. He has also designed multiple treatment systems for potable use for municipalities, focusing on removal of contaminants such as nitrate, uranium, chrome (VI), perchlorate and chlorinated organics from well water.

Additionally, Mr. Seshasayee has commissioned and provided operations training for several large integrated water treatment systems.

RELEVANT EXPERIENCE

Treatment System for 1,4-dioxane Destruction for Contaminated Site, Massachusetts. Mr. Seshasayee was responsible for developing and overseeing the pilot testing and subsequently designing a groundwater pump and treat system to remove iron, manganese and 1,4-dioxane. The design utilized proprietary media solution for iron and manganese removal followed by Advanced Oxidation Process (AOP) for 1,4 dioxane destruction. The system also incorporated a waste recovery system to comply with zero waste requirements. Mr. Seshasayee was also involved in developing performance standards and operations support for this project.

Treatment System for PFAS removal from Contaminated Site, Midwest US. For a confidential client in the Midwest US, Mr. Seshasayee is leading the design of a 300 gallon per minute (gpm) groundwater extraction and treatment system (GETS) for remediation of PFAS contaminated

groundwater. He led the design and oversight of treatability testing for pretreatment and column testing for PFAS removal. He also leads the precedent setting permitting effort for discharge of treated effluent. The treatment system currently in construction, consists of pretreatment, granular activated carbon (GAC) ion exchange (IX) resin for PFAS treatment and sludge dewatering system to manage solids, and will be housed in a pre-engineered metal building.

Design of a GWTS for Pesticides, VOCs, SVOCs and Arsenic, Maryland Mr. Seshasayee led the process design team for a groundwater extraction and treatment system (GWTS) to provide hydraulic capture of fractured bedrock/karst aquifer containing pesticides, VOCs, SVOCs, arsenic, iron, manganese, and other metals. The treatment system, currently in construction, will be comprised of the following unit operations: i) aeration/oxidation and crossflow filtration (down to 0.02 microns) for removal of arsenic, iron, manganese, and suspended solids, ii) arsenic/manganese specific adsorption media for metals polishing, iii) granular activated carbon (GAC) for removal of pesticides, VOCs, and SVOCs, and iv) a sludge dewatering system to manage solids generated from the aeration/oxidation and crossflow filtration operations.

Treatment System for Uranium Removal for Contaminated Site, Ohio. Mr. Seshasayee led the design for a 250 gpm treatment system to remove uranium from contaminated groundwater. The system included pretreatment and proprietary uranium selective ion exchange resin. Mr. Seshasayee was also involved in developing performance standards and contract negotiations for this project.

Treatment System for TOC and PFAS Removal for Groundwater, New Hampshire. Mr. Seshasayee led the treatment system design to remove total organic carbon (TOC) and PFAS at a federal site. The system utilized GAC for TOC removal and specialty resin for PFAS removal. He was also involved in developing performance standards and contract negotiations for this project.

Wastewater Treatment System for Semiconductor Manufacturer, California. Mr. Seshasayee was responsible for designing a wastewater treatment system capable of removing fluoride from rinse water from the manufacturing process to meet low effluent discharge limits. The design involved physical-chemical precipitation followed by filtration. To support design activities, Mr. Seshasayee developed and managed bench scale testing. He was also involved in startup support and troubleshooting for the treatment system.

Wastewater Treatment System for Aircraft Maintenance Facility, Texas. Mr. Seshasayee designed a wastewater treatment system capable of removing chrome (VI) from rinse water from an aircraft repainting facility to meet low effluent discharge limits. The design involved a two-step physical-chemical precipitation followed by a solids handling system. He was also involved in startup support and troubleshooting for the treatment system.

Wastewater Treatment System for Semiconductor Facility, Texas. Mr. Seshasayee designed a wastewater treatment system capable of removing hydrogen peroxide and dissolved copper from the manufacturing process to meet effluent discharge limits. The design involved physical-chemical precipitation followed by granular activated carbon and adsorptive media for peroxide

and copper removal. To support design activities, he designed and managed onsite pilot testing, startup support and troubleshooting for the treatment system.

Onsite Pilot testing for Silica Removal from Surface Water, Idaho. Mr. Seshasayee led onsite pilot testing to remove silica for surface water. The process involved conducting bench scale tests to determine the chemical dosing program necessary to optimize silica removal. Based on the bench scale tests, he then implemented the design on the full-scale system.

PFAS removal from well water, Massachusetts. Mr. Seshasayee developed process design, engineering drawings and performance criteria for a large well water treatment project for PFAS removal for potable use. The treatment design included pretreatment filters and specialty resin. He was also involved in contract negotiation and project execution for this project.

Nitrates removal from well water for multiple sites, Arizona. Mr. Seshasayee developed process design and engineering drawings and documents for multiple well water treatment projects for nitrate removal for potable use. The design included an integrated onsite regeneration and rinse recovery system using regenerable resin. He was also involved in contract negotiation and project execution for these projects.

Iron, Manganese and Arsenic removal from well water, California. Mr. Seshasayee developed process design, engineering drawings and documents for a well water treatment project for iron, manganese, and arsenic removal for potable use. The design included regenerative and adsorptive media for treatment. He was also involved in project execution, and operations support for this project.

PROFESSIONAL EXPERIENCE

Geosyntec Consultants, Inc., Chicago, Illinois, 2019-present
Evoqua Water Technologies LLC, Chicago, Illinois, 2014-2019
Aquatech International Corporation, Pittsburgh, Pennsylvania, 2011-2014

AFFILIATIONS

American Water Works Association (AWWA)

RULA DEEB, Ph.D., BCEEM, PMP

**PFAS, and other emerging contaminants
strategic consulting
litigation support/expert witness
site investigation and characterization
remedial strategy development
applied research
water quality**

EDUCATION

Ph.D., Civil and Environmental Engineering, University of California, Berkeley, 1999

M.S., Civil and Environmental Engineering, University of California, Berkeley, 1994

B.A., Chemistry and Mathematics, Warren Wilson College, Swannanoa, North Carolina, 1991

REGISTRATIONS AND CERTIFICATIONS

Board Certified Environmental Engineering Member (BCEEM)

Project Management Professional (PMP)

CAREER SUMMARY

Dr. Rula Deeb's technical expertise includes the cross-media fate and transport of contaminants and the remediation of complex soil and groundwater sites impacted by non-aqueous phase liquids (NAPL). Her focus on emerging contaminants has promoted awareness and improved the understanding of the sources, occurrence, fate and transport, and behavior of these compounds (including per- and polyfluoroalkyl substances (PFAS)), 1,4-dioxane, methyl tertiary butyl ether [MTBE] and other fuel oxygenates, perchlorate, n-nitrosodimethylamine [NDMA], endocrine disrupting chemicals [EDCs], pharmaceuticals and personal care products [PPCPs], and others) in natural and treatment environments. Dr. Deeb's doctoral research focused on substrate interactions of gasoline aromatics and oxygenates. As a post-doctoral fellow, she developed and implemented research programs in collaboration with scientists and engineers at other universities, consulting firms, and the United States Air Force on the remediation of sites impacted with contaminant mixtures. Her research has been recognized with awards from the National Science Foundation, United States Environmental Protection Agency (USEPA), Water Environment Federation, American Society of Civil Engineers, American Association of University Women, Air and Waste Management Association, American Chemical Society, and American Society for Microbiology. Dr. Deeb was also selected as a National Science Foundation Engineering Education Scholar for Excellence in Engineering Education.

Dr. Deeb is heavily engaged in the National Academy of Engineering Frontiers of Engineering program, which brings together emerging engineering leaders from industry, academia, and government to discuss pioneering technical work and leading-edge research in various engineering fields and industry sectors. She is the recipient of the 2008 Berkeley Engineering Innovation Young Outstanding Leader Award and the 2019 Association for Women Geoscientists

President's Award. She was recently inducted into Berkeley's Civil and Environmental Engineering Academy of Distinguished Alumni.

In addition to actively leading PFAS projects across the United States, Canada, and Australia, Dr. Deeb is heavily involved in research and development programs to design and advance practical and cost-effective remedial solutions and inform best-value management strategies for PFAS. She routinely provides litigation support services, including forensic investigations, source identification, and expert opinions regarding PFAS fate and transport, exposure, health effects, and other adverse outcomes as well as cost allocation and remedial cost estimates. In addition, Dr. Deeb has strongly advocated for advancing the state of knowledge on PFAS by organizing webinars and conferences with a strong PFAS focus, including The Remediation Summit (RemTEC) (2011 – 2019) and the Emerging Contaminants Summit (2016, 2018, 2020). In addition, she served on the organizing committee of a National Academies of Sciences, Engineering and Medicine workshop titled "Understanding, Controlling, and Preventing Exposure to PFAS" in September 2019.

Select highlights of Dr. Deeb's current and former assignments include the following projects.

Per- and Polyfluoroalkyl Substances (PFAS) and Other Emerging Contaminants

PFAS Investigation Work Plans at 14 California Landfills in Response to State Water Board Order WQ 2019-0006-DWQ, Republic Services, Multiple Locations. Dr. Deeb is the project director in planning PFAS investigations of groundwater and landfill leachate at 14 landfills in response to an investigative order from the California State Water Quality Control Board. She is overseeing the preparation of 14 site-specific work plans as well as a detailed sampling and analysis plan. Geosyntec is also tasked with providing quality control during work plan implementation and reporting, conducting field sampling at select sites, preparing final reports, and supporting the client with regulatory interactions.

PFAS Investigation Work Plan at a Southern California Airport in Response to State Water Board Order WQ 2019-0006-DWQ, Confidential Client, California. Dr. Deeb is a technical advisor for the preparation of a PFAS investigation work plan for a major airport in Southern California. Her technical expertise informed the assessment of likely aqueous film-forming foam (AFFF) storage and release areas, selection of field investigation techniques and equipment to minimize potential cross-contamination, and preparation of a PFAS sampling and analysis plan. Geosyntec plans to complete the field investigation following regulatory approval of the work plan.

Phased PFAS Investigation Work Plan, Confidential Client, Southern California. Dr. Deeb is the project director for assessing the potential presence of PFAS in shallow soils and groundwater at a property formerly used by the United States military and currently slated for redevelopment and residential and commercial use. Under her direction, Geosyntec reviewed readily available documents pertaining to historical operations and land use in the vicinity of the site, recommended sampling and analysis for PFAS, and prepared a work plan. Geosyntec plans to complete the field investigation and prepare a brief summary report.

Standard Operating Procedures for PFAS Sampling and Analysis, NASA Kennedy Space Center, Florida. Dr. Deeb provided technical review and direction in the preparation of a set of standard operating procedures (SOPs) for PFAS investigation. SOPs incorporate recommendations and best practices from state regulatory guidance documents, experienced commercial laboratories, and Geosyntec's experience conducting PFAS sampling. SOPs were prepared for conducting the following site activities: potable water sampling, groundwater elevation monitoring, groundwater sampling, direct push technology (DPT) soil sampling, DPT groundwater sampling, surface water sampling, sediment sampling, and investigation-derived waste (IDW) sampling. SOPs were implemented at the former NASA Kennedy Space Center PFAS investigation. SOPs are general and can also be used to guide PFAS investigations at other NASA facilities.

Evaluation of Site Assessment and Remediation from the Perspective of Potential Presence of PFAS, Confidential Client, Multiple Locations. Dr. Deeb was the technical director for an assessment at five sites where environmental investigation and remediation activities are ongoing. She prepared site-specific summaries to inform plans for additional environmental assessment, remediation, and/or management from the perspective of the potential presence of PFAS and identified opportunities at each site to adjust or modify activities to address PFAS, should they be found to occur in the environment.

Defense of Class Action Claim, PFAS Detections in Public and Private Water Supplies, Confidential Client, Colorado. Dr. Deeb was one of multiple Geosyntec PFAS experts retained for litigation support and data analysis to provide an independent review of litigation-related materials, expert reports, and site-specific reports related to AFFF and other PFAS sources, fate and transport, and potential exposure pathways.

PFAS Investigation in Surface Water and Groundwater at a Former Landfill, Confidential Client, Alabama. Dr. Deeb provided insights to the overall scope and procedures for investigating PFAS concentrations in surface water and groundwater at a former landfill. She recommended sampling locations based on a review of site documents and multiple potential sources of PFAS in the area, and recommended sampling and analytical methods and quality assurance/quality control (QA/QC) procedures.

Landfill Biosolids and Leachate Sampling and PFAS Analysis, Confidential Client, Michigan. Dr. Deeb served as the director of a project involving the design and implementation of sampling programs for PFAS in biosolids and landfill leachate at two Michigan landfills. She led the preparation of Sampling and Analysis Plans incorporating best practices, designed a QA/QC program, coordinated with analytical laboratories, and updated the client on results and implications.

Lines of Evidence to Assess the Effectiveness of PFAS Remedial Technologies, Strategic Environmental Research and Development Program (SERDP), Washington D.C. Dr. Deeb is the project director of a SERDP-funded project to prepare guidance for United States Department of Defense regarding lines of evidence to assess the effectiveness of PFAS remedial technologies.

Proponents of several innovative treatment technologies have claimed success in removing or destroying PFAS. However, removal mechanisms are often not understood, byproducts may not be measured, and the technology effect on other components in AFFF mixtures may be unknown. To improve return on investment and guide future investments in PFAS treatment technologies, this project will provide SERDP and others with practical decision tools, metrics, and guidance to inform the evaluation of PFAS treatment.

Field Demonstration to Enhance PFAS Degradation and Mass Removal Using Thermally-Enhanced Persulfate Oxidation Followed by Pump-and-Treat, Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP), Multiple Locations. Dr. Deeb is serving as the co-principal investigator of a three-year field study to demonstrate an in-situ technology to fully oxidize perfluorooctanoic acid (PFOA), other perfluorinated carboxylic acids (PFCAs), and PFCA precursors. These compounds are often present in AFFF formulations released to the environment at fire training facilities. This innovative, laboratory-proven technology uses thermally-enhanced persulfate at low pH. The field demonstration will provide insights into treatment efficacy as a function of pH, persulfate concentration, and aquifer geochemistry and will yield practical information for estimating life-cycle costs, treatment timeframes, and overall recommendations.

Frequently Asked Questions on PFAS, SERDP and ESTCP, Multiple Locations. Together with Oregon State University and the Colorado School of Mines, Dr. Deeb developed a document to provide remedial project managers and other stakeholders with a concise summary on the state of knowledge regarding PFAS as related to the use and release of AFFFs at United States military sites. Eight frequently-asked questions are addressed in this document (see <https://www.serdp-estcp.org/content/download/46353/431598/file/FAQ>).

PFAS-Focused Remedial Investigation (RI), Former Plattsburgh Air Force Base, New York. Together with prime contractor Ahtna Engineering Services, LLC, Geosyntec leads the characterization of the nature and extent of PFAS contamination in and around Plattsburgh Air Force Base, which potentially resulted from releases of AFFF. The goals include delineating dissolved PFAS plumes in groundwater that may impact groundwater used as drinking water. Gaining a greater understanding of the plumes potentially leaving the former installation, particularly bounding impacts to receptors or receiving waters both horizontally and vertically, is critical. The information that is collected during the field activities will be added to historical data and developed into a PFAS conceptual site model (CSM), then summarized and evaluated in a focused RI report. An updated groundwater model will be developed to assist in understanding PFAS migration. A Human Health Risk Assessment (HHRA) focused on the drinking water pathway, as well as a limited Feasibility Study (FS), will also be conducted. If required, a connection of a private drinking water well to the public drinking water supply and/or a whole home treatment system may be installed.

PFAS Sampling of Municipal Water Supply Wells, Confidential Client, Issaquah, Washington. Dr. Deeb reviewed PFAS sample collection protocols and analytical results from sampling municipal water supply wells. She contributed technical expertise to the plan to collect

confirmation samples, analyze split samples, and compare laboratory quantitation methods for branched-chain PFAS. She recommended a laboratory protocol for future sampling events.

State-of-the-Science Report: Per- and Polyfluoroalkyl Substances, Confidential Manufacturing Client, Multiple Locations. Dr. Deeb developed a detailed and comprehensive state-of-the-science review of PFAS. Topics covered included a detailed review of historical and current sources, products and uses, environmental fate and transport, toxicity, considerations for site investigations and conceptual site model development for PFAS-impacted sites, and recent developments in treatment technologies. The effort included a focus on PFAS associated with AFFF uses at airports and other industrial facilities, as well as a prospective evaluation of future AFFF best management practices and potential liabilities associated with current PFAS usage.

Development of a Real-Time Field Screening Tool for Perfluorooctanesulfonic Acid (PFOS) and PFOA, Eurofins Scientific, Multiple Locations. Dr. Deeb collaborated with Eurofins Scientific to develop a real-time inexpensive field screening tool to detect PFOS and PFOA in groundwater at sub-part per billion concentrations.

Site Characterization of PFAS-Impacted Sites at Two Air Force Bases, United States Air Force Civil Engineer Center (AFCEC), Cape Canaveral Air Force Station and Barksdale Air Force, United States. Dr. Deeb conducted site characterization activities at several areas where AFFF were used. Data were used to evaluate the fate and mobility of a full suite of PFAS. The project objectives included evaluating PFAS occurrence in soil and groundwater because of different types of operations, and the influence of co-contaminants and geochemistry on PFAS fate and transport. The results were used to inform a management approach for PFAS at these sites, and to understand better the fate and transport of PFAS in different environments.

Bioremediation as Relevant Attenuation Mechanism for PFAS, AFCEC, Los Angeles, California. In collaboration with the University of California at Los Angeles, Dr. Deeb evaluated the biodegradability of a range of PFAS. The project objectives included identifying and screening a variety of anaerobic bacteria, aerobic bacteria, and fungi capable of degrading PFAS through reductive defluorination or oxidative mechanisms. Samples collected from several field sites were tested for similar microorganisms and enzymatic activity. Laboratory work involved testing pure cultures and setting up microcosm studies under controlled conditions. The project team prepared a white paper summarizing the state of knowledge and ongoing research studies on the biodegradation of PFAS.

State of Knowledge Reports on PFAS, Confidential Client, Multiple Locations. Dr. Deeb co-authored a United States Naval Facilities Engineering Command (NAVFAC) technical report summarizing the state of practice for PFAS treatment, prepared a “Remediapedia” wiki-article summarizing PFAS occurrence, fate and transport, and treatment, and reviewed other summary reports on PFAS fate and transport and frequently asked questions.

REPRESENTATIVE PROFESSIONAL ACTIVITIES

Interstate Technology Regulatory Council

Dr. Deeb has contributed extensively to ITRC, a public-private coalition that produces documents and training to broaden and deepen technical knowledge and expedite quality regulatory decision-making while protecting human health and the environment. ITRC achieves its mission through its technical teams, which are composed of environmental professionals, including state and federal environmental regulators, federal agency representatives, industry experts, community stakeholders, and academia.

ITRC PFAS Team, Multiple Locations. As a team member, Dr. Deeb co-authored seven fact sheets and a technical and regulatory guidance document on PFAS. She is also conducting training on PFAS technical and regulatory issues for state regulators across the United States.

ITRC Industry Affiliates Program (IAP), Multiple Locations. Dr. Deeb represents Geosyntec as a member of the ITRC Industry Affiliates Program. She coordinates the involvement of Geosyntec representatives on ITRC expert teams on various remediation topics, highlighting the expertise of Geosyntec staff as nationwide experts contributing to state regulatory policies on emerging technologies and remediation practices of national interest.

Other Professional Activities

PFAS Expert Workshops, Multiple Locations. Dr. Deeb planned and facilitated three roundtable meetings among PFAS experts to collaboratively share key findings of ongoing research projects and collectively identify key research needs (2011, 2012, and 2014).

PROFESSIONAL EXPERIENCE

Geosyntec Consultants, Oakland, California, 2013 – Present

ARCADIS, Emeryville, California, 2011 – 2013

Malcolm Pirnie, Inc., Emeryville, California, 1998 – 2010

University of California at Berkeley, College of Engineering, Department of Civil and Environmental Engineering, Post-Doctoral Research Fellow, June 1999 – May 2000;
Graduate Student Researcher and Graduate Student Instructor, August 1992 – June 1999

Stanford University, Stanford, California, 1999

Air Force Research Laboratory, Tyndall Air Force Base, Panama City, Florida, Visiting Scientist, 1998 – 1999

United Nations, 1991 – 1992

Warren Wilson College, Department of Mathematics and Natural Sciences, Environmental Sciences Group, Research Assistant, 1988 – 1991

AWARDS AND RECOGNITIONS

Association for Women Geoscientists President's Award, 2019
University of California, Berkeley, Civil and Environmental Engineering Academy of Distinguished Alumni, 2019
SERDP Projects of the Year Award in the Environmental Restoration Program Area for "Biologically Mediated Abiotic Degradation of Chlorinated Ethenes: A New Conceptual Framework" with Dr. Michelle Scherer (University of Iowa), 2018
Industry Recognition Award for outstanding contribution as a member of the Remediation Risk Management ITRC team, ITRC, 2010
Engineering Innovation Young Outstanding Leader Award, University of California, Berkeley, 2008
Paul Busch Prize Winner, Malcolm Pirnie, 2003
Paul Busch Prize Nominee, Malcolm Pirnie, 2002
The 5th International Battelle Symposium on In-Situ and On-Site Bioremediation Student Paper Competition Award, Battelle, 1999
American Society for Microbiology Student Travel Award and Invited Oral Presentation at ASM's 99th General Meeting, American Society for Microbiology, 1999
STAR Graduate Fellowship, Environmental Protection Agency, 1996 – 1999
Engineering Education Scholar, National Science Foundation, 1998
Student Paper Award, Water Environment Federation, 1994 and 1998
Thomas R. Camp Scholarship, American Water Works Association, 1996
National and Regional Scholarships, Air and Waste Management Association, 1996
Graduate Student Fellowship, National Science Foundation, 1993 – 1995
Student Paper Award, American Society of Civil Engineers, 1994
Fellowship, American Association of University Women, 1993
Wilfred F. Langlier and David H. Caldwell Scholarships, Graduate Division, University of California at Berkeley, 1992.
Alton Pfaff Cup Annual Award, Warren Wilson College, 1991
Annual Student Award, American Chemical Society, Western North Carolina Chapter, 1991
Edward C. Jeffrey Annual Award for Excellence in the Physical Sciences, Warren Wilson College, 1991
Academic Excellence Award, Warren Wilson College, 1989 – 1991
John Bowley Derieux Research Award, North Carolina Academy of Sciences, 1991
Scholar's Medal, Warren Wilson College, 1990
Katherine Fitton Annual Award for Excellence in Mathematics, Warren Wilson College, 1990
Junior Marshall, Warren Wilson College, 1989

AFFILIATIONS

American Associates of Environmental Engineering and Science Professors, Member and
Industry Representative
Association for Environmental Health and Sciences
Groundwater Resources Association of California
National Ground Water Association
United States Environmental Protection Agency Science Advisory Board's Environmental
Engineering Committee
Water Environmental Federation
WateReuse Association

TEACHING EXPERIENCE AND PUBLICATIONS AVAILABLE ON REQUEST

C. KIRK CRAIG, P.E.
Senior Principal Engineer

**remediation management
remedial design, construction and operation
environmental compliance and permitting
research and development**

EDUCATION

M.S., Environmental Science and Engineering, Colorado School of Mines, Golden, CO, 2001

B.S., Zoology, Undergraduate Environmental Engineering Studies, Univ. of Florida,
Gainesville, FL 1996

Undergraduate Geological Studies, Colorado School of Mines, Golden, CO, 1992

REGISTRATIONS AND CERTIFICATIONS

Professional Engineer, CO No. 38402, 2004

Professional Engineer, AZ No. 44191, 2006

AZ Class A - General Engineering Contractor's License No. 278710

OSHA 40-Hour Health and Safety Training

OSHA 8-Hour Site Safety Supervisor Training

OSHA 8-Hour Health and Safety Training Annual Refresher

Medical First Aid and CPR Trained

CAREER SUMMARY

Kirk Craig, P.E., is a senior environmental engineer and a Senior Principal of the firm based in Arizona. He has worked in the professional engineering and environmental fields since 1996 and currently co-instructs the senior-level Geoenvironmental Engineering course at Arizona State University. His primary expertise is in the characterization and remediation of impacted soil, soil gas, surface water and groundwater at industrial and commercial properties.

Kirk has overseen operations and activities associated with the assessment and remediation of a variety of sites throughout the United States. His environmental engineering experience includes the design, construction, optimization, and operation of well over a 100 remedies using a variety of innovative and cutting-edge technologies. This includes notable experience treating various recalcitrant and emerging contaminants such as per- and polyfluoroalkyl substances, 1,4-dioxane and perchlorate

Kirk's consulting and project management experience includes multiple private and public-sector clients such as defense contractors, pharmaceutical manufacturers, chemical manufacturers/distributors, metals manufacturers, dry cleaners, railroads, gas/electrical service, and petroleum facilities, as well as the Department of Defense, Local/State/Federal regulatory agencies and municipalities. He has significant regulatory experience with the CWA, CERCLA and RCRA, as well as State/Local Air Quality Control, UST, Superfund, Aquifer Protection and Voluntary Remediation programs. Kirk's ability to relate to clients and regulators, combined with his technical expertise and regulatory compliance experience enables him to effectively understand client needs and provide regulatory agencies with acceptable cost-effective solutions.

Remediation Management and Investigation

Confidential Client (PFAS/VOCs), Midwestern United States, Principal Engineer/Senior Project Manager responsible for the design, permitting, construction and startup of an approximate 225 gallon per minute (gpm) groundwater extraction and treatment system (GETS) for remediation of PFAS contaminated groundwater. Geosyntec's scope includes pre-design investigations and studies, design of the extraction well network, conveyance piping and the treatment system, obtaining the necessary permits to discharge the treated effluent from the GETS. The treatment system consists of specialized pretreatment, granular activated carbon (GAC) and ion exchange (IX) resin for PFAS treatment and will be housed in a 12,500 square-foot pre-engineered metal building.

Morris Air National Guard Base (PFAS), United States Air Force and Army Core of Engineers, Tucson, AZ. Senior Technical Advisor for the completion of a Phase I Remedial Investigations (RI). Primary activities include development of a Project Management Plan, Quality Assurance Project Plan, Conceptual Site Model, Uniform Federal Policy Quality Assurance Project Plan, Human Health Risk Assessment, and RI report; technical guidance during multi-media sampling and installation of up to 25 groundwater monitoring wells; and completion of semi-annual groundwater monitoring.

Davis-Monthan Air Force Base (PFAS), United States Air Force and Army Core of Engineers, Tucson, AZ. Project Director and Principal Engineer for the completion of a Phase I Remedial Investigations (RI). Primary activities include development of a Project Management Plan, Quality Assurance Project Plan, Conceptual Site Model and RI report; installation of 24 groundwater monitoring wells to a depth of up to 500 feet below ground surface; and completion of groundwater, surface water, sediment and soil sampling.

Cannon Air Force Base (PFAS), United States Air Force and Army Core of Engineers, Clovis, NM. Project Director for the completion of a Phase I Remedial Investigations (RI) to evaluate the nature and extent of PFAS impacts from aqueous film forming foam (AFFF) usage at the base. Primary activities include development of a Project Management Plan, Quality Assurance Project Plan, RI Work Plan, and completion of the RI investigation. The RI investigation will include installation of monitoring wells to a depth of up to 400 feet below ground surface, sampling off-base private irrigation wells, surface soil sampling, soil sampling, and sediment and surface water sampling. After completion of the RI investigation a conceptual site model and RI report will be developed.

Confidential Drinking Water Municipality (PFAS), New England. Principal Engineer responsible for the preliminary design of an approximate 750 gpm carbon treatment system for PFAS removal from a primary municipal drinking water production well. The preliminary design and associated performance requirements were utilized for an accelerated three-month system construction to avoid loss of approximately 70% of the associated city's water supply during the high-demand summer months.

Intermediate Zone Aquifer, San Gabriel Valley Federal Superfund Site, (VOCs, Perchlorate, 1,4-Dioxane, Hexavalent Chromium, Selenium, Total Dissolved Solids), Confidential Client, City of Industry, CA. Engineering Manager responsible for coordination, scheduling and communication with cities/agencies/stakeholders; client representation at meetings with cities/agencies/ stakeholders; soliciting/implementing change management strategies to minimize cost and schedule impacts; support with engineering/construction related contractor selection and procurement; and providing senior level review of engineering related documents and design packages associated with the design and construction of the Intermediate Zone Interim Remedy. The design of the $\leq 2,000$ gpm pump and treat remedy includes eight 40,000-lb liquid-phase carbon vessels for VOC treatment, eight 159 cubic foot ion exchange resin vessels for perchlorate treatment, four 144-lamp UV/peroxide units for 1,4-dioxane treatment, multimedia filters, a six-train RO system for TDS, hexavalent chromium and selenium removal, pH adjustment, chlorination, and direct discharge to drinking water.

Phoenix-Goodyear Airport-North Federal Superfund Site (Perchlorate & VOCs), Crane Co, Goodyear, AZ. Project Manager/Senior Engineer in charge of all remedial investigations, feasibility studies, and active remediation activities at the site. The primary constituents of concern associated the approximate six-mile long and three-mile-wide plume of impacted groundwater included trichloroethylene and perchlorate. The Scope of Work at the site included:

- Optimization/O&M of four groundwater treatment systems ($> 2,000$ gpm) utilizing ion exchange for perchlorate and air stripping/liquid-phase carbon for VOC removal;
- Ongoing source area investigations, remedial investigations and feasibility studies;
- Sampling/monitoring of over 100 monitor, production and extraction wells;
- Ongoing groundwater investigation including the installation of approximately 12 monitoring wells annually;
- Development of groundwater flow and fate/transport models;
- Conduit well investigation; and
- Design/installation of approximately 29,000 feet of extracted/treated HDPE groundwater conveyance piping across city boundaries, through multiple properties, and in major city streets. Included the design of additional extraction and injection wells and modifications and upgrades to existing treatment system(s).

Shallow-Zone South Aquifer, San Gabriel Valley Federal Superfund Site, (VOCs, Perchlorate, 1,4-Dioxane, Selenium), Confidential Client, City of Industry, CA. Engineering Manager responsible for coordination, scheduling and communication with cities/agencies/stakeholders; client representation at meetings with cities/agencies/ stakeholders; soliciting/implementing change management strategies to minimize cost and schedule impacts; support with engineering/construction related contractor selection and procurement; and providing senior level review of engineering related documents and design packages associated with the design and construction of the Shallow-Zone South Interim Remedy. The design of the ≤ 200 gpm pump and treat remedy includes two 144-lamp UV/peroxide units for VOC and 1,4-dioxane treatment, three

10,000-lb liquid-phase carbon and catalytic carbon vessels for VOC treatment and hydrogen peroxide removal, multimedia filters, a four-train RO system for TDS and selenium removal, pH adjustment, and discharge to surface water. Other ongoing Engineering Manager responsibilities include: coordination, scheduling and communication with cities/agencies/stakeholders; client representation at meetings with cities/agencies/stakeholders; and support with engineering/construction related contractor selection and procurement.

Nammo Talley, Inc. (Perchlorate, VOCs, 1,4-Dioxane), Mesa, AZ. Project Manager/Senior Engineer responsible for assessing and remediating perchlorate impacted soil and groundwater. The Scope of Work under Kirk's management includes:

- Developed a Perchlorate Remedial Action Plan for source area groundwater hydraulic containment, treatment, surface water discharge, aquifer recharge, and in-situ vadose zone soil bioremediation.
- Design/construction of a perchlorate remediation system that initially includes two large groundwater extraction wells (up to 500 gpm each), two 800 gpm fluidized bed reactors, infiltration basins, as well as a surface irrigation and vadose zone injection system for the in-situ bioremediation of perchlorate impacted vadose zone soils.
- Currently completing an in-situ bioremediation pilot for the potential remediation of groundwater in fractured bedrock that is impacted with perchlorate, VOCs and 1,4-dioxane. In-situ perchlorate and VOC remediation is anticipated to be accompanied by ex-situ bioGAC for 1,4-dioxane removal. All operations have to be solar powered due to remoteness.
- Sitewide groundwater monitoring program and monitor well installation.
- Assisted the client and ADEQ in the development of an Aquifer Protection Permit.
- Participation in ongoing regulatory negotiations and strategy/planning discussions under Attorney Client Privilege with Legal Counsel.
- Future anticipated activities include enhanced bioremediation of deep vadose zone perchlorate impacts.

Former American Cyanamid Company Federal Superfund Site (VOCs), Wyeth, Boundbrook, NJ. Project Engineer/Task Manager. Developed a revised Feasibility Study and Remedial Action Plan for the excavation (>200,000 cubic yards) and ex-situ treatment of impacted soils from multiple Operable Units. Soil excavation and treatment system operation included the implementation of an extensive perimeter air monitoring program. Managed the design of process airstream handling and treatment systems as well as sub-floor aeration systems for a 240,000-square foot structure to be used for the ex-situ chemical oxidation and biological composting of contaminated soils. Design included sixteen 20,000-pound carbon vessels each with a 125-horsepower blower. Evaluated chemical oxidation and biological remediation processes for ex-situ soil remediation. Performed carbon modeling to predict anticipated usage rates. Managed the design and piloting of a hazardous waste landfill leachate mercury removal system. Developed modified mercury laboratory procedures required to provide consistent repeatable analytical

results. Managed the design and construction of a 200 gpm pH adjustment system with liquid phase granular activated carbon treatment. Performed carbon modeling to predict anticipated usage rates.

In-Situ Oxidation of PCE Groundwater Impacts via Microbubble Ozone injection, 7th & Missouri State Superfund (WQARF) Site, Arizona Department of Environmental Quality, Phoenix, Arizona (2018-2019). Principal Engineer in support of the expedited (approximately 6-month) design and construction of an in-situ microbubble ozone remediation system that includes five ~160-foot-deep, double-nested ozone injection wells and remediation compound with a 27-lb/day ozone generation system and injection system. After approximately 7 months of operation, approximately 40% tetrachloroethylene plume reduction has been observed.

In-Situ Oxidation of PCE Groundwater Impacts via Microbubble Ozone injection, 24th Street & Grand Canal State Superfund (WQARF) Site, Arizona Department of Environmental Quality, Phoenix, Arizona (2018-2019). Principal Engineer in support of the expedited design and construction of an in-situ microbubble ozone remediation system that includes six ~160-foot-deep, double-nested ozone injection wells and remediation compound with a 50-lb/day ozone generation system and injection system. After approximately 11 months of operation, the previously persistent tetrachloroethylene plume has been all but eliminated. Full groundwater closure is anticipated within one year.

Able Engineering (Hexavalent Chromium), Phoenix, AZ. Project Director/Senior Engineer for a cadmium/hexavalent chromium remediation project at a former aircraft parts manufacturer. This project was conducted under the ADEQ Voluntary Remediation Program. Following completion of site characterization activities, shallow soils were addressed through direct excavation. To prevent mobilization of deeper hexavalent chromium impacts (from 10-45 feet below ground surface) to groundwater, an in-situ gaseous reduction (ISGR) treatment approach using hydrogen sulfide gas was being implemented resulting in a No Further Action by ADEQ for the Site. This pioneering approach will be the first commercial application of the in-situ gaseous reduction (ISGR) approach for treatment of hexavalent chromium.

Prudential Overall Supply, State Superfund Site (VOCs), Phoenix, Arizona. Senior Engineer. Responsible the soil remediation activities at a former dry cleaning facility located within the Arizona Department of Environmental Quality West Ban Buren Water Quality Assurance Revolving Fund site. Managed the preparation of a soil vapor extraction pilot test work plan detailing protocols for the collection of soil vapor samples and performing radius-of-influence testing. Managed the preparation of a Remedial Action Plan summarizing results of site investigation and characterization activities and providing a recommended remedial alternative and implementation plan for the installation and operation of a soil vapor extraction (SVE) system. Design, installation, permitting (construction and air permits), startup and O&M of a 500 cfm SVE system with vapor-phase granular activated carbon utilizing 14 nested vapor extraction points. Remedial efforts resulted in a No Further Action determination for site soils from the Arizona Department of Environmental Quality.

Silverbell Jail Annex Landfill State Superfund Site (VOCs), City of Tucson Environmental Services, Tucson, AZ. Principal Engineer/Project Director responsible for the design and

construction of a 1,000 gpm groundwater extraction and treatment system. The system includes the following primary components: three deep (~300 feet below ground surface) groundwater extraction wells; two 20,000-pound liquid-phase carbon vessels for VOC removal; and beneficial reuse of the treated water at a City of Tucson reclamation facility. The preconstruction and design activities included groundwater modeling and hydrogeological studies. Geosyntec served as the prime consultant, general contractor and engineer of record for the treatment system design and construction. The ~\$4.4MM construction project was successfully completed in approximately 12 months and within budget. Geosyntec is managing the system O&M for a minimum of five years.

West Central Phoenix State Superfund Sites (VOCs), Arizona Department of Environmental Quality, Phoenix, AZ. Client Manager/Principal Engineer/ Project Director responsible for characterization and remediation activities associated with a group of five State Superfund sites. Specific activities include: completing a data gap evaluation; conducting an alternate source evaluation resulting in the completion of a soil vapor study; design of a source area hydraulic containment and treatment system; development of a regional remedy for all West Central Phoenix sites; completing a Feasibility Study and Preliminary Remedial Action Plan; implementing an optimized Early Response Action that has removed more than 7,000 pounds PCE and providing Community Advisory Board meeting support.

Shannon Road-Rillito Creek/El Camino del Cerro State Superfund Site (VOCs, 1,4-Dioxane), Arizona Department of Environmental Quality, Tucson, AZ. Client Manager/Principal Engineer/Project Director responsible for characterization and remediation activities associated with an approximate two-mile long VOC/1,4-dioxane plume emanating from a former unlined Pima County landfill. Specific activities include: conducting a data gap evaluation in support of Early Response Actions and to assess potential alternative source areas; conducting semiannual groundwater monitoring; completing a Feasibility Study and Preliminary Remedial Action Plan; collecting landfill gas samples and designing landfill gas Control & Collection System; developing a 3-D groundwater flow and contaminant transport model; and providing Community Advisory Board meeting support.

Central and Camelback ADEQ State Superfund Site (VOCs), Arizona Department of Environmental Quality, Phoenix, AZ. Client Manager/Principal Engineer/ Project Director responsible for characterization and remediation activities associated with a VOC plume emanating from a former commercial dry cleaner. Specific activities include: completing a data gap evaluation and Feasibility Study; developing a Preliminary Remedial Action Plan and Record of Decision; optimizing and operating groundwater extraction/ treatment and soil vapor extraction/treatment systems; conducting semiannual groundwater monitoring; design/implementation of source area and plume enhanced in situ bioremediation; and providing Community Advisory Board meeting support.

Cooper and Commerce State Superfund Site (VOCs), Arizona Department of Environmental Quality, Gilbert, AZ. Client Manager/Principal Engineer/ Project Director responsible for characterization and remediation activities associated with former facility that produced copper sulfate from scrap metal. Specific activities include: completing a data gap evaluation, Feasibility

Study and Preliminary Remedial Action Plan; optimizing/operating an existing soil vapor extraction system; installing new groundwater monitor and soil vapor extraction wells; conducting semiannual groundwater monitoring; developing a two-dimensional groundwater model; and providing Community Advisory Board meeting support.

Lake Havasu Ave and Holly Ave State Superfund Site (Hexavalent Chromium [Cr(VI)], Nitrates, VOCs), Arizona Department of Environmental Quality, Phoenix, AZ. Project Director/Project Manager/Principal Engineer responsible for providing a Focused Feasibility Study evaluation and comparison of potential Early Response Action options for significant vadose zone Cr(VI), nitrate and VOC impacts associated with the former McCulloch manufacturing facility. Additional support includes participation in ongoing regulatory/stakeholder negotiations and strategy/planning discussions. Directed and provided senior-level support for the implementation of highly a successful pilot test for the bioremediation of Cr(VI) to trivalent chromium. This pilot test will be transitioning to a full-scale Early Response Action.

Airgas/Air Liquide Phoenix Fill Plant Site (VOCs), Airgas, Phoenix, AZ. Project Director/Principal Engineer. Completed a vertical delineation and risk-based assessment of deep vadose zone impacts that resulted in a No Further Action determination for soils by the Arizona Department of Environmental Quality.

North Indian Bend Wash Federal Superfund Site (VOCs, 1,4-Dioxane), Arizona Department of Environmental Quality, Phoenix, AZ. Project Manager in charge of providing environmental remediation consulting services to ADEQ in association with the North Indian Bend Wash Superfund Site. Services include document review, technical interpretation, independent technical work, project status review and reporting, and technical dispute resolution.

Hassayampa Landfill Federal Superfund Site (VOCs, 1,4-Dioxane), Tonopah, AZ. Senior Engineer responsible for the design and installation of nested soil vapor extraction wells including soil vapor extraction pilot testing for the ongoing remediation of VOC-impacted soils. Developed a system optimization strategy to increase mass removal rates. Assist with the management of the SVE system O&M. Provided the design of vapor-phase carbon treatment system to replace a costly cryogenic distillation system for vapor-phase solvent recovery. Provide ongoing technical support for system operations.

Honeywell 34th Street Facility LUST Site (Petroleum Hydrocarbons, LNAPL), City of Phoenix Aviation Department, Phoenix, AZ. Project Manager in charge of providing environmental remediation consulting services to the City of Phoenix for the Honeywell 34th Street Facility located adjacent to the Phoenix Sky Harbor International Airport. Remediation activities at the site include operation of a ~3,500 cfm bioenhanced SVE system with a thermal oxidizer, vapor-phase carbon and vadose zone air injection. From May 2009 to September 2018, 3+ feet of free product had been eliminated and approximately 17 million pounds of hydrocarbons had reportedly been treated at the site. Services include document review, technical interpretation, independent technical work, project status review and reporting, and technical dispute resolution. Groundwater closure has been obtained by the State UST program. Full closure with the Aviation Department is anticipated within three years.

Multiple Retail Petroleum and Bulk Plant Sites (Petroleum Hydrocarbons, LNAPL), ConocoPhillips, Multiple Locations, AZ. Department Manager/Senior Engineer. Prepared multiple Site Investigations, Feasibility Studies, and Remedial Action Plans for the treatment of impacted soil and groundwater. Managed the design, permitting, installation and operation of more than 30 soil and groundwater remediation systems throughout the state of Arizona. Types of remediation systems included excavation, soil vapor extraction, air/ozone sparge, biosparge, multi-phase extraction, and chemical oxidation.

56th Street and Earll Drive (VOCs, 1,4-Dioxane), Arizona Department of Environmental Quality, Phoenix, AZ. Project Director for the independent evaluation of a third party 3-D groundwater fate and transport model to assess the suitability of input parameters and key attributes that influence the reliability of the model predictions.

Western States Petroleum, Inc. Site (BTEX), AIG Global Claims Services, Inc.), Phoenix, AZ. Project Manager/Engineer. Provided a third-party review of the site-specific data and remedial progress to provide an assessment of the remedial progress and provide recommendations with respect to optimizing remedial activities and developing alternative remedial strategies (e.g., site-specific risk-based closure) that optimize the remedial activities, advance the site through the remedial process, and reduce the associated remedial duration and costs.

Stormwater Treatment, West Miramar Landfill, City of San Diego Environmental Services Department, San Diego, California (2019). Supervising the design and implementation of storm drain coagulant dosing system to improve stormwater discharge quality, as well as engineering support for implementation of *ex situ* treatment of impounded stormwater by coagulation.

East Central Phoenix State Superfund Sites (VOCs), Arizona Department of Environmental Quality, Phoenix, AZ. Client Manager/Principal Engineer/ Project Director responsible for remediation activities associated with a group of three State Superfund sites. Specific activities include: completing a data gap evaluation; providing system optimization, operation and maintenance for three SVE systems; installation of additional SVE wells, vapor monitor wells and confirmation borings; and providing/implementing alternative site closure strategies.

Lowry Air Force Base Federal Superfund Site (VOCs), US Air Force, Denver, CO. Project Engineer. Provided design support, system optimization, and technical oversight for a 225-scfm, 30-gpm MPE system to remediate source area VOC-impacted soil and groundwater. The MPE system design incorporated the use of a slurry wall containment system keyed into bedrock for isolation of the source area subject to MPE. Provided design support and technical oversight for a 500-gpm pump and treat system for hydraulic containment of VOC-impacted groundwater at the property boundary.

Pueblo Chemical Depot Federal Superfund Site (VOCs), US Air Force, Pueblo, CO. Project Manager. Designed and managed the construction, installation, and operation of a soil vapor extraction system with granular activated carbon to remediate VOC-impacted ground water and soils. Provided technical oversight of project performance. Developed supporting documents including, Remedial Action Plan, scope of work/request for proposals, work plans, monitoring plans, operation and maintenance (O&M) manuals, and performance evaluations. Assisted in the

development and implementation of in-situ chemical oxidation and enhanced anaerobic biodegradation pilot studies.

Pemaco Federal Superfund Site (1,4-Dioxane), USEPA, Maywood, CA. Project Manager/Senior Engineer. Provided to EPA an evaluation of available advanced oxidation processes for treatment of 1,4-dioxane impacted groundwater. Assisted with the retrofit design, installation, startup, troubleshooting and permitting of an AOP that utilizes UV activated titanium dioxide catalyst to generate radicals from dissolved oxygen for the treatment of 1,4-dioxane and VOC impacted groundwater.

Hartford Petroleum Release Site (Petroleum Hydrocarbons, LNAPL), 212 Environmental Consultants, Hartford, IL. Project Director/Principal Engineer responsible for completing the design of ~3,000 cfm multiphase extraction system associated with a network of ~120 multiphase extraction wells. Thermal oxidation will provide treatment of the extracted vapors. The design also accommodates significant solids separation/handling, as well as liquid-phase carbon treatment of extracted liquids prior to discharge to sanitary sewer. Addition services provide include the management of construction oversight activities associated with the installation of multiphase extraction conveyance piping installation and wellhead redesign/optimization.

Aluminum Extruding Facility (VOCs & 1,4-Dioxane), Plymouth Tube Company, Chandler, AZ. Senior Engineer. Prepared and submitted an agency approved groundwater Remedial Action Plan for the treatment of VOC impacted groundwater both on and off site. Designed and implemented a SVE pilot test. Managed the design, permitting, and installation of: a 500 cfm SVE system with vapor phase granular activated carbon to remediate soil vapors containing chlorinated organic compounds; a limited groundwater pump and treat system with liquid phase GAC to remediate impacted groundwater containing chlorinated organic compounds; and the system upgrades and expansion to incorporate the treatment of 1,4-dioxane in the groundwater using ultraviolet and chemical oxidation. Provide ongoing senior level oversight for the SVE and pump and treat systems' O&M and compliance sampling.

Multiple Retail Petroleum and Bulk Plant Sites (Petroleum Hydrocarbons, LNAPL), ConocoPhillips, Multiple Locations, AZ. Department Manager/Senior Engineer. Managed the design, permitting, installation and operation of more than 30 soil and groundwater remediation systems throughout the state of Arizona. Types of remediation systems included excavation, soil vapor extraction, air/ozone sparge, biosparge, multi-phase extraction, and chemical oxidation.

Beaver Hollow Minimart UST Site (Hydrocarbons), Flag Car Wash, Camp Verde, AZ. Project Director/Principal Engineer in charge of the design, construction and operation of a 250 cfm SVE system with electric catalytic thermal oxidized for treatment of vadose hydrocarbon and BTEX impacts. The design included installation of new lateral lines for existing and new SVE wells. Following completion of active remedial activities, developed a cost-effective risk-based remedial closure strategy that resulted in compliance with Arizona Department of Environmental Quality Underground Storage Tank requirements while providing significant long-term cost savings for the client.

Former Dry Cleaner (VOCs), Phoenix, AZ. Project Manager/Senior Engineer. Completed the delineation of tetrachloroethylene (PCE) impacted soil and soil vapor. Conducted an indoor air and vapor intrusion assessment. Successfully completed the design, installation, and operation of a SVE system for remediation of PCE impacted soil vapor.

Cave Creek Landfill (VOCs), Maricopa County, Phoenix, AZ. Senior Engineer. Completed the implementation and evaluation soil vapor extraction pilot test for the remediation of VOC-impacted soils and soil gas.

Multiple Retail Petroleum and Bulk Plant Sites (Petroleum Hydrocarbons, LNAPL), ConocoPhillips, Multiple Locations, AZ. Department/Senior Manager. Prepared multiple Site Investigations, Feasibility Studies, and Remedial Action Plans for the treatment of impacted soil and groundwater. Managed the design, permitting, installation and operation of more than 30 soil and groundwater remediation systems throughout the state of Arizona. Types of remediation systems included excavation, soil vapor extraction, air/ozone sparge, biosparge, multi-phase extraction, and chemical oxidation.

Confidential Client (Metals & PCBs), Teterboro, NJ. Project Engineer responsible for construction oversight and compliance sampling associated with a large excavation project (~200,000 cubic yards) for soils impacted with PCBs and heavy metals. Complexities of the excavation project included numerous buildings to be protected within the excavation area and dewatering.

Chemical Distribution Facility (VOCs), Confidential Client, Phoenix, AZ. Senior Engineer. Provided technical support and oversight for the operation and maintenance of a 200-cfm soil vapor extraction system with vapor phase granular activated carbon to remediate soil vapors containing chlorinated organic compounds.

Confidential Site and Client (VOCs & BTEX), Lynwood, CA. Senior Engineer. Engineering design and implementation support for the construction of a SVE remediation system, an electrical resistive heating (ERH) remediation system, and a soil excavation project to address VOC impacted soil and groundwater.

Multiple Former MGP Sites, Public Service Enterprise Group Inc. (PSE&G), NJ. Project Engineer. Assisted in the development and implementation of multiple former MGP Sites' Remedial Action Plans throughout northern New Jersey. Remedial activities primarily included drilling oversight, excavation oversight, confirmation sampling, and perimeter air monitoring.

Municipal Wastewater Treatment Facility, Cranberry, PA. Project Manager. Designed and implemented the construction and installation of the first nickel alloy catalyzed packed bed scrubber in North America for treatment of Autothermal Thermophilic Aerobic Digestion (ATAD) system off-gas.

Regulatory Compliance

Vapor Intrusion (VI) Guidance Document Development Support, Arizona Department of Environmental Quality (ADEQ), Phoenix, AZ. Project Director/Principal Engineer. Senior support during the review of ADEQ's existing VI guidance and available supporting documents,

identification of gaps in ADEQ's existing guidance and develop a detailed VI guidance outline and draft VI guidance document that address the identified gaps and provide comprehensive yet flexible investigation strategies for VI sites.

West Central Phoenix – East Grand Avenue State Superfund Site (VOCs), Arizona Department of Environmental Quality, Phoenix, AZ. Project Director/Principal Engineer. Senior support during the review of the Feasibility Study (FS) Report prepared by others on behalf of Univar USA Inc. The review assessed the completeness, accuracy and applicability of the FS with respect to the regulatory requirements and current/historical site conditions (e.g., impacts to the groundwater flow regime associated with the lining of the Salt River Project Grand Canal). The review also assessed potential alternative sources and scenarios that may have contributed to the contamination at or associated with the Site.

Tempe Marketplace (PCBs), Arizona Department of Environmental Quality (ADEQ), Phoenix, AZ. Project Director/Principal Engineer. Senior support during the review of the groundwater flow and solute transport model developed by others on behalf of Honeywell International Inc. for the site.

Deer Valley Computer Park Voluntary Remediation Site (VOCs), Arizona Department of Environmental Quality (ADEQ), Phoenix, AZ. Project Director/Principal Engineer. Senior support during the review of the groundwater flow and solute transport model developed by others on behalf of Honeywell International Inc. for the site.

Fashion Cleaner Site (PCE), Arizona Department of Environmental Quality (ADEQ), Phoenix, AZ. Project Director/Principal Engineer. Senior support during the review of vapor intrusion modeling that had been conducted for the site by others. Provided and assessment of ADEQ's implementation of the USEPA Johnson and Ettinger Model, and the vapor intrusion screening level calculation conducted by others.

Mineral Park Mine (Metals), Arizona Department of Environmental Quality, Mohave County, AZ. Project Director/Principal Engineer. Provided professional support services to ADEQ with respect to an evaluation of the groundwater impacts, conceptual site model (CSM) and remedial alternatives for groundwater impacts associated with the Mineral Park Mine including: sources of constituents to groundwater; hydrogeology (alluvial/bedrock geology, groundwater flow direction and role of faults affecting groundwater movement); geochemistry (water quality across mine footprint and downgradient, temporal and spatial data trends for constituents of concern COCs exceeding water quality standards) and Interpretation of groundwater flow and quality

RCRA Facility Investigation (VOCs), Clean Harbors Arizona, Phoenix, Arizona. Project Manager responsible for the preparation of a RCRA Facility Investigation Work Plan, QAPP, and Site Health and Safety Plan. Project activities included review of historical site operations and sampling activities, proposal of investigative activities, and preparation of site investigation documents for submittal to ADEQ. Responsible for the reparation of the response to agency comment documents and costing for implementation of proposed Work Plan investigative activities.

Confidential Dairy, Confidential Location. Project Manager/Senior Engineer. Implemented an air monitoring program to assess the potential for off-site air emissions of hydrogen sulfide (H₂S) gas from a waste water lagoon. Provided a technology assessment and preliminary design of an aeration/mixing system for mitigation of potential H₂S generation.

Former Pharmaceutical Research & Development Facility, Confidential Location. Senior Engineer. Coordinated staff and provided review of environmental compliance management services during the closure of an approximate 290,000 square foot research facility. Services included initial review of environmental compliance. Conducted review of RCRA hazardous, non-hazardous, and biohazard waste consolidation, profiling, and disposal process; air quality records, emissions calculations, and agency correspondence; and industrial waste water discharge permit compliance and closure.

Former Metal Salvaging Facility, Tempe, AZ. Senior Engineer. Site Investigations and reporting associated with residual PCB contamination. Assisted with entering site into the AZ Voluntary Remediation Program and obtaining a closure letter with respect to PCBs.

NASA White Sands Test Facility, Las Cruces, NM. Project Manager. In response to comments from the New Mexico Environmental Department, completed a soil gas source analysis to support the conclusion that volatile organic compounds (VOCs) are off-gassing from the groundwater. Assisted in the development of SVE pilot testing procedures and work plan. Managing the development of site specific soil vapor remediation action levels.

Landfill Gas Evaluation, Cave Creek Landfill, Maricopa County, Phoenix, AZ. Senior Engineer. Completed an evaluation to determine the efficacy of the ongoing operation of an existing landfill gas flare. Resulted in decommissioning the landfill flare in lieu of SVE for vadose remediation.

Confidential Chemical Plant, Maricopa County, AZ. Principal Engineer. Providing assistance with new chemical plant property identification and procurement, as well as Engineering, Procurement and Construction firm solicitation and procurement. Providing regulatory and stakeholder interaction support for plant permitting and construction.

Research and Development

University Collaboration. Spear-headed a collaboration between Geosyntec's SiREM labs and the Arizona State University Biodesign Institute for the commercialization of the AutoPilot. The AutoPilot uses *in situ* flow-through sediment column microcosms for the simultaneous testing of multiple remediation technologies under field conditions.

COVID-19 Disinfection. Along with two other Geosyntec professionals, developed a commercial-grade gaseous ozone disinfection system that has proven via in-house testing to completely inactivate SARS-CoV-2 (see publications)

PROFESSIONAL HISTORY

Geosyntec Consultants, Phoenix, Arizona; 2010-Present
AMEC Geomatrix, Scottsdale, Arizona, 2008-2010
ATC Associates Inc., Tempe, Arizona, 2004-2008

O'Brien & Gere, Edison, New Jersey, 2002 - 2004
NuTech Environmental, Denver, Colorado, 1998 - 2002

AFFILIATIONS AND POSITIONS

Faculty Associate, Arizona State University (ASU), Environmental Engineering Program, 2020 to Present
Corporate mentor for ASU Environmental Engineering Program Capstone Project, Spring 2021
External Advisory Board, ASU, Ira A. Fulton Schools of Engineering, Environmental Engineering Program 2017 to Present
Association of Environmental Engineering & Science Professors, Sustaining Member and Geosyntec Point of Contact
Environmental Professionals of Arizona
Arizona Environmental and Natural Resources Law Section
Arizona Water Reuse Association
National Association of Environmental Professionals
Society for Mining, Metallurgy & Exploration (former)
California Utility Executive Management Association (former)

LECTURES AND INVITED PRESENTATIONS

2013-03 Craig, K. "In Situ Microcosm Array (ISMA) - A Novel In-Situ Remediation Testing Technology." *Environmental Professionals of Arizona's 9th Annual Gatekeeper Regulatory Roundup*, April 2-3, Phoenix, Arizona
2014-08 Craig, K. "Emerging Remediation Technologies." *Environmental Professionals of Arizona Luncheon*, August 11, Phoenix, Arizona
2014-09 Craig, K. "An inclusive, current and accurate Conceptual Site Model is essential, Remediation of a Hazardous Waste Landfill Superfund Site in Arizona." *Association of Environmental & Engineering Geologists 57th Annual Meeting*, September 23, Scottsdale, Arizona
2016-03 Craig, K. "Superfund Multi-Process Groundwater Treatment System Design, Challenges to Date." *Environmental Professionals of Arizona's 12th Annual Gatekeeper Regulatory Roundup*, March 29, Phoenix, Arizona
2016-03 Craig, K. "Full-Scale In-Situ Treatment of Hex Chrome in Soil Using Hydrogen Sulfide Gas." *Environmental Professionals of Arizona's 12th Annual Gatekeeper Regulatory Roundup*, March 30, Phoenix, Arizona
2016-12 Craig, K. "Impacted Groundwater as a Source Drinking Water: Design, Permitting and Regulatory Requirements for a Large Potable End Use Groundwater Remediation System in California." *National Groundwater Association Summit*, December 5, Nashville, Tennessee
2017-02 Craig, K. and Groenevelt, H. "Quantitative Passive Vapor Sampling for VOCs." *Arizona Department of Environmental Quality Training*, 10 February, Phoenix, Arizona
2017-03 Craig, K. "Design and Permitting of Large Potable End Use Remediation System in CA - Why, Where, and How This Should be Considered and Implemented in AZ." *Environmental*

Professionals of Arizona's 13th Annual Gatekeeper Regulatory Roundup, March 16, Phoenix, Arizona

2018-03 Craig, K., Petty, B., Zhou, C. "Breakthroughs in 1,4-Dioxane Treatment: Cost Effectively Treating 1,4-Dioxane in a Chemically Complex Water Stream" *Environmental Professionals of Arizona's 14th Annual Gatekeeper Regulatory Roundup*, March 22, Phoenix, Arizona

2019-02, Craig, K. "In-Situ Gaseous Reduction of Cr(VI) in Vadose Zone Soils with H₂S Gas", *Remediation Technology Summit*, 28 February, Denver, Colorado

2019-03 Arizona State University Guest Lecturer EVE 452 "Contaminated Sites...Discovery through Closure", *IRA A. Fulton Schools of Engineering, Environmental Engineering Program*, March 6, Tempe, Arizona

2019-03 Craig, K. "Using Interactive Environmental Visualization for Enhanced Site Characterization and Remedy Implementation - Accurate CSMs Resulting from Expertise in 3-D Site Characterization" *Environmental Professionals of Arizona's 15th Annual Gatekeeper Regulatory Roundup*, March 6, Phoenix, Arizona

2019-07 Craig, K. "What It Takes to be an Environmental Engineer...Then and Now.", Arizona State University, *IRA A. Fulton Schools of Engineering, Environmental Engineering Program, Director's Lecture Series*, July 31, Tempe, Arizona

2020 and 2021 Spring Semesters Craig, K. and Boyer, T, Arizona State University - **Faculty Associate EVE 452 Geoenvironmental Engineering**, *IRA A. Fulton Schools of Engineering, Environmental Engineering Program*, Tempe, Arizona

PUBLICATIONS

2020-12 Volkoff, S., Carlson, T., Leik, K., Smith, J., Graves, D., Dennis, P., Aris, T., Cuthbertson, D., Holmes, A., Craig, K., Marvin, B., Nesbit, E., **Demonstrated SARS-CoV-2 Surface Disinfection Using Ozone**, *Ozone: Science & Engineering*, December 21

HAMID AMINI, PH.D., P.E.

**water/wastewater management process engineering
landfill gas management and engineering
renewable energy generation
civil and environmental engineering**

EDUCATION

Ph.D., Environmental Engineering, University of Central Florida, Orlando, FL, 2011

M.Sc., Environmental Engineering, Iran University of Science & Technology, Tehran, Iran,
2006

B.Sc., Civil Engineering, Iran University of Science & Technology, Tehran, Iran, 2002

REGISTRATIONS AND CERTIFICATIONS

Professional Engineer, California, No. C 85896

40-Hour HAZWOPER Training in accordance with OSHA 29 CFR 1910.120(e)

CAREER SUMMARY

Dr. Amini is a Principal in the process engineering and geo-environmental groups of Geosyntec Consultants. Dr. Amini has provided his technical knowledge and experience to a wide range of projects in his years of experience. These projects have involved water and wastewater management process engineering design and construction, sustainable solid waste management design and construction, compliance monitoring, renewable energy generation, hydroelectric power plant design, onshore oil drilling platforms construction quality assurance. Dr. Amini also has experience in conducting feasibility studies, preparing detailed cost analyses, and technical specifications. Dr. Amini has published several peer-reviewed articles in ISI rated journals and made several presentations at national and international technical conferences and symposiums. Dr. Amini also has experience in teaching and mentoring graduate and undergraduate level classes/students at the University of Central Florida.

RELEVANT EXPERIENCE

WATER

Baldwin Park Operable Unit, Feasibility Study, Design, and Permitting of Nitrate Removal System, La Puente Valley County Water District, Baldwin Park, CA. Project director and Engineer of Record for designing and permitting a 2,500 gallon-per-minute (gpm) nitrate treatment system for potable water supply. The nitrate treatment system will be a new process within an existing groundwater remedy system. The treated water is served to the local community for potable use.

Confidential Groundwater Remediation Superfund Site, Design of the Drinking Water Treatment System, San Gabriel Valley, Confidential Client, Los Angeles, CA. Project engineer and assistant project manager for designing and preparing bid documents for construction of a 3 MGD treatment plant to produce drinking water for the La Puente Valley County community.

The main treatment processes of the system include liquid granular activated carbon (LGAC) for treatment of VOCs and 1,2,3-trichloropropane, ion exchange (IX) resin for treatment of perchlorate, ultraviolet light/hydrogen peroxide advanced oxidation (UV/Ox) for treatment of 1,4-dioxane, and reverse osmosis (RO) polishing for treatment of inorganics to meet drinking water standards.

Confidential Groundwater Remediation Superfund Site, Design of the Groundwater Treatment System, San Gabriel Valley, Confidential Client, Los Angeles, CA. Project manager and Engineer of Record for designing and permitting a 300 gpm groundwater treatment plant. The remedy system includes major treatment processes including LGAC, UV/Ox, Media Filtration, and RO, as well as extraction wells, inline booster pumps, conveyance pipelines, reservoir, and other ancillary processes.

Confidential Superfund Site, Feasibility Study for Chromium VI Treatment System, Confidential Client, Los Angeles, CA. Project engineer for performing feasibility studies on various treatment technologies for removal of chromium VI from potable water with focus on various types of IX, UV/Ox, AOP, and RO systems. Dr. Amini is providing technical oversight of the treatment technology assessments and evaluating ways to optimize the remedial systems while maintaining compliance.

Omega OU2 Groundwater Remediation, Design of the Water Conveyance Pipeline, Responsible Parties Group, Los Angeles, CA. Project engineer and assistant project manager for designing extraction wells and ~10 miles of groundwater conveyance pipelines. The remedial project includes siting and installation of several groundwater extraction wells, conveyance pipelines, and treatment system. The treated water is planned to be discharged to surface waters.

Avalon Canyon Bedrock Wells Extraction and Treatment System, Design of the Groundwater Extraction System and the Iron and TDS Removal Treatment System on Drinking Water Network, Santa Catalina Island Company, Catalina Island, CA. Project manager and engineer for analyzing alternatives, and performing conceptual and detailed design of the treatment system on the Catalina drinking water network.

Catalina DBP Mitigation System, Design of the Disinfectant Byproduct (DBP) Mitigation System on Drinking Water Network, Southern California Edison, Catalina Island, CA. Project manager and engineer performing technology analysis and feasibility study, designing and preparing bid documents, and coordinating and overseeing construction and installation work of the DBP mitigation system on the Catalina drinking water network.

Catalina Howlands Well Treatment System, Design of the Iron and Manganese Removal Treatment System on Drinking Water Network, Southern California Edison, Catalina Island, CA. Project manager and engineer for designing, preparing bid documents, and coordinating and overseeing construction and installation work of the Iron and Manganese Removal treatment system on the Catalina drinking water network.

WASTEWATER

Palm Springs Ariel Tramway, Wastewater Treatment System, Palm Springs, CA. Project director and Engineer of Record for engineering-procurement-construction (EPC) of two wastewater treatment system projects for removal of organic loadings through solids handling and MBBR system, for total project value of \$6 million.

Spa De Soleil, Wastewater Treatment and Permitting, Los Angeles, CA. Project director for evaluating treatment of acetone and O&G and permitting compliance negotiations with POTW.

Confidential Food/Beverage Client, Wastewater Treatment and Permitting, Ontario, CA. Project director and Engineer of record for treating BOD and TSS and permitting compliance negotiations with POTW.

Sunshine Canyon Landfill, Wastewater Treatment and Permitting, Sylmar, CA. Project manager and Engineer of record for hydrogen sulfide treatment system and permitting compliance negotiations with POTW.

Turano Baking Co., Wastewater Treatment System Design, Henderson, NV. Project manager for EPC of a \$500,000 wastewater treatment system at the production facility for removal of organic loadings.

Swire Coca-Cola, Fruitland, Idaho, Wastewater Treatment System, Fruitland, ID. Project manager for EPC of a \$2 million wastewater treatment system for pH adjustment prior to discharge to the POTW.

Confidential Food/Beverage Client, Wastewater Treatment and Permitting, City of Industry, CA. Project engineer permitting compliance monitoring and negotiations with POTW.

BKK Landfill Leachate Treatment System, Feasibility Study of Leachate Treatment System, Los Angeles County, CA. Project engineer for performing the technology analysis and feasibility study, for installing a leachate collection and treatment system at the BKK Landfill to treat high concentrations of 1,4-dioxane, DDE, ammonia, and other contaminants.

STORMWATER

Weber Metals Stormwater Treatment System, Design of Stormwater Collection, Control, and Treatment System, Weber Metals Inc., Long Beach, CA. Assistant project manager and project engineer for designing, permitting, and implementing a new stormwater collection, control, and treatment system for removal of metal constituents from surface runoff water at the Weber Metals Inc. metal forging facility.

LANDFILLS

Olinda Alpha Landfill, Design of Landfill Gas Collection & Control System (GCCS) Masterplan, Orange County Waste & Recycling, Orange County, CA. Project engineer for evaluating current operations and recommending system optimizations to the existing GCCS, and designing the masterplan for the expansion and operation of the GCCS through the active lifetime of the landfill.

Frank R. Bowerman Landfill, Design of Condensate Management System, Bowerman Power LFG, LLC, Orange County, CA. Project engineer for preparing the options evaluation matrix, conceptual design, and operation workplan for discharging landfill gas (LFG) condensate into the waste mass. The workplan was approved for execution by the California Regional Water Quality Control Board (RWQCB) in October 2015. Geosyntec will be involved in the execution process.

Seminole Road Landfill, Design and Construction Oversight of the GCCS Expansion and Modification, DeKalb County, GA. Project engineer for designing expansions and modifications to the GCCS over the operating lifetime of the landfill. Project engineer on the construction of vertical gas extraction wells, and lateral and header collection pipes, with tasks including managing the on-site construction quality assurance (CQA) technician, reviewing and approving construction submittals, reviewing Contractor invoices and change order requests, conducting weekly construction meetings, and preparing the as-built report and drawings.

Seminole Road Landfill, Monitoring, Investigation, and Analysis of GCCS, DeKalb County, GA. Project engineer on GCCS Operation and Maintenance (O&M) project, with activities including compliance monitoring, maintenance, shutdown response, coordination with the 3.2 MW energy plant operators, and regulatory reporting.

Seminole Road Landfill, Greenhouse Gas Monitoring Plan and Database Development, DeKalb County, GA. Prepared greenhouse gas (GHG) monitoring plans and databases to comply with the U.S. Environmental Protection Agency (USEPA) Mandatory GHG Reporting Rule. Used the USEPA online GHG reporting tool (e-GGRT) and calculation spreadsheets to prepare and submit Annual GHG reports.

Seminole Road Landfill, Renewable Fuels Facility Client Representative, DeKalb County, GA. Project engineer on the landfill gas to renewable natural gas (LFG-to-RNG) and compressed natural gas (CNG) fueling station projects. Assisted in design, construction, and O&M oversight, reviewing Contractor invoices and change order requests, conducting weekly progress meetings, and preparing monthly DOE grant reports.

Seminole Road Landfill, Solar Farm Construction Design, DeKalb County, GA. Project engineer on the solar farm construction engineering project, with tasks including preparing conceptual design drawings, technical documentation, and construction summary report for realizing a power purchase agreement (PPA).

OTHER

Onondaga Lake Remediation Project, Syracuse, NY. Prepared calculation packages and design drawings for the gas collection system of the dredge material disposal site and prepared technical specifications for the disposal site closure system.

Dalton-Whitfield Westside Landfill, Rocky Face, GA. Field engineer for installation of the perimeter collection and control system, with tasks including construction oversight and quality assurance of gas well installation, preparing as-built drawings, and preparing the final construction report.

Statesville Landfill Solar Project, Charlotte, NC. Prepared cost estimate and proposal in response to the RFP for construction of a solar project at the closed Statesville Landfill site. With award of the project to Geosyntec, performed as assistant project manager, performed the technical feasibility analysis, and prepared the final feasibility report.

Seymareh Hydroelectric Power Plant, Ilam, Iran. Assistant design manager for the turnkey project, with tasks including supervising design consultants, controlling design drawings and technical specifications, and controlling compliance with applicable codes and regulations.

Maroon Concrete Oil Reservoirs, Omidieh, Iran. Project engineer for the turnkey project, with tasks including supervising design consultants, controlling design drawings and technical specifications, and controlling compliance with applicable codes and regulations.

Dorood On-Shore Oil Well Drilling Platforms, Khark Island, Iran. Project engineer on the construction project, with tasks including performing construction oversight and CQA of foundation construction and drill rig platform installation, preparing progress reports and conducting weekly construction meetings with client, and reviewing subcontractor invoices.

PROFESSIONAL EXPERIENCE

Geosyntec Consultants, Huntington Beach, CA, November 2011 – Present

University of Central Florida, Orlando, FL, Department of Civil and Environmental

Engineering, Graduate Research Assistant, August 2007 – November 2011

Jyane Construction Company, Tehran, Iran, January 2007 – August 2007
Tablieh & Parhoon-Tarh JV, Tehran, Iran, January 2006 – January 2007

Boland Payeh Construction Company, Tehran, Iran, September 2003 – January 2006

Alisaz Construction Company, Khark Island, Iran, September 2001 – September 2002

AWARDS AND RECOGNITIONS

Best Reviewer Award, Air & Waste Management Association, 2016

Solid Waste Management Scholarship, University of Central Florida, 2008

AFFILIATIONS

American Society of Civil Engineers (ASCE)

American Water Works Association (AWWA)

Solid Waste Association of North America (SWANA)

TEACHING EXPERIENCES

Guest Lecturer, Civic Engagement for Engineers, Greenhouse Gas Emissions – Cap and Trade, University of Central Florida, Orlando, FL, Fall and Summer 2010

Guest Lecturer, Solid Waste Management, Climate Change – Carbon Emissions, University of Central Florida, Orlando, FL, Fall 2009 and Fall 2010

Research Mentor, Supervised/mentored graduate and undergraduate students, University of Central Florida, Orlando, FL, January 2010 – November 2011

PEER-REVIEWED PUBLICATIONS

Amini, H.R., D.R. Reinhart, A. Niskanen. “Comparison of first-order-decay modeled and actual field measured municipal solid waste landfill methane data,” *Waste Management*, 2013, 33, 12, pp. 2720-2728.

Amini, H.R., D.R. Reinhart, K.R. Mackie; “Determination of landfill gas modeling parameters and uncertainties,” *Waste Management*, 2012, 32, 2, pp. 305-316.

Amini, H.R., D.R. Reinhart. “Regional prediction of long-term landfill gas to energy potential,” *Waste Management*, 2011, 31, 9-10, pp. 2020-2026.

Saeedi, M., **H.R. Amini.** “Stabilization of heavy metals in wastewater treatment sludge from power plants air heater washing,” *Waste Management & Research*, 2009, 00, pp. 1-7.

Saeedi, M., **H.R. Amini.** “Characterization of a thermal power plant air heater washing waste,” *Waste Management & Research*, 2007, 25, pp. 90-93.

Saeedi, M., **H.R. Amini.** “Chemical, physical, mineralogical, and leaching characteristics of a thermal power plant air heater washing waste”, *International Journal of Environmental Research*, 2006, Vol. 1, No. 1, pp. 74-79.

SELECT PRESENTATIONS

Bulusu, S., **H.R. Amini.** “Landfill Gas Migration Control – What Works, What Doesn’t?,” *Global Waste Management Symposium*, June 2014, Orlando, Florida.

Amini, H.R., D.R. Reinhart; “Evaluating landfill gas collection efficiency uncertainty,” 13th *International Waste Management and Landfill Symposium*, Sardinia 2011, Italy, October 2011.

Amini, H.R., D.R. Reinhart; “US landfill gas emissions: Obligatory prevention or voluntary collection?” *Association of Environmental Engineering and Science Professors Research and Education (AEESP) Conference*, Tampa, FL, July 2011.

Amini, H.R., D.R. Reinhart; “Economic benefits from landfill gas to energy production,” *Air & Waste Management Association’s (A&WMA) 104th Annual Conference & Exhibition*, Orlando, FL, June 2011.

Amini, H.R., D.R. Reinhart; “Regional prediction of landfill gas to energy generation: Florida, US,” 2010 *Florida Energy Systems Consortium Conference*, Orlando, FL, 2010.

Amini, H.R., D.R. Reinhart; “Regional prediction of landfill gas to energy generation: Florida, US, 2010 *Waste-to-Fuels Conference*, Jacksonville, FL, 2010.

Amini, H.R., D.R. Reinhart; “Uncertainty estimation of LFG generation, 13th *Annual LMOP Conference*, Baltimore, MD, 2010.

Amini, H.R., D.R. Reinhart; “LFG to Energy: Incentives and benefits,” 46th *Annual Florida Air & Waste Management Association’s (A&WMA) Conference*, Captiva Island, FL, 2009.

JEFF TRACY, P.G.

**soil and groundwater remediation
site closure strategy development
environmental portfolio management/owner's representative
building decommissioning and demolition**

EDUCATION

B.S., Geology, University of Wisconsin, Milwaukee, Wisconsin, 1992

REGISTRATIONS AND CERTIFICATIONS

Licensed Professional Geologist, Wisconsin, 13-1163

OSHA HAZWOPER 1910.120

- 40 Hour Initial Training – 1992
- 8 Hour Refresher – Annual, last completed in March 2020
- Supervisor Training

RCRA Hazardous Waste Management Annual Training – April 2020 (refresher)

DOT Shipper Training (every three years) – April 2020 (refresher)

CAREER SUMMARY

Mr. Tracy is a Licensed Professional Geologist with over 25 years of experience in environmental project management, primarily in the practice of owner's representation for site and portfolio management; site closure strategy review and development; soil and groundwater quality investigation and remediation; spill response and management; vapor intrusion assessment; demolition planning and management; and brownfields redevelopment. Provided value added services for projects at oil refineries, railroad facilities, municipal sites, and a variety of manufacturing and commercial facilities.

Mr. Tracy strives to understand client goals relative to site outcomes and has extensive experience negotiating changes in remedial strategies at Superfund and State-lead remediation sites that are consistent with the client's objectives.

REPRESENTATIVE PROJECTS

Per- and Polyfluoroalkyl Substances (PFAS) Investigations

Tyco Fire Technology Center, Tyco Fire Products, Marinette, Wisconsin. Project Manager. Responsible for managing the overall design, permitting, construction and startup of an approximate 225 gallon per minute (gpm) groundwater extraction and treatment system (GETS) for remediation of PFAS contaminated groundwater. Geosyntec's scope includes pre-design investigations and studies; design of the extraction well network, conveyance piping and the treatment system; obtaining a precedent-setting permit to discharge the treated effluent from the system; and managing construction. The treatment system consists of specialized pretreatment,

granular activated carbon (GAC) and ion exchange (IX) resin for PFAS treatment and the system will be housed in a 12,500 square-foot pre-engineered metal building.

Third Party Review and Strategy Development, Confidential Client, Confidential Location. Project Manager. Provided third-party review services for investigation and proposed remediation activities at a property impacted with PFAS. Evaluated existing and developing remedial technologies to address PFAS in soil and groundwater, and provided client with options related to existing technologies, potential options using several developing technologies, and providing information related to technologies still in development but were not considered a tested technology outside of the laboratory. Evaluated release and deposition mechanisms, transport processes (groundwater, surface water, and air) and assisted with developing investigation strategies.

Due Diligence Investigation, Confidential Client, Confidential Location. Project Manager. Evaluated soil and groundwater quality for the presence of PFAS at a former manufacturing facility during due diligence prior to a property transfer. Managed project where soil and groundwater samples were collected and analyzed for PFAS. Ensured field staff were properly trained to prevent cross-contamination of PFAS from clothing, sample supplies, and other materials that may contain PFAS. Quality control samples confirmed proper sample collection procedures were followed. Prepared a letter presenting the results.

Liability Evaluation, Confidential Client, Multiple Locations. Project Manager. Evaluated company records, current and historic operations, and surrounding properties to identify the potential for environmental liabilities associated with the PFAS use.

Cannon Air Force Base, United States Air Force, Department of Defense, Arizona. PFAS Project Support. Prepared standard operating procedures to collect soil, groundwater, and surface water samples that may be impacted with PFAS. Developed sample and analysis plans for collecting samples at several surface water bodies across the base.

Hill Air Force Base, United States Air Force, Department of Defense, Utah. PFAS Project Support. Prepared standard operating procedures to collect soil, groundwater, and surface water samples that may be impacted with PFAS.

Groundwater Remediation – Alternatives Analysis

Former Manufacturing Facility Alternatives Analysis, Confidential Client, Duluth, Minnesota. Project Manager. A previous consultant installed a pump and treat system at the downgradient edge of a groundwater plume to prevent groundwater from migrating to a wetlands approximately 1 mile from the site. Completed an alternatives analysis and developed an alternate remedy consisting of injecting a bio-barrier wall immediately downgradient of the source (sludge in an abandoned sewer beneath a building). Trichloroethylene concentrations immediately downgradient of the bio-barrier wall decreased from 9,000 micrograms per liter to less than 1 micrograms per liter. Six months after installing the bio-barrier, decreases in contaminants of concern are beginning to occur in wells approximately 1/8 mile from the injection site. The regulatory agency has agreed to discontinue the pump and treat system.

Former Manufacturing Site – Remedy Change, Confidential Client, Iowa. Project Manager. The United States Environmental Protection Agency (USEPA) required the client to install and operate soil vapor extraction and groundwater pump and treat systems at a former manufacturing facility impacted with chlorinated solvents. A fire destroyed the building and damaged the treatment systems. Rather than repair/replace the system, we proposed to implement enhanced in-situ bioremediation (EISB) as a pilot study to the USEPA. The USEPA approved the pilot study after review of the work plan. Injections, which included a carbon substrate, solvent destructing bacteria, calcium polysulfide to reduce the oxidation reduction potential, and a buffering solution. Injections were completed in summer of 2018, and initial monitoring results indicate the groundwater environment is changing to support biodegradation.

Operating Manufacturing Site – Remedy Evaluation, Confidential Client, New Jersey. Project Manager. A pump and treat system is being operated to treat chlorinated compounds in the groundwater at an operating manufacturing facility in New Jersey. Groundwater concentrations reached asymptotic conditions; we evaluated alternative remedies to replace the pump and treat system. Alternatives evaluated included EISB and in-situ chemical oxidation (ISCO). EISB enhanced with ozone is the selected remedy based on groundwater and vadose zone conditions. Currently (January 2020) developing a work plan to implement the alternative remedy.

Environmental Portfolio Management/Owner's Representative

Former Milwaukee Die Casting Company, Pharmacia LLC, Milwaukee, Wisconsin. Project Coordinator and Owner's Representative for a time critical removal action, which included demolition of a PCB-impacted building, and removal of soil with PCBs and chlorinated volatile organic compounds. Negotiated with the USEPA On-Scene Coordinator to successfully implement the Administrative Settlement Agreement and Order on Consent while maintaining the goals of the Respondents. Saved over \$1,000,000 during the project by researching and negotiating alternative waste disposal options for storm water impacted by PCBs and negotiating Master Service Agreement with multiple waste disposal facilities. Managed the project using earned value analysis to ensure the project was completed on time and within budget. Implemented a proactive health and safety program that resulted in no recordable injuries or significant health and safety issues during the active field activities over two summer seasons. Project regulated by the USEPA and the Wisconsin Department of Natural Resources.

Portfolio Project Management, Confidential Client, North America and Europe. Owner's Representative. Responsible for the financial, technical, safety, compliance, and management aspects of a portfolio of active remediation sites for a major manufacturing company. The sites are located throughout the United States and Europe; and include Superfund sites and state-lead sites at various stages of remediation, from active construction through operation and maintenance.

Century City Redevelopment Project, Redevelopment Authority of the City of Milwaukee, Milwaukee, Wisconsin. Project Manager. Project Manager and Owner's Representative for the environmental investigation and remediation, demolition, and redevelopment of a former 75-acre industrial property in an economically depressed part of the City of Milwaukee. Services include

managing Phase I and Phase II Environmental Site Assessments, environmental site investigations, soil remediation, free product delineation and characterization, underground storage tank removals, regulated (RCRA, TSCA, and non-hazardous) waste management activities, and lead based paint and asbestos abatement. Also managed the external portion of the redevelopment of a 15-acre sub-parcel, which included soil remediation, railroad track spur design and construction, site grading, storm water management, and construction management. Acted as owner's representative and directed and provided oversight of other consultants and contractors and negotiated with regulators during the project. Project regulated by the Wisconsin Department of Natural Resources.

Locomotive Derailment, CN, Oshkosh, Wisconsin. Owner's Representative. Managed a response action to a locomotive that derailed and released approximately 1,000 gallons of diesel fuel to a stream that led to Wisconsin's largest inland lake. Activities included preparing a work plan to remove the locomotive, two rail cars, diesel fuel, lube oil-contaminated materials, and restore the environment. Managed placement and maintenance of booms, removal of visible free-phase petroleum product from the waterway, removal of remaining petroleum product from the locomotive, and removal of petroleum-contaminated materials from the creek, surrounding banks, and derailed locomotive to prevent additional/future petroleum releases to the creek. Managed contractor coordination, permitting, sampling, and waste profiling. Acted as client representative with regulatory agencies including the United States Environmental Protection Agency and the Wisconsin Department of Natural Resources.

Capital Improvement Support, Tekni-Plex, Milwaukee, Wisconsin. Owner's Representative during an electrical system capital improvement project at a manufacturing facility leased by Geosyntec's client. Responsibilities include reviewing project plans (infrastructure and design plans, soil management plan, spill response plan), providing soil management options, and documenting construction and soil and groundwater management procedures during construction of electrical infrastructure. Geosyntec was retained to ensure our client's improvement project does not lead to them being identified as a responsible party for remediation of known soil and groundwater contamination at the property.

Building Decommissioning and Demolition, and Redevelopment

Former Milwaukee Die Casting Company, Pharmacia LLC, Milwaukee, Wisconsin. Project Coordinator and Owner's Representative for a time critical removal action, which included demolition of a PCB-impacted building. Developed a demolition and waste management plan, decontaminated portions of the building so non-TSCA disposal or management of waste materials was possible. Successfully pilot tested removal of PCB-impacted paint from structural steel using a technology that did not create a secondary waste. Managed asbestos abatement activities.

Century City Redevelopment Project, Redevelopment Authority of the City of Milwaukee, Milwaukee, Wisconsin. Project Manager. Completed pre-demolition assessments of approximately 2,000,000 square feet of building space, developed demolition and waste management plans, managed lead-based paint and asbestos abatement activities, identified and removed hazardous, universal, and TSCA-regulated wastes, and managed demolition of the

buildings. Monitored air quality and implemented dust mitigation programs as necessary. Recycled much of the waste for re-use on the site.

Vapor Intrusion Assessment

Tekni-Plex, Tekni-Plex Flexibles, Milwaukee, Wisconsin. Project Manager. Completed a vapor intrusion and indoor air quality evaluation for a third-party owned property occupied by Tekni-Plex. Client objective was to ensure occupant safety in a building above a solvent-impacted groundwater plume.

Manufacturing Facilities Vapor Intrusion Risk Analysis, Confidential Client, Manufacturing Sites Within the United States. Project Manager. Completed a desktop study to determine the risk of vapor intrusion at client-owned manufacturing facilities, prioritized risk, and implemented vapor investigations based on the risk profiles.

Manufacturing Facility, Off-Site Vapor Evaluation, Confidential Client, Olean, NY. USEPA requested Geosyntec's client install a sub-slab depressurization system in an off-site office building. The off-site office building is adjacent to a closed landfill with an unknown waste acceptance history, and the building is above a groundwater plume with multiple responsible parties. Geosyntec recommended completing a soil gas survey between the client's operating manufacturing facility and the office building to evaluate the vapor source in the office building. The USEPA directed our client to proceed with the soil gas survey (January 2020).

PROFESSIONAL EXPERIENCE

Geosyntec Consultants, Milwaukee, Wisconsin, 2019 – Present
BSI Professional Services (formerly Quantum Management Group), Thiensville, Wisconsin,
2013 – 2019
AECOM, Milwaukee, Wisconsin, 2006 – 2013
Celerity Environmental, Mequon, Wisconsin, 2001 – 2007
Advent Environmental, Milwaukee, Wisconsin, 1993 – 2001
Drake Environmental Services, Menomonee Falls, Wisconsin, 1992 – 1993

AFFILIATIONS

American Chemical Society – 2019
American Institute of Professional Geologists – 2019
Federation of Environmental Professionals - 2016

INVITED PRESENTATIONS

Century City: A Brownfields Story. University of Wisconsin, Milwaukee: Innovative Cities Lecture Series (Co-presented with Benji Timm, Redevelopment Authority of the City of Milwaukee).

Successful Management of an Emergency Response Associated with a Derailment. CN National Environmental Meeting.

Technical, Regulatory and Legal Issues Associated with the Use of Per- and Polyfluoroalkyl Substances (PFAS). Milwaukee Bar Association, September 2019. (Co-presented with Dr. Rula Deeb, Geosyntec).

PFAS Forensics Tools. American Institute of Professional Geologists, PFAS: Beyond the Theoretical and What's Working Conference, Madison, Wisconsin. February 27, 2020.

Lines of Evidence to Assess the Efficacy of PFAS Remedial Technologies. Federation of Environmental Technologists, PFAS 2021: Professional Development Series, Webinar. Abstract accepted January 2021. Webinar in May 2021 (Date TBD). Co-presented with Mary Ensich, Ph.D., Geosyntec).

MARY ENSCH, PH.D.

perfluoroalkyl substances (PFAS)
electrochemical oxidation
remediation
electrochemical sensing

EDUCATION

Ph.D., Chemical Engineering, Michigan State University, East Lansing, Michigan, 2020

B.S., Chemical Engineering, Michigan State University, East Lansing, Michigan, 2016

REGISTRATIONS AND CERTIFICATIONS

40-hour HAZWOPER

CAREER SUMMARY

Dr. Ensched is a Senior Staff Professional with Geosyntec Consultants who joined the groundwater remediation group in the Milwaukee, Wisconsin office. Her expertise is in the mineralization of per- and polyfluoroalkyl substances (PFAS) using electrochemical destruction. She focused on PFAS presence in complex solutions such as landfill leachate or following a preconcentration method such as ion exchange. In addition, she has worked on biological and heavy metal sensing using electrochemical methods.

In her current role, Dr. Ensched is responsible for providing support on a variety of remediation services, focusing on growing PFAS opportunities in the Great Lakes Region.

Electrochemical Destruction of Per- and Polyfluoroalkyl Substances (PFAS)

Electrochemical Destruction of Per- and Poly-Fluoroalkyl Substances (PFAS) Using Boron-Doped Diamond (BDD) Electrodes: Application Towards Concentrated Regenerate Solutions, MSU MTRAC AgBio Starter Award, East Lansing, Michigan. Dr. Ensched investigated the destruction of PFOA and PFOS in simulated ion exchange regenerate solutions using an energy saving technique in a bench-top process. Her role was to perform the analysis, experimentation, and data evaluation as well as instruct an undergraduate student to assist with the process. Dr. Ensched was also in charge of managing the timeline and analytical budget for this project as well as preparing reports, presentations, and follow-up proposals for the funding committee.

Per- and Poly-Fluoroalkyl Substances (PFAS) Remediation in Landfill Leachate Using Boron-Doped Diamond (BDD) Electrodes, City of Grand Rapids, Michigan, East Lansing, Michigan. Dr. Ensched was responsible for arranging sample pick-up and drop-off times with the client and analytical lab. She was also responsible for assisting with the laboratory experimentation and data analysis. Dr. Ensched presented results to the client in regularly scheduled project update meetings.

Electrochemical Sensor Development

Isatin Detection Using a 3-in-1 Boron-Doped Diamond (BDD) Sensor, Ph.D. Dissertation Research, Michigan. Dr. Ensched worked with project engineers who were designing a sensing platform to test its ability in the detection of the biological compound of isatin. Her role was to perform the electrochemical analysis experiments and relay the progress and applicability of the sensors back to the project team.

Indium Tin Oxide Film Characteristics for Cathodic Stripping Voltammetry, Fraunhofer USA Inc. Center for Coatings and Diamond Technologies and Ph.D. Dissertation Research, East Lansing, Michigan. Dr. Ensched investigated the effects of changing fabrication parameters on the ability to sense manganese with the produced electrode material. Her role was to use each electrode produced in a bench-top study to determine if manganese could be detected in an aqueous sample.

General PFAS Remediation Projects

PFAS Evaluation, Confidential Client/Attorney Privilege Site. Geosyntec was engaged to complete a PFAS evaluation in soil and groundwater prior to a potential purchase of a property. Dr. Ensched prepared the Task Hazard Analysis and work plan for the project; managed field work by arranging for drillers, utility locators, sample analysis, and equipment rental; coordinated all purchase orders and invoices for the project; and participated in the field sampling (soil and groundwater). Finally, Dr. Ensched prepared a report summarizing the data for submittal to the client.

Cannon Airforce Base PFAS Investigation, Clovis, New Mexico. Dr. Ensched completed literature and document research to find historical boring logs for the site. She also reviewed the standard operating procedures for groundwater sampling and inserted PFAS specific procedures and provided technical support on PFAS-related issues to the project team.

Project Support

Manufactured Gas Plant (MGP) Site Investigation, Confidential Utility, Illinois. Dr. Ensched supported project work by updating laboratory report tracking documents, completing data validation, and performing quality control for data and tables. She also assisted in compiling the tables for the project using Microsoft Access and Excel.

Remedial Investigation, Confidential Client/ Attorney Privilege site. Dr. Ensched prepared tables summarizing existing and developing remedial technologies for PFAS. The client requested Geosyntec prepare tables for their internal use and decision-making process associated with their PFAS-impacted sites.

Manufactured Gas Plant (MGP) Site Investigation, Confidential Utility, Illinois. Dr. Ensched used GIS software and Excel to assist with the production of figures and tables for the Remedial Options Report and Remedial Action Plan.

Manufactured Gas Plant (MGP) Site Investigation, Confidential Utility, Illinois. Dr. Ensched used GIS software to assist with the production of figures for the project's Site Investigation Report, Remedial Options Report, and Remedial Action Plan.

Field Work Support

Vapor Intrusion Evaluation Support, Confidential Client, Milwaukee, Wisconsin. Dr. Ensched assisted with collecting indoor air samples using summa canisters to evaluate indoor air quality at a manufacturing facility.

Conducting Building Pressure Cycling at 9 Clark Commons Phase 1 Units, Flint, Michigan. Dr. Ensched assisted with building pressure cycling (BPC), sub-slab soil gas sample collection, and indoor air sampling for 9 residential units.

PROFESSIONAL EXPERIENCE

Geosyntec Consultants, Inc., Milwaukee, Wisconsin, 2020 – Present

Michigan State University, Michigan, Graduate Research Assistant, January 2017 – August 2020

Michigan State University, Michigan, Undergraduate Research Assistant, August 2015 – December 2016

AWARDS AND RECOGNITIONS

Clifford Humphrys Fellowship for Water Quality in the Great Lakes, Michigan State University, 2019

Best Poster Award, Engineering Graduate Research Symposium, Michigan State University, 2019

2nd Place Dew Good Award for Public Service Technology, Engineering Graduate Research Symposium, Michigan State University 2019

Travel Grant for the 69th Annual Meeting of the International Society of Electrochemistry, 2018

REPRESENTATIVE PUBLICATIONS

2020 **Mary Ensched**, Cory A. Rusinek, Michael F. Becker, Thomas Schuelke. "A combined current density technique for the electrochemical oxidation of perfluorooctanoic acid (PFOA) with boron-doped diamond". Water and Environment Journal.
<https://doi.org/10.1111/wej.12616>

2020 Witt Suzanne, Nick Rancis, **Mary Ensched**, Vanessa Y. Maldonado. "Electrochemical destruction of 'Forever Chemicals': The right solution at the right time". The Electrochemical Society Interface.

- 2019 **Mary Enschede**, Bettina Wehring, Greg D. Landis, Elias Garratt, Michael F. Becker, Thomas Schuelke, Cory A. Rusinek. “*Indium tin oxide film characteristics for cathodic stripping voltammetry*”. ACS Applied Materials & Interfaces.
<https://doi.org/10.1021/acsami.8b22157>
- 2018 **Mary Enschede**, Vanessa Y. Maldonado, Greg M. Swain, Robert Rechenberg, Michael F. Becker, Thomas Schuelke, Cory A. Rusinek. “*Isatin detection using a boron-doped diamond 3-in-1 sensing platform*”. Analytical Chemistry.
<https://doi.org/10.1021/acs.analchem.7b04045>

INVITED PRESENTATIONS

- 2020 “*Advancements in Electrochemistry for the Sensing of Aqueous Compounds and Persistent Compound Destruction*” PEDAG Webinar, January 2021.
- 2019 “*PFAS Remediation Research at the MSU Fraunhofer Center*” Senator Peters’ Staff Retreat. East Lansing, Michigan.
- 2019 “*MSU-Fraunhofer’s Approach to PFAS Remediation*” Our State’s Greatest Natural Resource – Water; PFAS – State Responses. Training event for staff working in the Michigan Legislature put on by the MSU Institute on Public Policy and Social Research (IPPSR). Lansing, Michigan.
- 2019 “*Cleaning up PFASs- Overview of Methods for Contaminated Wastewater*” Michigan Association of Hazardous Materials Professionals: Annual Conference and Business Meeting. Howell, Michigan
- 2019 “*PFAS remediation at MSU-Fraunhofer: electrochemical destruction in wastewater and landfill leachates using boron-doped diamond electrodes*” Engineering Society of Detroit/ Michigan Waste & Recycling Association; Solid Waste Technical Conference. East Lansing, MI.
- 2019 “*PFAS remediation at MSU-Fraunhofer: electrochemical destruction in wastewater and landfill leachates using boron-doped diamond electrodes*” Michigan National Association for Surface Finishing; Annual Technical Session. Grand Rapids, MI.



Appendix B

Geosyntec Research

Geosyntec's PFAS-related Research Projects through SERDP and ETSCP Programs

Demonstration of Smoldering Combustion Treatment of PFAS-impacted Soils/IDW, SERDP

Savron/Geosyntec was contracted by the SERDP program to demonstrate the application of smoldering combustion to treat PFAS in soils or investigative derived wastes (IDW). The successful treatment of PFAS by smoldering was demonstrated. Additional work was recommended to further improve the mass balance of the PFAS destruction, as well as address impacts of heterogeneity on the smoldering process.

Smoldering Combustion Treatment of PFAS-Impacted Investigation-Derived Waste, SERDP

Smoldering combustion (STAR) is a low-cost, energy efficient thermal technique that has been successfully deployed across the world to treat hydrocarbon contaminated waste materials. Initial phases of this study demonstrated removal of PFAS from impacted soils to below detection limits (0.05 micrograms per kilogram [$\mu\text{g/kg}$]) using low concentrations of GAC as a surrogate fuel. A second SERDP study was evaluated to refine the fluorine mass balance and investigate parameters that can be modified to further enhance PFAS destruction. Additional large scale lab experiments and a field pilot test were performed in 2021 to explore the impacts of scale and heterogeneity on PFAS destruction.

This project won the 2021 SERDP Environmental Restoration Project of the Year Award.

Guidance for Assessing the Ecological Risks of PFAS to Threatened and Endangered Species at Aqueous Film Forming Foam-Impacted Sites, SERDP

Developed a guidance document presenting a current state-of-the-practice overview of available methods, best practices, and key data gaps in assessing the potential for risks from exposure to PFAS for threatened and endangered (T&E) species at aqueous film forming foam (AFFF) impacted sites. It is intended to provide clear guidance to quantitatively evaluate ecological risks to PFAS, and enable site managers to make defensible, risk-based management decisions using the best available information and approaches.

Catalyzing Rapid Information Transfer Among Key Stakeholders on PFAS at Contaminated Military Sites, ESTCP

On behalf of SERDP/ESTCP, Rula Deeb, Jason Conder, and other Geosyntec staff collaborated with Dr. Jennifer Field of Oregon State University and Dr. Christopher Higgins from the Colorado School of Mines to prepare a summary report titled "*Frequently Asked Questions (FAQs) regarding PFASs associated with AFFF use at U.S. Military Sites, California*", a succinct FAQ fact sheet, YouTube videos, webinars, and publications on PFAS chemistry, fate and transport and treatment at impacted sites and conducted outreach activities to disseminate information on this topic.

Lines of Evidence to Assess the Effectiveness of PFAS Treatment, SERDP

Geosyntec staff prepared a guidance for the U.S. Department of Defense (DoD) regarding lines of evidence to assess the effectiveness of PFAS remedial technologies. Proponents of several innovative treatment technologies have claimed success in removing or destroying PFASs. However, removal mechanisms are often not understood, byproducts may not be measured, and the technology effect on other components in AFFF mixtures may be unknown. To improve return on investment and guide future investments in PFAS treatment

technologies, this project provides SERDP and others with practical decision tools, metrics, and guidance to inform the evaluation of PFAS treatment.

Hydrothermal Treatment of PFAS, SERDP

Geosyntec is collaborating with the Colorado School of Mines to evaluate hydrothermal technologies for on-site destruction of PFAS and co-contaminants present in PFAS IDW. Geosyntec has collected and shipped soil and groundwater samples from a PFAS-contaminated site to Colorado School of Mines for bench-scale testing and has provided technical review of laboratory results. Geosyntec will also conduct technology transfer activities for this project.

Biochar-Amended Biofilters to Remove PFAS and Other Trace Organics from Stormwater, California, SERDP

As part of two separate research projects through the DoD's SERDP program, Geosyntec is partnered with Texas Tech and Stanford University to evaluate stormwater best management practices (BMP) treatment effectiveness and risks of sediment recontamination from stormwater discharges from DoD bases and facilities.

The team will lead the research efforts in the initial development of a draft plan for implementation of the biochar (BC) biofilters at the field scale. Geosyntec will assist the project team with bench-scale plans and result evaluations to ensure that considerations of real-world application are included in the evaluation and development of a project deliverables. Geosyntec will also take the lead in creating a technical design manual for specifications and implementation of BC biofilters for improved stormwater management.

Validation of a UV/TiO₂ Activated Alkaline Media for Destruction of PFAS in Concentrated Liquid Waste Streams, SERDP

Geosyntec staff are teamed with the University of Missouri Kansas City to validate the efficacy of a novel cement-based filter media for destroying PFAS. A series of lab-based batch and column tests will be performed. Geosyntec will assist the project team with sample collection of PFAS in concentrated waste streams.

Assessing and Mitigating Bias in PFAS Levels during Ground and Surface Water Sampling, SERDP

Geosyntec staff reviewed and compared PFAS sampling guidance published by federal and state regulatory agencies, professional organizations, and industry leaders. Staff also reviewed peer-reviewed publications that provide a scientific basis for PFAS sampling protocols. Collective knowledge was gathered to inform project research and key messages were distilled as guidelines for project managers, consultants, and regulators. The project is led by researchers at Oregon State University, with collaboration from AECOM, Jacobs, and CDM Smith.

Treatability Studies to Enhance PFAS Degradation Using Thermally-Enhanced Persulfate Oxidation, ESTCP

Geosyntec was a part of an applied research project to evaluate in situ thermally-enhanced persulfate treatment at low pH to enhance PFAS destruction. Collaborators include the University of California at Berkeley and the Naval Facilities Engineering Command (NAVFAC) Expeditionary Warfare Center (EXWC). Treatability studies were conducted to demonstrate that the technology can fully oxidize perfluorooctanoic acid (PFOA) and other perfluorinated carboxylic acids (PFCAs) as well as polyfluorinated substances that are present in AFFF and degrade naturally over time to produce PFCAs. Treatability studies were conducted using soil and groundwater collected from a former fire training site in Jacksonville, Florida. Results provided insights into

treatment efficacy as a function of pH, persulfate concentration, and aquifer geochemistry. Geosyntec prepared a demonstration plan for conducting a field demonstration.

ER Wiki, ESTCP

Geosyntec was invited to co-develop the PFAS article for the Enviro.wiki page with Dr. Jennifer Field from Oregon State University and Dr. Christopher Higgins from Colorado School of Mines. The Enviro.wiki website was developed as part of ESTCP project ER-201569-T2. Articles related to site characterization and remediation are written by nationally and internationally recognized experts who provide a concise summary of the current state-of-practice and relevant research results.

Development and Application of Injectable Fuels/Adjuncts for In Situ Treatment of PFAS and Co-contaminants in Source Areas by Smoldering Combustion, SERDP

Geosyntec work conducted under SERDP has shown that adding a surrogate fuel, such as GAC at low concentrations can support smoldering and generate high temperatures that can decompose PFAS. This project will demonstrate that EVO mixed with low amounts of colloidal or powered activated carbon, colloidal activated carbon alone can be successfully distributed through the source zone below the water table and smoldered to treat PFAS source areas in situ. Application of the technology in PFAS source zones will result in significant mass removal/destruction resulting in reduced source zone mass discharges to plumes and downgradient receptors and has the potential to achieve current soil cleanup guidelines.



Appendix C

Summary of Treatment Design Projects

Representative Projects Demonstrating Treatment System Design Experience

Project Name & Execution	Capacity (gpm) Avg./Max.	COCs	Unit Operations
Montrose Chemical Groundwater (Torrance, CA) Design/Bid/Build	700/1000	VOCs, Metals, pCBSA, and Pesticides	FE, LGAC, AS, AOPs, CMF, and VGAC
Confidential Chemical MFR (TN) Design/Bid/Build	5/20	Organophosphates, Organothiophosphorus Compounds, and Metals	ChemOx, GSF, Ozonation, MMF, LGAC, and SH/D
Puente Valley Operable Unit (San Gabriel Valley, CA) Design/Build/Operate	1500/2000	VOCs, NDMA, Nitrate, TDS, Perchlorate, and 1,4-Dioxane	FE, MMF, LGAC, IX, UVOx, UV+H2O2, RO, and pH
El Monte Groundwater Remediation System (El Monte, CA) Design/Build/Operate	1000/1200	VOCs plus Future 1,4- Dioxane, NDMA, Perchlorate, and Chromium (VI)	FE, MMF, pH, LGAC, and CHL; UVOx and IX in Future
Sunday Mine Complex Water Treatment Plant (San Miguel County, CO) Design/Bid/Build	200/300	Uranium, Radium, Metals, and Anions	FE, RO, IX, PREC, EVAP, and LS
Perchlorate Treatment System (Mesa, AZ) Design/Bid/Build	350/800	Perchlorate	FE, MMF, FBR, Reinjection and ISB
Perchlorate Groundwater ISB System (Henderson, NV) Design/Bid/Build	300/600	Perchlorate	FE, Bag Filtration, pH, EDA, Reinjection, and ISB
Lee County Leachate Treatment (Lee County, SC) Design/Build	50/75	Ammonia, BOD, TDS, and Color	MBR, UF, NF, and RO
Confidential Chemical MFR (GA) Design/Bid/Build	100/200	Radium and Aluminum	PREC and Flocculation
Confidential Beverage Bottler (GA) Design/Bid/Build	50/200	BOD and TSS	pH, SBR, and MMF
Confidential Coal Miner (BC) Design/Bid/Build	600/2500	Nitrate, Selenium, Other Metals, and Calcite	pH, MMF, FFB, Biofouling Control, EDA, Antiscalant Addition, Heating

ABBREVIATIONS

AOP = Advanced Oxidation Processes; AS = Air Stripping; BOD = Biochemical Oxygen Demand; ChemOx = Chemical Oxidation; CHL = Chlorine Disinfection; CMF = Catalyzed Media Filtration; EDA = Electron Donor Addition; EVAP = Evaporation; FBR = Fluidized Bed Reactor; FE = Flow Equalization; FFB = Fixed-Film Bioreactor; GSP = Greensand Polishing; ISB = In-Situ Bioremediation; IX = Ion Exchange; LGAC = Liquid-Phase Granular Activated Carbon; LS = Lime Softening; MBR = Membrane Bioreactor; MMF = Multimedia Filtration; NF = Nanofiltration; OWS = Oil-Water Separation; pH = pH adjustment; PREC = Precipitation; RO = Reverse Osmosis; SBR = Sequencing Batch Reactor; SH/D = Solids Handling/Dewatering; TDS = Total Dissolved Solids; TSS = Total Suspended Solids; UF = Ultrafiltration; UVOx = Ultraviolet Oxidation; UV + H2O2 = Advanced Oxidation by UV Photolysis of Hydrogen Peroxide; VGAC = Vapor-Phase Granular Activated Carbon; VOCs = Volatile Organic Chemicals.

March 29, 2022

Eric Lindman, PE
City of Wausau – Engineering
City Hall
407 Grant St.
Wausau WI 54403

Subject: Qualifications / Professional Experience Related to PFAS Treatment & Removal from Drinking Water

Dear Mr. Lindman;

The City of Wausau is looking for information on PFAS treatment experience to add to their team so a holistic approach to meeting their water quality objectives can be achieved. The project goal is to provide a treatment process that will meet the less than 20 part per trillion (ppt) and less than 1 Heath Index for PFAS as set by the Department of Health as well as meeting DNR and PSC regulatory requirements. Wausau wants to incorporate the PFAS treatment system in their existing work for the new water treatment facility and wants a solution that meets the varied objectives.

Our attached documentation of professional experience demonstrates our expertise and strong qualifications for PFAS identification and solutions.

AECOM can provide a highly capable team for this project because:

- ◆ Our project manager, **Angel Gebeau**, PE has a depth of work experience in the PSC and DNR regulatory environment in working over two decades on groundwater drinking water treatment within the state. She also spent a decade managing groundwater treatment projects within AECOM which include geographically separated and highly technical AECOM staff. Angel's resume is provided. Attachment #1, Slide 25 lists clients Angel has worked with in Wisconsin in the past two years. She works in the Stevens Point WI and within an hour drive of Wausau.
- ◆ AECOM has a breadth of staff available for the project work and has identified staff to work on this project including national expert **Chris Curran** who is the North American PFAS lead and completed over a dozen treatment projects, **Francisco Barajas Rodriquez** who operates the Austin PFAS treatability lab that allows AECOM to self-perform rapid small scale column testing (RSSCT) at a bench scale on multiple options for PFAS treatment, and **Nomble Lee** who joined AECOM after her previous work with an ion exchange company that has a PFAS selectivity resin. Nomble will be able to provide information on the expectations of total organic carbon (TOC) and the Tulsion A-72 MP resin by Thermax on the PFAS removal process. Their resumes are provided. Outside this team, AECOM can also reach out to its global team and collaborate with its staff experts worldwide. For example, AECOM's local team can reach out to staff as needed currently operating and managing PFAS drinking water treatment systems at other locations in North America.
- ◆ AECOM has a strong local support team. **Lanette Altenbach** is another local Wisconsin AECOM staff member who routinely meets with DNR regarding PFAS concerns and can provide background on the regulatory processes. Currently, AECOM has over 17 PFAS projects in Wisconsin. Monthly, 20 AECOM staff meet to discuss PFAS issues including drinking water, wastewater, regulations, and other PFAS areas of interest in Wisconsin.
- ◆ The AECOM team has completed over 30 water treatment projects. The AECOM WI team projects for dewatering treatment are not included in that total. AECOM projects in WI have not generated a PFAS wastewater stream as all waste products have been media only.
- ◆ AECOM's inhouse treatability lab allows for evaluation of granular activated carbon (GAC) and other adsorptive media from multiple vendors and can allow for PFAS spike testing and other pre-treatment modification testing. Information on pilot testing can be found in Attachment #1 beginning on slide 26. Most PFAS groundwater sites are unable to run their wells to allow for



similar site pilot testing that the City of Wausau is performing. AECOM's RSSCT bench scale testing only requires 10 gallons per column tested. Information from the treatability lab has been suitable for design of the projects noted in Attachment #1 on slide 23. The treatability lab can mimic pre-treatment including iron and manganese removal. For other utilities that have completed previous PFAS treatability testing (typically RSSCTs by vendors) AECOM has utilized the treatability study results to reduce the scope and perform only the testing desired for arriving at the best, non-product biased alternatives. Bench scale testing is typically less than \$50,000 including four columns, sample pre-treatment, and dozens of PFAS samples to focus on the breakthrough periods. The final report has historically been completed within six weeks of sample shipment to the lab.

- ◆ AECOM has a proprietary system for complete PFAS destruction called Defluoro and has managed waste streams from GAC and Ion Exchange (IX) treatment systems. This equipment allows AECOM to treat wastewater from the bench scale testing as appropriate. AECOM understands waste disposal concern from water and media disposal and is highly qualified to discuss concerns relating to wastewater with the City team.
- ◆ AECOM has a team mentality and is eager to be a part of a collaborative engineering team to achieve a solution. AECOM has a history of working collaboratively with other engineering teams and as part of Wisconsin Section of AWWA has met many of the key staff statewide and has worked alongside them in building up the state-wide drinking water industry. AECOM looks forward to discussion on scope and developing a plan.
- ◆ AECOM understands the funding mechanisms of the Wisconsin Safe Drinking Water Loan (SDWL) process and how it may impact equipment selection and schedule.
- ◆ AECOM has a strong alternatives analysis methodology (examples Slide 19 and 38) that would allow the City and Utility to select the best alternative to continue into construction. The analysis includes multiple cost and non-cost factors. An example evaluation is the cost to increase the treatment equipment by one increment and the associated reduction in PFAS anticipated. Other options include space saving using IX media compared to the operational costs for ultimate media disposal. Other alternatives can include procurement for specific equipment that can extend out years due to production issues compared to alternatives that can have faster implementation rates.
- ◆ AECOM has a firm understanding of community engagement and can integrate into existing community engagement processes or assist in a project specific communication plan and platform. AECOM staff looks forward to developing that scope with the City and Utility to meet the specific needs of the local community.

A detailed response to specific comments provided in the RFQ is attached for your review as well as a proposed set of slides for a potential presentation.

This AECOM team has recently been selected to serve as the PFAS treatment engineers for the Madison Water Utility Unit Well #15 based on our qualifications and is currently assisting Weston Water Utility. AECOM staff are eagerly looking forward to working with DNR on these PFAS systems using our successful work across North America as an indication and path to success in Wisconsin as well.

Sincerely,

AECOM

Angel Gebeau, P.E., BCEE
Senior Project Manager
715.342.3023
Angel.gebeau@aecom.com

RFQ Response:

List of key personnel involved in the proposal:

Resumes of key staff provided

Angel Gebeau – Project manager and lead engineer
Chris Curran – Lead technical engineer (North American experience)
Lanette Altenbach – Regulatory support (Wisconsin experience)
Francisco Barajas Rodriguez – PFAS treatability and testing lead
Noble Lee – IX treatment lead and project engineer

Presentation

Slides 3, 4, and 5 to be presented by PM introducing team and providing story (slide 5) on 24-hour response time to waste disposal and regulatory question from Wisconsin client as well as noting strength of external support in Wisconsin and nationally.

Examples of PFAS treatment/removal completed projects

Attachment #1, slides 9 through 22 provide sample projects as follows:

Slides 9 and 10 - Confidential Client – AECOM designed and is operating this facility. Variations in PFAS concentrations from wells was evaluated to maximize GAC use.

Slides 11, 12, and 13 - Chemical Manufacturer NJ – Project had pre-treatment requirements that increased the cost for the project. AECOM had provided pH control systems that the operator turned off after startup without consulting the designer and resulted in fouling of the GAC. This illustrates what may happen if the designer is not aware of scaling potential or if the owner does not communicate with operators. Understanding water chemistry avoids costly issues.

Slides 14, 15, 16, and 17 - Westborough MA – Review included repurposing of treatment vessels that were evaluated to not be as effective as construction of a building expansion and vertical GAC vessels.

Slides 18 and 19 - Suez Orange, NJ – Fast-tracked the installation an interim ion exchange system until full plant design including GAC was completed. Project included the alternative decision model referenced on slide 19.

Slides 20, 21, and 22 – Braintree, MA – integration of PFAS treatment into a newly constructed water treatment facility included review of existing TOC reduction measures and the impact on PFAS.

Consultant's experience related to PFAS in water and wastewater

In addition to project locations across the USA referenced on slide 7, AECOM has performed tens of thousands of water or wastewater PFAS sampling nationwide. Two example projects from Michigan include:

1. AECOM completed the Statewide Wastewater Treatment Plant Biosolids PFAS Evaluation completed for Michigan Department of Environment, Great Lakes, and Energy (EGLE) and details can be located at: <https://publications.aecom.com/pfas/solutions/statewide-wastewater-treatment-plant-biosolids-pfas-evaluation> This details the completed project with over 300 samples for agricultural fields, and over 200 samples from liquid and solid process at wastewater treatment facilities.



2. AECOM was awarded the Wastewater program following the successful statewide PFAS sampling of drinking water that AECOM completed for EGLE. The drinking water report created by AECOM for that project can be accessed from:
https://www.michigan.gov/documents/pfasresponse/2018_PFAS_Sampling_of_Drinking_Water_Supplies_in_Michigan_663543_7.pdf Page 22 of the pdf provides the survey results from the State of Michigan PFAS sampling in drinking water.

Slide 8 summarizes the range of work that AECOM can perform relating to PFAS identification and solutions. In general, AECOM experts can support the full range of PFAS related questions.

Slide 23 includes more than 30 examples of AECOM's PFAS treatment experience.

Experience with WDNR and PSC regulations and PFAS projects in WI

Slide 24 identifies AECOM's PFAS experience in Wisconsin ranging from site investigation to treatment of water in dewatering systems. The dewatering projects included WPDES discharge and WDNR discussions.

Slide 25 identifies 13 Wisconsin drinking water systems that project manager Angel Gebeau worked with in the past two years. PSC submittals were provided for City of Sheboygan, Plover, Weston, and New London of those listed. WDNR submittals were required for ten of those utilities. Dozens of other water utilities outside the past two years have also been supported by AECOM in both PSC and DNR submittal processes. AECOM has worked with several regulatory agencies in other states and use the strategies to achieve success in other geographies as part of the permitting process for DNR. AECOM has navigated PSC submittals and is aware of the need for early submission when possible and a strong alternatives analysis to meet PSC requirements as part of the submittal process.

Written Page Limit for Proposal -

AECOM has limited the written response pages and provided Attachment #1: A potential slide presentation in an effort to adequately respond to the RFQ. AECOM requested leniency on the page limit as the slide presentation submittal exceeds the page limit; however, the AECOM team felt it was appropriate to include the slide deck to allow adequate review prior to the April 6th meeting, if selected. The City Engineer did approve the additional pages via email correspondence.

Slide Presentation –

An example slide deck is provided as Attachment #1. To meet the 15-minute time limit the focus point will be slides 1 through 8, two projects selected from slides 9 through 22, slides 23 through 25, slides 35 through 40, and slides 44 through 46. AECOM staff will be prepared to discuss other slides if ample time is available and at the request of the City.

Specific questions and responses:

- 1.a) *What is the consultant's experience in design of PFAS removal from groundwater?*
Experience is significant and is listed in Attachment #1 slides 6 through 25.
- b) *For both drinking water and for groundwater remediation?*
Drinking water is the focus for the experience listed and will be the most economical solution. A list of groundwater PFAS remediation projects can be supplied upon request.

- c) *With what types of removal systems do you have experience?*
Slides 30 through 34 identify AECOM's experience with removal systems and pilot testing including granular activated carbon, ion exchange resins, and various novel sorbents listed on that slide. AECOM has obtained proprietary medias for testing and has used these various medias in bench scale and full-scale processes.
- 2) *Has the consultant worked with the WDNR on PFAS removal in drinking water or with PFAS removal for groundwater remediation?*
Yes, the list on Slide 24 illustrates dewatering projects and remediation projects in Wisconsin that required AECOM to work with DNR for that water treatment process.
- 3) *Does the consultant have experience in PFAS removal related to wastewater and biosolids (Class A or Class B)?*
AECOM has completed sampling in both wastewater biosolids and water streams and has completed several reviews related to PFAS in wastewater. In general, source reduction remains the preferred method for PFAS reduction in wastewater. We also have three other removal related projects listed for your review.
1. AECOM worked with a Wisconsin confidential client to design a zero-liquid discharge from their industrial facility due to PFAS concerns.
 2. AECOM conducted a National Wastewater Treatment Plant (WWTP) PFAS Study that included eight states and nineteen WWTPs. The study included an initial screening and then a mass balance to understand the final fate of PFAS in the treatment process. The mass balance included review of nine water sampling locations in the process and five solids sampling locations.
- 4) *What is the consultant's experience in the field of fate & transport of PFAS?*
AECOM has a wide range of experience in evaluation of fate and transport of PFAS and AECOM has published presentations completed by AECOM technical experts including bioaccumulation and Defluoro PFAS destruction technology. Those can be accessed at: <https://publications.aecom.com/pfas/insights>
- 5) *What proven technologies and emerging technologies for PFAS treatment does the consultant have experience? Either experience in the lab, pilot testing or testing through full scale temporary treatment of PFAS?*
While AECOM continues to develop and review new technologies for PFAS treatment, the standard technologies for drinking water systems include granular activated carbon and ion exchange. Slide 30 describes other novel sorbents that have been tested with success but are not typically used for drinking water consumption at this time.
- 6) *What is the consultant's experience in design of drinking water and wastewater treatment facilities? Specifically, what is the experience in Drinking Water and Wastewater Treatment and working with state and federal regulators?*
AECOM has two current water treatment design projects for water utilities within Wisconsin and the project manager has completed over 50 DNR submittals related to drinking water treatment over her career.
AECOM in North America and has hundreds of active drinking water and wastewater projects and additional project listing can be provided upon request.
- 7) *What is the consultant's experience in corrosion control treatment optimization? What methods/chemicals of CCT?*
Angel Gebeau has completed corrosion control desktop studies for four water systems and phosphate and pH adjustment for over 10 water utilities. AECOM North American water treatment team has been engaged and various corrosion control and lead service programs for clients including Philadelphia and Denver. Quirien Muylywyk is an AECOM VP in water quality and is one of many AECOM experts that this project team can reach out for support in corrosion control.



8) *Experience in drinking water disinfection using chloramines? Other disinfection methods?*

Angel Gebeau has worked with several systems using gas, liquid, and solid chlorine, on-site chlorine generation, chloramines, subsequent system chloramine boosting, ozone, permanganate, UV, and chlorine dioxide. Her most recent experience with chloramine was developing an analysis and boosting protocol for a federal installation in Florida. This facility was purchasing water as a subsequent system and experienced significant issues with variability in chloramine residual.

9) *What is your experience in managing PFAS generated waste including reactivation of spent carbon, single use resin, disposal of contact media and/or destruction?*

AECOM operates facilities that manage the disposal of PFAS treatment wastes and understand the disposal requirements. AECOM experience concludes waste management authority should be limited to highly trained and experienced individuals, formal standards for management of waste should be developed, and reclamation of spent carbon should be completed where possible with reputable carbon regeneration vendors. A lower regeneration price from an unknown vendor may not provide the best long-term value or strategy to mitigate contaminant disposal risk due to PFAS management. AECOM can provide a list of approved disposal facilities if regeneration is not possible. AECOM has a reclamation facility audit program and also have worked on a Defluoro technology that may be used for waste destruction in very concentrated waste streams.

Statement of Intent

While outside the noted scope, because PFAS contamination has been in the news regularly as a serious health concern, AECOM suggests consideration for highlighting the project through community engagement and development of a PFAS Communications Plan. Slide 44 is provided as an example of what AECOM has done for other clients with community engagement both in person and virtually.

One very historically successful option is an AECOM virtual room for engagement. For an example please see: <https://aecomviz.com/360-virtual-rooms/>

An article AECOM presented on achieving social equity through virtual reality:

<https://aecom.com/blog/achieving-social-equity-through-virtual-reality/>

If selected, AECOM would look to the City to provide indication if this potential scope item should be included in the presentation.

Angel Gebeau

Drinking Water Engineer

Education

BS, Environmental
Engineering, Michigan
Technological University,
2001

Years of Experience

With AECOM: 21

Licenses/Registrations

Board Certified
Environmental Engineer
Professional Engineer,
Virginia, Minnesota,
Wisconsin, North Dakota,
Michigan, Washington,
Texas

Professional Affiliations

American Academy of
Environmental Engineers
and Scientists
American Water Works
Association
Wisconsin Rural Water
Association
Wisconsin Section of
AWWA

Summary

Ms. Gebeau is a senior engineer and the North America and Global Water Treatment Practice Area coordinator. She currently serves as a groundwater treatment specialist and a technical specialist with Chris Curran on the Emerging Contaminants Technical Practice Group for the global treatment technical practice for AECOM. She has worked on numerous water treatment systems throughout the US. Her focus has been in the design of new drinking water treatment facilities and the evaluation of current facilities. She has been involved in numerous drinking water treatment projects at various communities and several military installations.

Project Experience

Water Treatment Plant 4, St Louis Park,

Minnesota. Design engineer responsible for water treatment process design from pilot study protocol development through shop drawing review. Treatment capacity is 1,200 gpm. Facility designed for removal of iron, manganese, radium, VOCs, and future 1,4 Dioxane treatment. Includes low profile air strippers with slide-out trays for VOC removal, high service pumping, and chemical feed systems for fluoride, gas chlorine, and HMO. System had site constraints with construction in the existing water treatment facility. Pilot testing included ozone and peroxide and UV and peroxidized advanced oxidation processes. Ozone and peroxide AOP was selected from the pilot testing and full-scale design was approved by the regulatory agency. As the concentrations of 1,4 Dioxane increase the equipment will be purchased and placed online.

Water Treatment Plant 6, St Louis Park,

Minnesota. Design engineer responsible for water treatment process design from pilot study protocol development through regulatory submittal and approval. Treatment capacity is 1,200 gpm. Facility designed for removal of iron, manganese, radium, VOCs, PAHs, and 1,4 dioxane treatment. Includes low profile air strippers with slide-out trays for VOC removal, high service pumping, and chemical feed systems. Building design accounted for many site restraints. Pilot testing included ozone and peroxide

and UV and peroxidized advanced oxidation processes.

Confidential Client, Perchlorate Treatment Facilities, Confidential.

Designed plant layout, tabulated major process equipment and equipment specifications, sized air compressor, completed process flow schematic, reviewed equipment sizing, and tabulated equipment items for piping and instrumentation.

Water Treatment Plant 6, City of Edina, Minnesota.

Design engineer responsible for water treatment process design from pilot study protocol development through shop drawing review. Treatment capacity is 4,400 gpm (24mld) and treats water from four well sources. Facility designed for removal of iron, manganese, radium, and vinyl chloride. Treatment processes include oxidation/disinfection with chlorine gas, hydrous manganese oxide addition for radium adsorption, horizontal pressure filters with activated media for iron, manganese, and radium removal. Includes low profile air strippers with slide-out trays for vinyl chloride removal, high service pumping, and chemical feed systems for fluoride and polyphosphate. System had unique site constraints with construction in the lower level of an existing parking garage.

Pearl Harbour Air Force Base, Contingency Response Plan, Pearl Harbour AFB, Hawaii. Project

engineer for the contingency response plan for potential contamination of water system. Completed a grab-and-go book used to assist in an emergency contamination situation.

Chlorination System Design, Various Clients.

Completed chlorine system design for over a dozen groundwater systems. Included reviews of chlorination effects on water quality at each site. Iron, manganese, hydrogen sulfide, ammonia (breakpoint chlorination), and water corrosivity. Presented at national water conference on comparisons of chlorination systems.

Confidential Client, Perchlorate Ion Exchange Media Resin, Riverside, California. Reviewed various IX resin available for perchlorate removal. Completed preliminary analysis of perchlorate treatment for each media and cost analysis for each media. Provided recommendations for media and treatment services for client. Reviewed resin replacement versus resin regeneration for expended resin.

Perchlorate Treatment Pre-Feasibility Study, GESDEC, Geneva Switzerland (Project Engineer). Responsible for a technical study of the treatment options for perchlorate treatment using ion exchange, specialty GAC media, fluidized bed reactors, or reverse osmosis. Reviewed regionalization of the treatment options and cost estimates for planning level source water analysis. Utility was evaluating the risk associated with the surface water source and the costs for treatment of specific groundwater sources.

Robins Air Force Base, Granular Activated Carbon Breakthrough Review, Robins AFB, Georgia.

Project engineer for a technical study of the GAC system at Robins AFB. Modelled GAC breakthrough for TCE, perchlorate, and miscellaneous compounds to determine the effect of increased TCE levels and changes in raw water quality on GAC performance. Determined the carbon life expectancy and provided suggestions for optimizing performance.

Evaluation of Water Treatment Plants (WTPs) and Disinfection Systems for Conformance with Navy Overseas Drinking Water (ODW) Surface Water Treatment (SWT) Requirements Guidance Commander Fleet Activities Yokosuka (CFAY), Yokosuka, Japan, Commander Fleet Activities Sasebo (CFAS), Sasebo, Japan. Subject Matter Expert and engineer for comparison of treatment

and distribution system construction and operational data with regulatory requirements. As of 3/2022, the existing information has been compiled and data gaps submitted to the water providers for response.

Chlorination System Design, Various Clients.

Completed chlorine system design for over a dozen groundwater systems. Included reviews of chlorination effects on water quality at each site. Iron, manganese, hydrogen sulfide, ammonia (breakpoint chlorination), and water corrosivity. Presented at national water conference on comparisons of chlorination systems.

Corrosion Control Studies, Lackland AFB, Texas, Waterloo, Iowa, and multiple others. Completed a corrosion control study, which indicated factors in lead and copper concentrations due to corrosion. Included a regulatory review and WaterPro! corrosion modeling.

Disinfection Byproducts (DBP) Studies, Little Rock AFB and multiple others. Completed disinfection byproducts studies and review of distribution systems for sampling locations for DBPs for multiple military clients.

Master Planning Evaluation, Weston, Wisconsin, Verona, Wisconsin and multiple others. Project engineer and subject matter expert for review of water system operations from source water supply to final distribution to develop a list of current or anticipated regulatory concerns to be addressed in the capital improvements plan developed in the Master Planning Document.

History of General Services for Water Utility Clients in Wisconsin: City of Neillsville, Plover Water Utility, Whiting Water Utility, Village of Amherst, Verona Water, Watertown Water Utilities. Work projects have included emergency response to water quality concerns, nitrate treatment system design with ARRA funding, lead and copper corrosion control review, well rehabilitation review, filter maintenance and backwash operations review, risk assessments, emergency response plans, and a myriad of responses to the needs of the utilities.

Chris Curran, PE

Senior Environmental Engineer/Senior Technical Advisor/PFAS Treatability

Education	Years of Experience	Licenses/Registrations	Professional Affiliations
MS, Environmental Health Engineering, Pennsylvania State University, 2001	With AECOM: 23	Professional Engineer, Delaware	Water Environment Federation
BS, Civil Engineering, Virginia Polytechnic Institute and State University, 1995	With Other Firms: 2	Professional Engineer, Maryland	American Public Works Association
			Pennsylvania Water Environment Association

Summary

Chris has more than 25 years of experience in water and wastewater, environmental, and water resources engineering, including both technical lead and project management for infrastructure design. Over the past 15 years, Mr. Curran has been successfully involved with many planning through detailed design and construction support for the removal of PFAS compounds from potable water, groundwater remediation, leachate, and stormwater systems.

Project Experience

Orange County Water District / Irvine Ranch Water District, Orange County, CA. Provided quality review of a treatment system using ion exchange for PFAS from a 2,000 gpm supply well. Improvements include integration of the treatment process into the existing system with the addition of pre-filtration and relocation of disinfection needs.

US Air Force Facility, CA. Lead engineer on a pilot system to evaluate performance of novel adsorbent on PFAS removal at an existing groundwater treatment system. Upon exhaustion, the sorbent will be regenerated and the concentrate treated for PFAS destruction with AECOM's DE-FLUORO electrochemical oxidation process.

Suez Chestnut St PFAS Project Orange, NJ Project lead that conducted a feasibility study for the installation of ion exchange or GAC to address PFAS levels in the raw water that exceeded NJDEP state regulations. Incorporation of the best available technology and location within the existing 3.5 MGD treatment train were evaluated considering numerous site constraints and continual operations of plant during construction. AECOM now preparing the 65% design for use in permitting and advancement of design-build delivery to compress schedule.

Tritown Regional Water Treatment Plant PFAS Design, Braintree, MA. Lead bench testing, treatability assessment and design of implementing PFAS treatment to comply with new state PFAS regulations on a new 13 MGD regional surface water facility. Testing was performed to determine the most effective carbon and the integration into the proposed treatment train considering total organic carbon (TOC) removal as well for disinfection by-product mitigation. Existing treatment train consists of oxidation, dissolved air flotation and deep bed GAC filtration. Upon review it was determined that enlargement

of the proposed deep bed GAC filtration to achieve desired PFAS removal needs concurrent with TOC would be most cost-effective when compared to dedicated tertiary GAC or IX facilities. Provisions will include the ability to add a novel adsorbent for additional targeted PFAS removal during any periods of elevated TOC in the source water that may impact PFAS breakthrough rates.

Confidential Client, Colorado. Provided technical review of two new regional ion exchange treatment facilities sized at 5 MGD and 10 MGD to provide treatment for 27 wells impacted by PFAS compounds.

US Air Force Facility, MA. Lead engineer conducting alternative evaluation for treatment options to upgrade an existing groundwater treatment system to mitigate PFAS in outfall and comply with PFAS6 state potable regulations.

Water Treatment Plant Upgrades for PFAS, Westborough, MA. Performing treatability testing and detailed design for improvements at a 3 MGD groundwater supplied water treatment facility impacted by PFAS. Treatability testing for GAC, a novel adsorbent and modelling of IX was conducted to evaluate media performance. An alternative analysis is now being performed to identify the most optimal integration into the existing facility considering site constraints and processes.

Process Water Treatment System, Parkersburg, WV. Lead verifier. Project involves design for a process water system impacted by multiple PFAS. Currently, a 2.2 MGD production well is impacted in the part per billion range with both short and long chain PFAS. We evaluated GAC and IX technologies based on treatment effectiveness and project timing for installation considering permitting requirements and developed a design for initial use of GAC that can be retrofitted to IX in the future if warranted for life-cycle cost savings. Project challenges included elevated inorganics requiring pre-treatment and the need

for new backwash facilities along with site constraints that included limited space availability for the two parallel trains of 80,000 lb GAC vessels arranged in series with lead-lag operation.

Water Treatment Plant Evaluation for PFAS, Newburyport, MA. Performing sampling and evaluation of multiple sources including springs, groundwater supply wells and surface water reservoirs that contribute to the raw water supply of the facility. Considerations for PFAS and other water quality drivers such as disinfection by-products, taste and odor and seasonal algae are being evaluated to determine the most optimal approach for either specific sources or the combined blended raw water supply to the plant.

Water Treatment Plant Upgrades for PFAS, Pennsville, NJ. Providing quality review of proposed design improvements for a 3 MGD groundwater supply impacted by PFAS. In addition, improvements to address elevated iron /manganese and residual management.

Water Treatment Facility Plan, Ann Arbor, MI. Starting evaluation of potential impact of PFAS sources in the surface water supply feeding the 50 MGD treatment facility. Existing pilot studies and full-scale demonstration of GAC performance will be reviewed and a strategy developed to consider the potential impact of PFAS should treatment be necessary given the current source water trends and proposed process configurations for necessary softening improvements.

PFAS Study of Three Wastewater Facilities, Los Angeles County Sanitation District, CA. Developed a white paper regarding PFAS analytical results at three large wastewater/re-use facilities for LA County. The deliverable provided guidance on potential available treatment technologies to comply with anticipated water quality standards being considered by the State.

Collaborative Water-Energy Research Center (CoWERC) - AECOM is the sole engineering consultant on a collaborative team of academia, industry and utility partners from the US and Israel. Working at the intersection of water and energy, the team will research, develop, and commercialize technology in three areas: energy-efficient enhanced water supply, wastewater reuse and resource recovery, and energy-water systems. Representing AECOM with a focus on the development of technologies to address micro-organic constituents that presently pass-through water reclamation facilities with the primary class of compounds including PFAS.

Confidential Client, Water Treatment Plant Upgrades, Mid-Ohio River Valley, OH. Task Manager and Lead Design Engineer responsible for process upgrades to 10 water treatment plants ranging up to 2.4 mgd in Ohio and West Virginia after regional groundwater supplies were

contaminated with PFAS. The design used a GAC treatment process design that was applicable to each facility, but the overall design needs, constraints, and hydraulic/treatment complexities were unique to each water treatment plant.

Technical Support, Design-Build of Granular Activated Carbon (GAC) Addition, Wood County, WV. Completed a design-build addition of a GAC treatment to remove PFOA from an existing public water facility. GAC treatment systems were installed at three locations. One system has a flow of 900 gpm and the other system at 700 gpm. Project involved well water evaluation, verification of water distribution model, treatment process design, permitting, construction, start-up, and OM&M. This project is unique with the accelerated timeframe to get the GAC in operation as there was a "do not drink" advisory on the city's drinking water. AECOM was able to prepare a design and permit package in six weeks and put an operational system within six weeks from mobilization. AECOM worked with multiple stakeholders to expeditiously achieve significant milestones ahead of the deadline. A third system with a flow of 450 gm was constructed in 2019.

Confidential Client, Spruance Groundwater Treatment Plant Upgrade Design, Richmond, VA. Performed design through construction support for an upgrade of an existing 125 gpm collection, transmission, and treatment system to an expanded 360 gpm system for enhanced site capture. System includes 48 extraction wells located in six different alignments and 14,500 lineal feet of transmission mains. The system consists of oxidation, pH adjustment, sedimentation, and filtration processes to remove high iron, aluminum, and manganese levels; an air stripping system for removal of volatile organics; and granular activated carbon to treat PFOA. Residuals are managed in thickening tanks and centrifuge dewatering units. Project is located on active industrial facility.

Confidential, Groundwater Remediation, Parlin, NJ. Lead Design Engineer responsible for concept through final design of a 500 gpm groundwater collection, transmission, and treatment system to address PFAS. The system consists of 5 extraction wells and transmission to a facility with oxidation, sedimentation, and filtration processes to remove high iron levels; an air stripping system for removal of volatile organics; and GAC to remove PFOA. The effluent is disposed via a groundwater reinjection system using infiltration basins to enhance groundwater recovery and assist in plume capture. The layout of the process limits energy needs by allowing for gravity flow and using sand drying beds for residuals management.

Aquarion Rewak Well PFAS Evaluation, CT. Lead engineer conducting a bench treatability and alternative evaluation to provide PFAS treatment at an existing water treatment plant. The study is evaluating the optimal location for PFAS treatment related to an existing air stripper for VOC removal and pH adjustment so that the well can be put back into service and comply with regulations.

Francisco Barajas, Phd, EIT

Process Engineer

Education	Years of Experience	Licenses/Registrations	Professional Affiliations
MS, Environmental Health Engineering, Pennsylvania State University, 2001	With AECOM: 5.5 With Other Firms: 6	Professional Engineer, Delaware Professional Engineer, Maryland	Water Environment Federation American Public Works Association Pennsylvania Water Environment Association
BS, Civil Engineering, Virginia Polytechnic Institute and State University, 1995			

Summary

Dr. Barajas is an environmental engineer and treatability subject matter expert working in water and wastewater treatment, and soil and groundwater remediation, among other areas. He has collaborated with project managers, engineers, and remediation practitioners in over 50 different projects, conducting treatability testing to improve project performance, lower treatment costs, and support technology selection. These projects range from PFAS treatment in various media employing different approaches such as enzyme-mediated degradation, adsorption on carbon-based media, ion exchange resins and novel adsorbents, and electrochemical oxidation. Dr. Barajas has experience in bench-scale evaluations for treatment of complex industrial wastewater, sediment dewatering, remediation of organic contaminants (via chemical oxidation and bioremediation), in-situ stabilization of waste and sediments, and immobilization of coal combustion residuals (CCR) heavy metals in groundwater.

Project Experience

Confidential Industrial Client, Bench-Scale Treatability Study for Treatment of PFAS in Landfill Leachate (in progress). Lead a series of laboratory-scale evaluations for the removal of PFAS from raw landfill by using Rapid Small-Scale Column Testing (RSSCT) packed with commercially available novel adsorbents. The study is evaluating the performance of a modified bentonite and a novel cyclodextrin.

US-Israel Collaborative Water-Energy Research Center (CoWERC), Bench-Scale Evaluation of Novel Cyclodextrins for their Removal of PFAS from Various Water Matrices (in progress). Long-term collaboration with researchers at Northwestern University to evaluate and validate the performance of novel and recently synthesized cyclodextrins for their capacity and selectivity to separate PFAS from various water matrices. Designing an RSSCT test for one novel cyclodextrin on pre-treated municipal wastewater influent. Facilitating technical support transfer between AECOM and Northwestern University to improve methodology and experimental design for the evaluation of novel adsorbents.

Confidential Municipal Water Supplier, Bench-Scale Treatability Study to Evaluate the Performance of Granular Activated Carbon (GAC) on PFAS Removal from Drinking Water (in progress). Conducted RSSCT evaluation on air-sparged and non-sparged water influent to understand the effect of air sparging on the performance and bed-life of GAC media for the removal of PFAS from the water matrix. The study also characterized the presence of volatile organic compounds (VOCs) and total organic

carbon. RSSCT results will indicate if air-sparging has a positive influence on the GAC performance.

Air Force Civil Engineering Center (AFCEC), Broad Agency Announcement (BAA) #2128, 2021 (in progress). Principal investigator for a BAA field demonstration on the use of a novel cyclodextrin adsorbent to remove PFAS from groundwater coupled with AECOM's DE-FLUORO™ technology to destroy PFAS in the sorbent regenerant waste solution. The treatment train is an innovative approach to leverage high selectivity and capacity from a novel sorbent with DE-FLUORO™'s ability to destroy PFAS.

Confidential State Agency Client, Evaluation of Adsorptive Media for the Removal of PFAS from Groundwater at an Industrial Site (in progress). Conducted technology screening for commercially available products that can separate PFAS from water matrices. Lead laboratory batch isotherm tests on eight different adsorbents including a GAC, ion exchange resins, an iron oxide, and a cyclodextrin. Currently designing an RSSCT test to evaluate the specific throughput from the top three performing medias.

Confidential Federal Government Client, Evaluation of In Situ Stabilization (ISS) for PFAS in Soil via Leachability Tests (in progress). Assisted in technology screening and lead a bench-scale evaluation of various ISS recipes for their ability to immobilize PFAS in four different soils from a site in Germany. The methods employed included German methodology similar to the synthetic precipitate leachate procedure (SPLP) and multiple extraction procedure (MEP) for long term

leachability effects. The additives under evaluation include GAC, biochar, and a modified bentonite.

AECOM Funded Research Project, Evaluation of Phytoaccumulation of PFAS in various Plant Tissues (2021). Collaborated on a proof-of-concept evaluation of PFAS bioaccumulation on tissues from various plant species grown *in vitro* and *in vivo*, including tea plant leaves, gifblaar, alfalfa, tall fescue, and field pennycress.

Confidential Federal Government Client, Evaluation of Adsorptive Media for the Removal of PFAS from Groundwater (2021). Collaborated with AECOM's Omaha, NE, federal program personnel to design and implement a comprehensive bench-scale treatability study evaluation of five adsorptive media (one GAC and four ion exchange resins) to remove PFAS from groundwater. The study included a batch isotherm evaluation to characterize isotherm parameters useful to predict adsorption capacities. In addition, RSSCT was conducted on the five medias to evaluate their specific throughput for regulated PFAS compounds. The results of the bench-scale study were integrated into a life-cycle analysis model to select the best media(s). The best performing media(s) will be evaluated on an on-site pilot-scale treatment system.

Confidential State Agency Client, Bench-Scale Evaluation of AECOM's Electrochemical Oxidation Technology (DE-FLUORO™) on the Destruction of PFAS in Waste Effluent from Surface Active Foam Fractionation (SAFF) Treatment (2021). Conducted a bench-scale evaluation of electrochemical oxidation to destroy PFAS compounds in a waste sample from a SAFF treatment process. The SAFF waste contained PFAS at near 5 grams per liter (g/L) and total organic carbon at 4 g/L. The test was conducted with a bench-scale tubular membrane electrode reactor unit. PFAS destruction was up to 75% of the initial mass.

Town of Westborough, MA, Bench-Scale Treatability Study to Evaluate the Performance of Three Granular Activated Carbon (GAC) Products on PFAS Removal from Drinking Water (2021). Conducted RSSCT evaluation on the performance and bed-life of three commercially available GAC media for the removal of PFAS from groundwater to be used as a drinking water source. Two of the GAC products were of bituminous origin and one was coconut-shell based. The RSSCT test indicated a high longevity of all three GACs with slight differences in bed lives and specific throughputs. This information was utilized in a feasibility study that compared the use of GAC media against ion exchange resins.

Braintree Tri-Town Water Treatment Facility, MA, Bench-Scale Treatability Study to Evaluate the Performance of Two Granular Activated Carbon (GAC) Products on PFAS Removal from Drinking Water (2020). Conducted RSSCT evaluation on the performance and bed-life of two GAC media for the removal of PFAS from surface water to be used as a drinking water source. One of the GAC products had been used at the treatment facility for deep bed

filtration, while the second product was a specialized GAC already proven for PFAS and other organic contaminants. The goal was to evaluate if the GAC used in deep bed filtration had a similar performance as the specialized GAC. The RSSCT results indicated a significantly higher longevity in the specialized GAC product.

Confidential Industrial Client, Bench-Scale and On-Site Pilot-Scale Evaluation of liquid Carbon-Based Sorbent for PFAS Removal from Groundwater (2020-2022). Conducted a bench-scale evaluation of a novel graphene oxide suspension product on the removal of PFAS from groundwater using soil and groundwater batch tests. Assisted on data monitoring and review from an on-site pilot-scale study for in-situ injection of a commercially available colloidal carbon suspension to demonstrate the removal of PFAS at monitoring wells located near the injection well.

Confidential Client, Treatability Study on PFAS Treatment Via Adsorption, 2020. Conducted a bench-scale study to evaluate the proof-of-concept removal of PFAS from groundwater using a commercially available graphene oxide suspension.

Minnesota Pollution Control Agency, Pigs Eye Landfill Pilot Study, St. Paul, Minnesota, 2019. Performed the experimental design, planning, costs estimation, and execution for bench-scale activities to evaluate the effectiveness of an existing remedial approach to remove PFAS from groundwater at the Pigs Eye Lake site. The treatability study focused on improving the composition of a select fill in a permeable barrier that is being considered for full-scale implementation. Flow-through column tests were performed to determine breakthrough of relevant PFAS. A second treatability study was approved to evaluate biochar and other commercial media, such as peat moss, a modified bentonite, and two types of GAC.

Confidential Client, Recycling and Environmental Enterprise Facility Bench PFAS Treatment (2019). Conducted a series of bench-scale treatability studies to treat PFAS impacted pre-treated landfill leachate water and reverse osmosis reject waste. The experiments evaluated the performance of AECOM's DEFLUORO™ technology on the degradation of several PFAS compounds, including PFOA and PFOS, as well as short chain perfluoroalkyl acids, with the goal of providing an alternative to off-site disposal.

US Air Force Center for Engineering and the Environment, Broad Agency Announcement PFC Remediation, Austin, Texas, 2017. Performed a bench-scale treatability study to evaluate the effectiveness of a novel PFAS remediation scheme via enzyme-catalyzed oxidative coupling (ECOC) reactions induced in situ by the amendment of the enzyme laccase.

Lanette Altenbach, PG

Senior Hydrogeologist

Education	Years of Experience	Licenses/Registrations	Professional Affiliations
BS, Geological Engineering, Missouri-Rolla University, 1985 Practical Nurse, WCTI, 1974	With AECOM: 21 With Other Firms:14	Professional Geologist, Wisconsin	Wisconsin Groundwater Association American Institute of Professional Geologists Association of Engineering Geologists

Summary

Ms. Altenbach is a senior hydrogeologist in the environment group with over 35 years of experience. Her specialties include brownfield redevelopment projects, PFAS investigations, transaction due diligence, environmental assessments, feasibility studies, hydrogeologic investigations, remedial designs, remedial actions, Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act programs, and project quality assurance/quality control planning.

Ms. Altenbach has managed progressively complex projects including brownfield and manufacturing RCRA-compliance projects from the initial assessment or transaction due diligence, through remediation that ultimately resulted in regulatory closure. Her strengths are clear, concise communications and managing projects within budgetary and time constraints.

Project Experience

PFAS Investigations – Various Sites in Wisconsin, Project Manager, Lead Hydrogeologist. Lead hydrogeologist and/or project manager for the evaluation of site with PFAS contamination or suspected PFAS contamination. Assisted with the development of a work plan and investigation of a large commercial airport where PFAS impact had been identified in the open waterway present across the site. Helped identify potential source areas and assisted in the evaluation of the results of subsurface investigation at each source area. The project is ongoing.

Managed foam sample collection on various Wisconsin waterways under contract to the Wisconsin Department of Natural Resources. When observations of foam on waterways were reported to the WDNR, the WDNR would confirm the occurrence and ask for sampling of the foam. Sample events occurred in a variety of settings: drainage ditches, creeks, rivers and inland lakes.

Wisconsin Assessment Monies (WAM) Program – Various Sites, Wisconsin, Project Manager, Lead Hydrogeologist. AECOM is a selected contractor for the Wisconsin Department of Natural Resources grant program supporting municipalities with redevelopment. Municipalities request financial assistance for a brownfield site and if they receive

an award, the WDNR then contracts AECOM to conduct the work. As project manager for the program, Ms. Altenbach provides the scope of work and cost estimate, then directs staff to complete the work as needed. The services provided range from Phase I Environmental Site Assessments to site investigation services. Some recent sites have included investigations for PFAS contamination. Sites with likely history of PFAS use based on a Phase I ESA have been confirmed as sites with PFAS contamination in soil and groundwater.

City of Kenosha, Kenosha, Wisconsin, Project Manager, Lead Hydrogeologist. Continuing to manage the environmental and engineering aspects of the brownfield redevelopment of the former Chrysler Kenosha Engine Plant. Assisted the City with the procurement of funding (grants and loans), managed the work according to funding types and provided documented as needed for reimbursement requests. Assisted the City with oversight during building demolition by the liquidation trust. Led a team of qualified staff through the investigation (Phase I ESA through site investigation) and remediation aspects of the project. Participated in redevelopment planning and is currently integrating those plans into the remedial work in progress.

Confidential Steel Mill Company, Steel Mill Investigation, East Chicago, Indiana. Lead Hydrogeologist. Project hydrogeologist and QA/QC specialist for a steel mill in East Chicago, Indiana. Planned, implements and reported an investigation conducted for compliance with a 3013 order. Primary author of four sampling and analysis work plans and a quality assurance project plan. Managed the field work conducted under the approved work plans. Conducted a field audit during sampling activities. Provided data verification and validation for the laboratory analytical work. Co-authored final reports for the investigative efforts.

Town of Ashford, Brownfield Redevelopment, Ashford, Wisconsin, Project Manager. Managed a response for redevelopment of the Old Ironsides Battery site. Responsible for the investigation and remediation of lead-impacted soil. The county acquired the site through tax delinquency and sought to bring the property back into use. Negotiated with the Wisconsin Department of Natural Resources regarding scope of the investigation, remediation and ultimate case closure requirements. The site received closure and has been placed back on the tax rolls.

Smith Fibercast, Chlorinated Solvent Site Investigation and Remediation, Little Rock, Arkansas, Lead Hydrogeologist. Responsible for the investigation of chlorinated solvents at a fiberglass pipe manufacturer. Evaluated the hydrogeologic setting and identified subsurface terrace gravels as the primary conduit for contaminant transport. Identified a remedial approach. Activities at the site are ongoing.

Flexfab Molded Products, Former Manufacturing Facility Investigation, Racine, Wisconsin. Responsible for the investigation of a chlorinated solvent plume at a former molded rubber manufacturing facility. Planned and directed the investigative effort that was conducted in a phased manner. Remedial action is complete and the project has received closure from the Wisconsin Department of Natural Resources.

Atlas Metals, Soil Vapor Extraction System Installation, Waukesha, Wisconsin. Project manager responsible for helping a metal fabrication facility that had solvent contamination in the soil and groundwater achieve case closure. Oversaw installation and operation of a soil vapor extraction system. Modeled containment transport in the groundwater to demonstrate that the solvent plume was stable or receding and to predict the plume's future behavior. Obtained case closure from the WDNR.

Illinois Environmental Protection Agency, Galesburg Landfill, Final Capping Documentation, Galesburg, Illinois. Responsible for site QA/QC documentation during the installation of a final cover system including management of a waterway that was present through the middle of the landfill. This work was conducted for the Illinois Environmental Protection Agency (IEPA) Superfund Program.

Nomblé F. Lee

Process Engineer

Education	Years of Experience	Professional Affiliations	American Water Works Association
MS, Environmental Engineering, Temple University	With AECOM: 6 mos With Other Firms: 7.5	National Society of Black Engineers Society of Women Engineers	American Society of Civil Engineers
BA, Biology, Temple University			

Summary

Nomblé is a Water Resources Engineer within the Northeast Water Business Line. With the completion of M.S. Environmental Engineering, she has a strong background in water chemistry, hydrology drinking water treatment and chemical analysis. Nomblé also has in depth experience with the application of ion exchange resin to remove/reduce unwanted contaminants from water sources, focusing mainly on Perchlorate and PFAS removal. As a Water Resources Engineer Nomblé, will use her technical knowledge and problem-solving skills to tackle urgent and challenging water resource projects.

Project Experience

AECOM, Rouseff & Gowen Green Stormwater Infrastructure Design, Philadelphia, PA. Served as assistant to lead Green Stormwater Infrastructure (GSI) Designer for AECOM's On-Call Contract to design GSI retrofits within streets, public parks, recreation center, parking lots, and other public city spaces with the Philadelphia Water Department. Produce initial planning documents based on existing conditions and GSI feasibility across an area of interest. Development of survey baseplans, site investigations, design calculations and cost estimates.

AECOM, PWD Wastewater Master Plan Update, Philadelphia, PA. Served as assistant to technical lead to update Philadelphia's wastewater master plan which identifies and prioritizes capital improvements at the City's three Water Pollution Control Plants with a total capacity of almost 1000 MGD. Tasked with organizing and updating data for almost 3,000 assets from various disciplines. Used asset condition, status, and location to create graphs and displays that prioritized asset replacements and estimated capital cost for client. Served as assistant to lead engineer aiding in hydraulic model review and draft of client report.

AECOM, Delaware County Water Quality Control Authority (DELCORA) Eastern Service Area Tunnel, Chester, PA. Served as assistant to project manager for the design of a new deep rock tunnel from Western Regional Treatment Plant (W RTP) to the Darby Creek Pump Station to carry wet weather flow from the region to the plant for treatment. Tasked with aiding in communication to client, preparation of deliverables and meeting minute keeping.

AECOM, PFAS Research and Business Development, regional. Served as PFAS ion exchange specialist tasked with researching and tabulating current state regulation and PFAS sampling data from drinking water plants to aid in PFAS business development. Creation of spreadsheet that assembles industry contacts for PFAS to attain future leads.

Purolite Corporation, Anion Exchange Buffered Resin Development, Philadelphia, PA. Served as lead application engineer tasked with creating and validating a buffered resin formula for a client experiencing drastic changes in pH during system startup due to increases in chloride. The data from this research was used to reduce/eliminate resin rinse down time and ensure water system protection from high chloride to sulfate mass ratio which can create lead to leaching potential in piping systems.

Purolite Corporation, PFAS Ion Exchange (IX) Media Product Development, Philadelphia, PA. Served as lead application engineer tasked with examining ion exchange media characteristics and client water chemistry challenges to determine PFAS product effectiveness and develop a new market approach. This involved designing various pilot and isotherm column test focused on the impact of media characteristics on both long and short chain PFAS resin performance. As well as the organization and analysis of internal/external data. Results of this project were utilized to the PFAS product formula to better suit the needs of the emerging PFAS market.

Purolite corporation, Ion Exchange System Design, Philadelphia, PA. Served as application engineer tasked with utilizing customer water chemistry, facility setup and target contaminant level to determine feasible ion exchange design specifications involving routine calculations and product data. Systems designed include softening, demineralization, nitrate and PFAS removal.



QUALIFICATIONS FOR

City of Wausau Professional Experience Related to PFAS Treatment and Removal from Drinking Water



Delivering a better world

Agenda

01

AECOM Team

02

PFAS Experience & Expertise

03

Challenges

04

Funding, Schedule, and
Community Engagement





AECOM

01

**AECOM
Team**

AECOM's Phase 1 Team



Angel Gebeau, PE, BCEE
Project Manager /Lead Engineer



Lanette Altenbach, PG
Wisconsin PFAS Regulatory Support



Francisco Barajas Rodriquez
PFAS Treatability Lead



Nombale Lee
PFAS IX Lead and Project Engineer



Chris Curran
North American PFAS Lead - Water

AECOM's Project Team

PFAS Initiative – Wisconsin Team

- 20 AECOM employees in Wisconsin including Lanette and Angel.
- Meet monthly to discuss PFAS issues within WI with regular email updates

PFAS – Global Team

- Over 200 AECOM employees with significant representation from North America and Australia
- Regular meetings and communications via platform

RE: PFAS Waste Management Question



Curran, Christopher

To: Holman, Lance; Cuento, Bjorn

Cc: Gebeau, Angel

nce – I knew you were the right person to ask!!! This is great and the best e
n certainly use the discussion at the bottom to give some great insight.

anks for the quick reply!

om: Holman, Lance <lance.holman@aecom.com>

ent: Friday, March 18, 2022 10:27 AM

o: Curran, Christopher <chris.curran@aecom.com>; Cuento, Bjorn <bjorn.cu

c: Gebeau, Angel <Angel.Gebeau@aecom.com>

ubject: RE: PFAS Waste Management Question

ris,

PA has indicated PFAS containing waste will be regulated under RCRA, 10/26
<https://www.epa.gov/newsreleases/epa-responds-new-mexico-governor-and>

- Rulemaking 1 – propose adding perfluorooctanoic acid (PFOA), perflu
 o Characteristic wastes must be treated to meet the underlying
- Rulemaking 2 - RCRA Corrective Action Program has the authority to
 1004(5). This modification would clarify that emerging contaminants
 o Implementation schedule for rulemaking not finalized

dditionally, October 2021, EPA published a PFAS roadmap highlighting pote
<https://www.epa.gov/pfas/pfas-strategic-roadmap-epas-commitments-action>

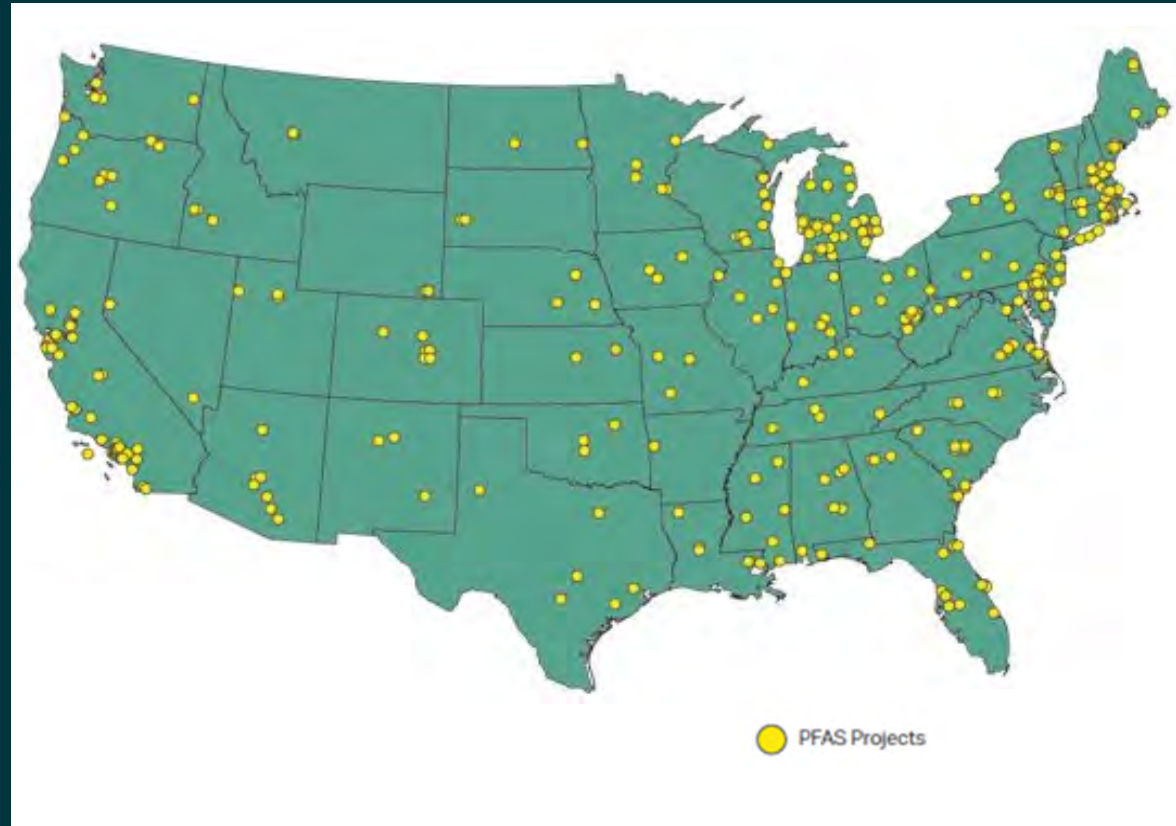
- Establish a national primary drinking water regulation for PFOA and
groups of PFAS. (Science Advisory Board consultation ongoing) prop

02

**PFAS Experience
& Expertise**

AECOM's PFAS Experience

- ✓ 20+ Years
- ✓ 300+ PFAS Project Sites
- ✓ 20+ PFAS Sites in Wisconsin
- ✓ 500+ Trained PFAS Samplers
- ✓ 75,000+ PFAS Samples



AECOM's PFAS Experience

**PFAS
Strategy/Goal
Alignment/
Regulations**

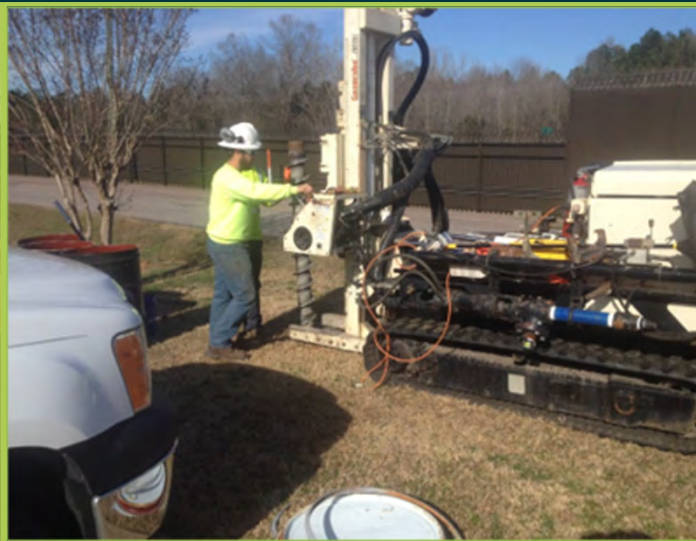
**Public Outreach
and
Communications**

**PFAS
Sampling /
Assessment**

**Source
Identification
and Forensics**

**Potable Water
Feasibility
Analysis**

**Treatment
Design /
Construction /
O&M**



Potable Water PFAS Treatment Systems

- Nine municipal potable systems (2005-Current)
- GAC process
- Treating over 2 billion gallons annually
- Performing ~16 changeouts annually
- Integration into process / wastewater management
 - Fe/Mn removal plants
 - Softening plants (with cationic IX resins)
 - Direct disinfection
 - Varying pumping / pressure conditions
 - Flood plain considerations
 - Backwash capabilities



PFAS Management: Operational Considerations

- Lead/Lag vessels treating PFAS from < 1ppt to 22ppb
- GAC changeout criteria: 15 ppt (lag beds)
- Sampling and change-out strategy to maintain bed life

Treatment Location	Influent PFOA Concentration (µg/L)		Operating Time Between Changeout (Months)		
	min	max	min	max	average
PWS-1	0.138	0.49	4	11	8
PSW-2	0.19	1.2	2	6	4
PWS-3	1.8	14	2	4	3
PWS-4	0.24	1.3	2	10	5
PWS-5	0.0119	0.107	4	22	7
PWS-6	<0.001	0.021	6	17	12
PWS-7	<0.0032	0.041	6	18	11
PWS-8	0.0035	<0.021	10	13	12



PFAS Groundwater Treatment

Chemical Manufacturer, NJ

INDUSTRIAL FACILITY

- 5 extraction wells – 400 gpm
- Pretreatment (VOCs, Iron, pH, avoid calcium precipitation)
- Residuals management – thickening / sand filters
- Discharge to groundwater via rapid infiltration basins



PFAS Groundwater Treatment

Chemical Manufacturer, NJ

INDUSTRIAL FACILITY

- 5 extraction wells – 400 gpm
- Pretreatment (VOCs, Iron, pH, avoid calcium precipitation)
- Residuals management – thickening / sand filters
- Discharge to groundwater via rapid infiltration basins

\$2.6 million engineering fee including site characterization, evaluations, and full design

\$12 million Construction

AECOM is not contracted for O&M. Current O&M includes exchange of 2 GAC vessels (20,000 lbs each) once per year for PFAS, general operations, solids disposal, and chemical addition.



PFAS Groundwater Treatment

Chemical Manufacturer, NJ

- PFAS treatment effectiveness is significantly impacted by other water components.
 - Media plugging
 - Competition with PFAS
- Raw PFAS ~10ppb to <150ppt
- A complex pretreatment system may be required to address interfering constituents upstream of the PFAS removal process.



- Fouling of GAC leads to scaling, agglomeration and plugging.

Westborough, MA Case Study

Groundwater Treatment Plant

- Current Total Capacity: 1.3 MGD

Two Groundwater Sources

- GW 1
 - o PFAS6 = 11.7 ng/L (November 2020)
 - o Capacity = 0.5 MGD
- GW 2
 - o PFAS6 = 28.1 ng/L (November 2020)
 - o Capacity = 0.8 MGD



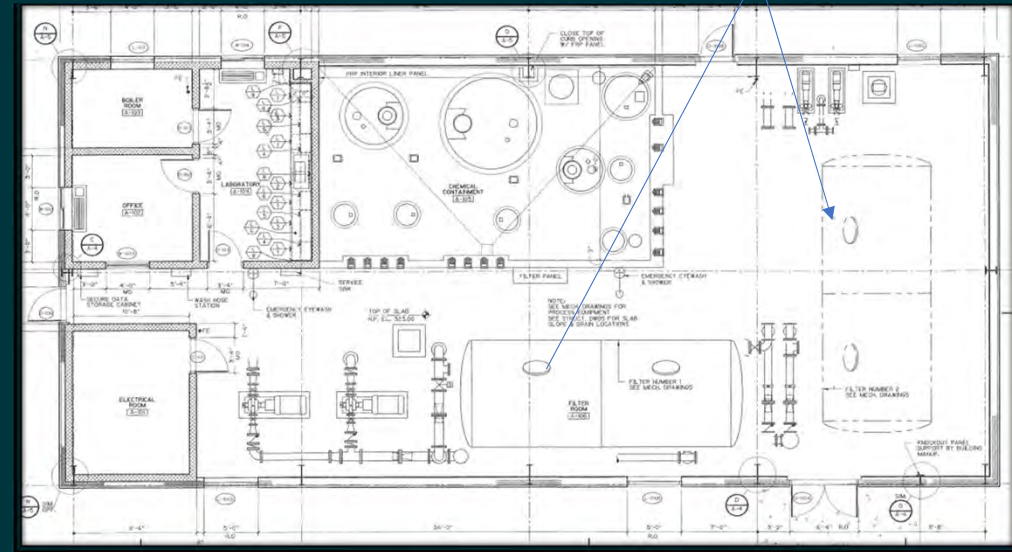
Westborough, MA Case Study

- GAC versus IX
- Vessel Configurations
- O&M Costs
- Reliability of the Proposed Process



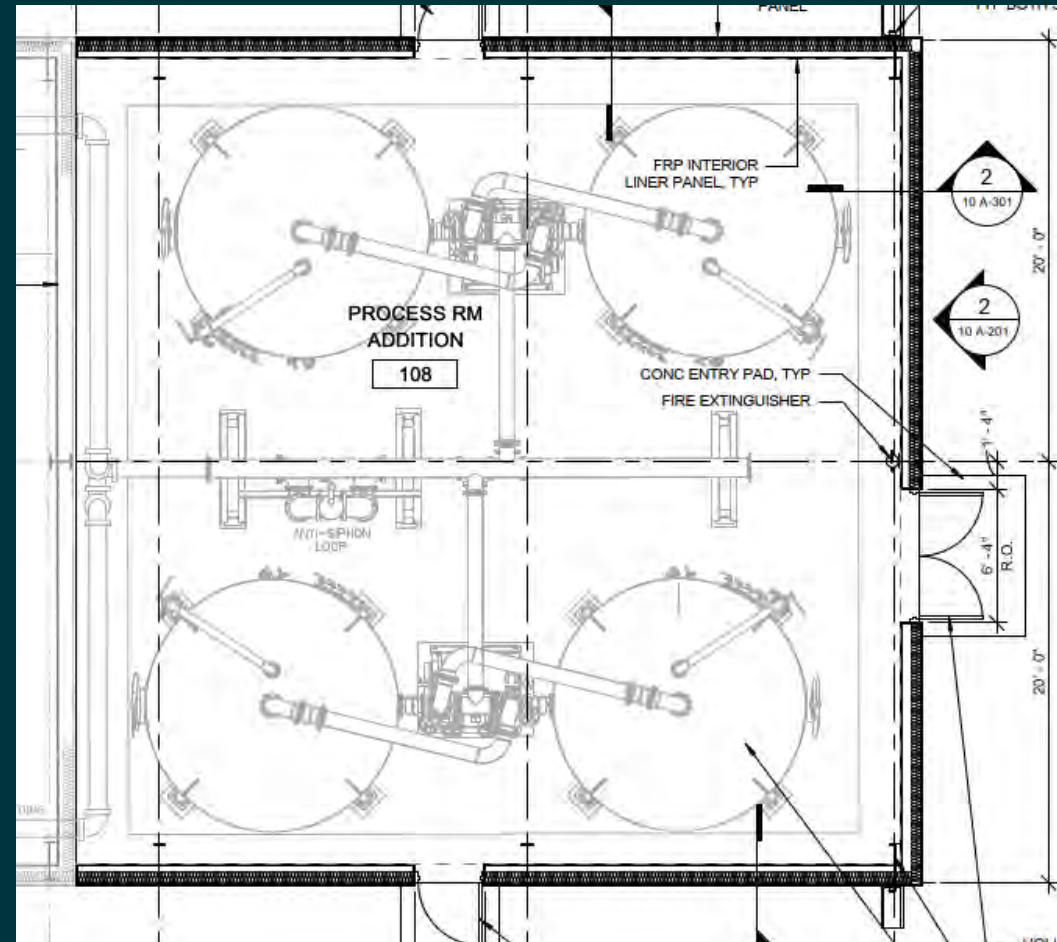
Horizontal Pressure Vessels

Parameter	Units	Result (ppt)
Total PFAS	ng/L	32.54
Total Regulated PFAS	ng/L	26.99
TOC	mg/L	0.93
pH	pH units	6.58
ORP	mV	345.5
DO	mg/L	8.45
EC	μS/cm	854
TSS	mg/L	3.8
Turbidity	NTU	2.14



Westborough, MA Case Study

Total System		
Total Flow	900	gpm
Number of Trains	2	
Vessels Per Train	2	
Vessel Diameter	12	feet
Per Pressure Vessel		
Flow Rate	450	gpm
Loading Rate	3.98	gpm/sf
Empty Bed Contac Time	12.12	min
Carbon Weight	20,000	lb
Carbon Density	0.44	g/cm3
Specific Throughput	295,000	L/kg
Time until Exhaustion	1092	days
Time until Exhaustion	2.99	years

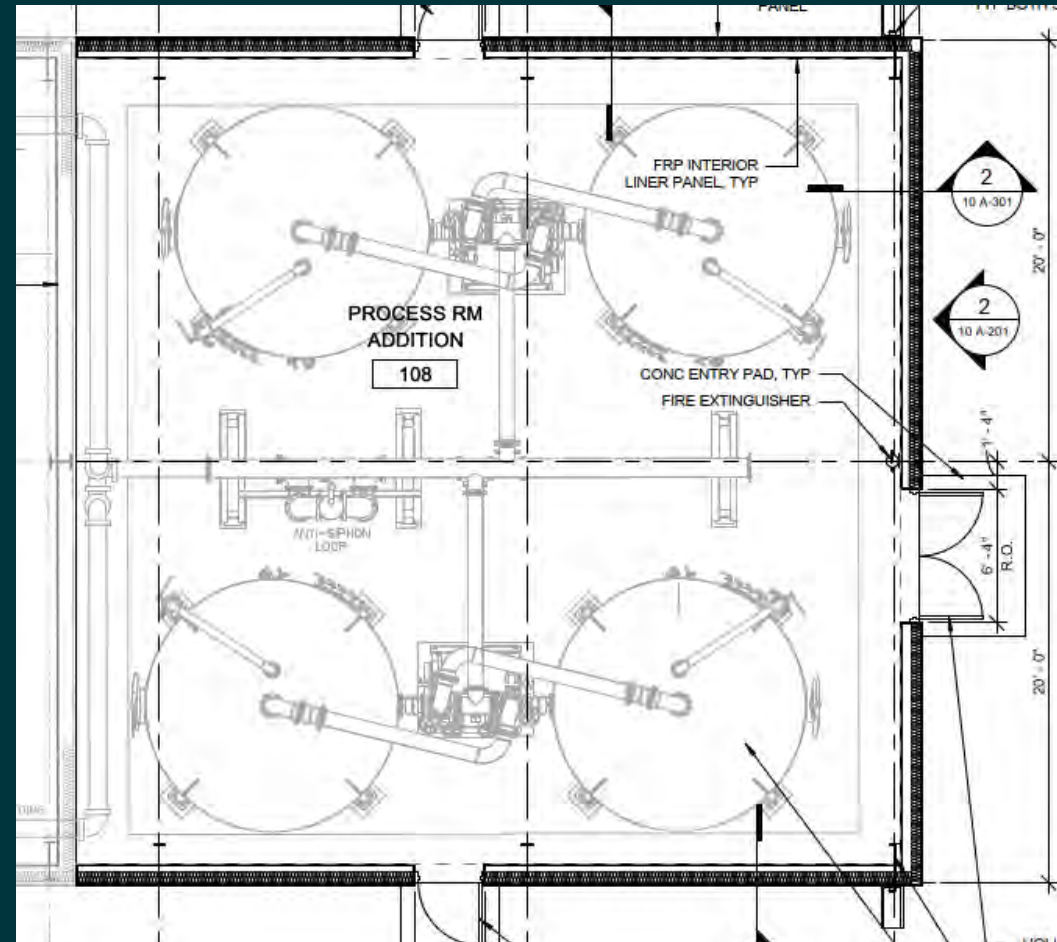


Westborough, MA Case Study

Engineering - \$200,000

Capex - \$6Million

PFAS6 < 20ppt



Suez Orange, NJ Case Study

2,450 gpm total from 5 wells treated at one site

PFOA 25ppt raw water treated to <10ppt

Site constraints and drivers that may drive best approach:

- Integration of PFAS treatment into facility design considering the existing structure and demolition plans
- Operational challenges
- System capacity / future needs
- Site conditions for media change-out needs
- Hydraulics
- Backwashing needs
- Spent media handling

Capex -	\$8 million estimated
Engineering -	\$50,000 Feasibility Study
	\$50,000 30% Design
	\$350,000 65% Design



Suez Orange, NJ Case Study

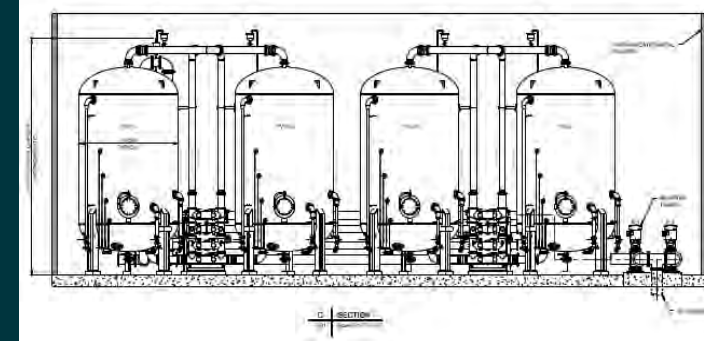
Table 2-14: Alternative Decision Model

Criteria Weighting				
Level 1 Criteria	Level 1 Weighting*	Level 2 Criteria	Level 2 Weighting*	Net Total Weight
Impact on Existing Conditions	15%	Continuity of Operations	50%	7.5%
		Impact on Plant Hydraulics	50%	7.5%
Constructability	40%	Impact to Schedule (incl lead time)	30%	12.0%
		Impact on raw water line	30%	12.0%
		Footprint/ MOPO Concerns	40%	16.0%
Process Operations	15%	PFAS Reduction	20%	3.0%
		Process flexibility	30%	4.5%
		Minimize Waste Handling	30%	4.5%
		Media Changeouts	20%	3.0%
Cost	30%	Construction Cost	30%	9.0%
		O&M (elec, media, labor, etc)	20%	6.0%
		Net Present Value - 20 Year Period	50%	15.0%
Total:	100%	Total: 100%		

Rank

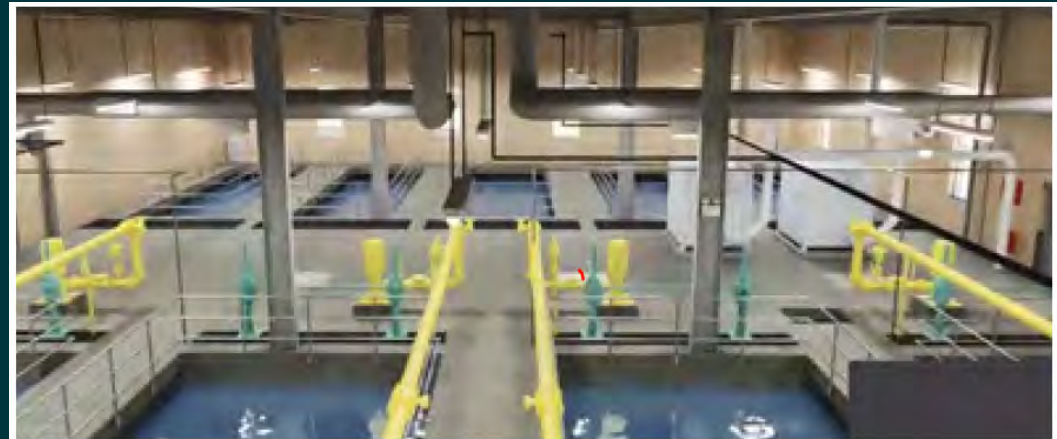
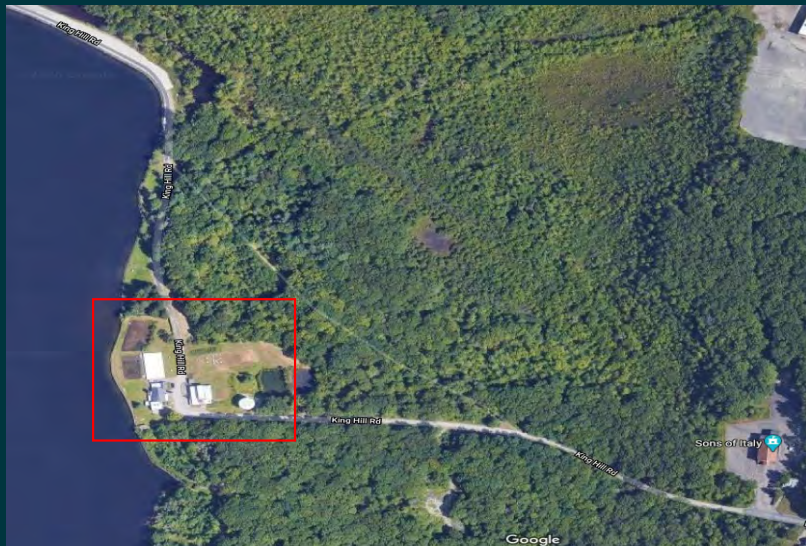
Decision Model Scores			
Alt 1A	Alt 1B	Alt 2A	Alt 2B
3	3	3	3
2	2	4	4
4	3	2	1
1	1	4	4
3	4	1	2
4	4	4	4
1	4	1	4
4	2	4	2
3	4	3	4
4	3	2	1
2	4	1	3
2	4	1	3
2.7	3.1	2.2	2.7
2	1	3	2

* Weighting refers to the impact on the total score
Decision Model Scoring: 1 - poor; 2 - fair; 3- great; 4-excellent



AECOM Case Study – PFAS Strategy – Braintree, MA

- New State Regulatory Drivers
- Scale: 13.5 MGD
- Total Raw Water PFAS: 33 ng/l
- TOC: 2.5 mg/l (Seasonal Variability)
- Simulated EBCT: 16 – 28 min

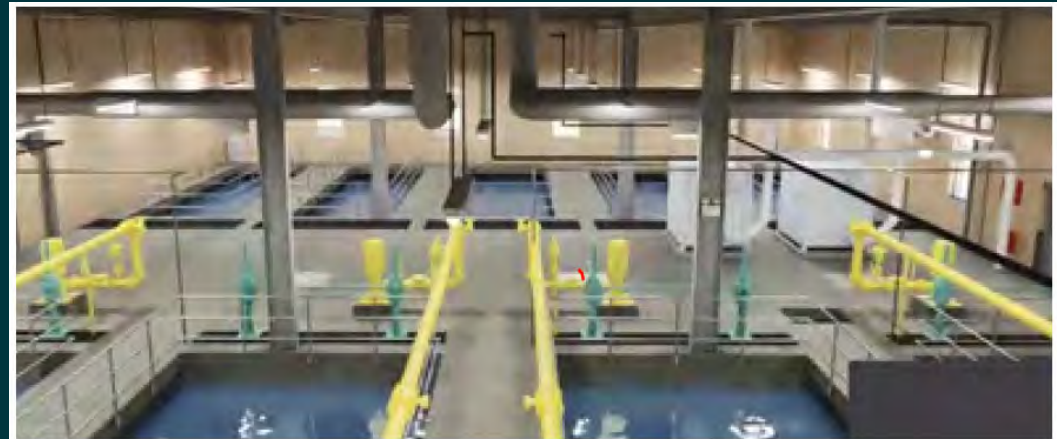
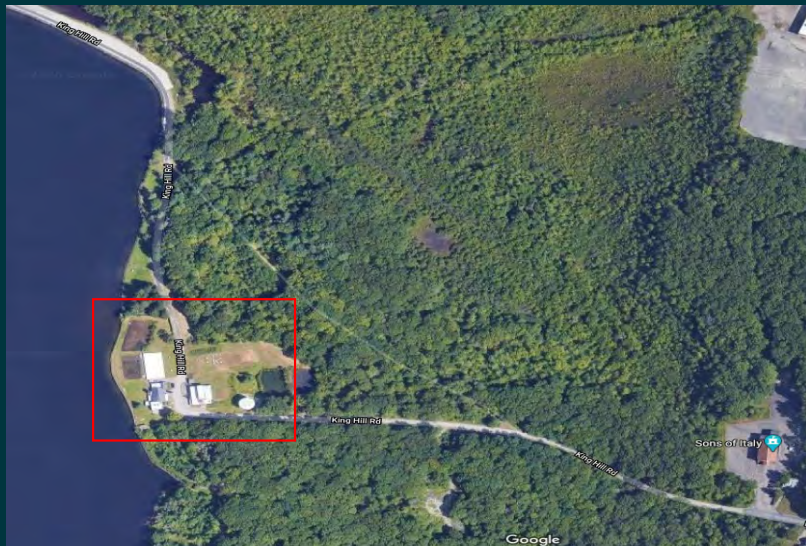


Proposed DAF and Enlarged Deep Bed Filters for TOC/PFAS Treatment



AECOM Case Study – PFAS Strategy – Braintree, MA

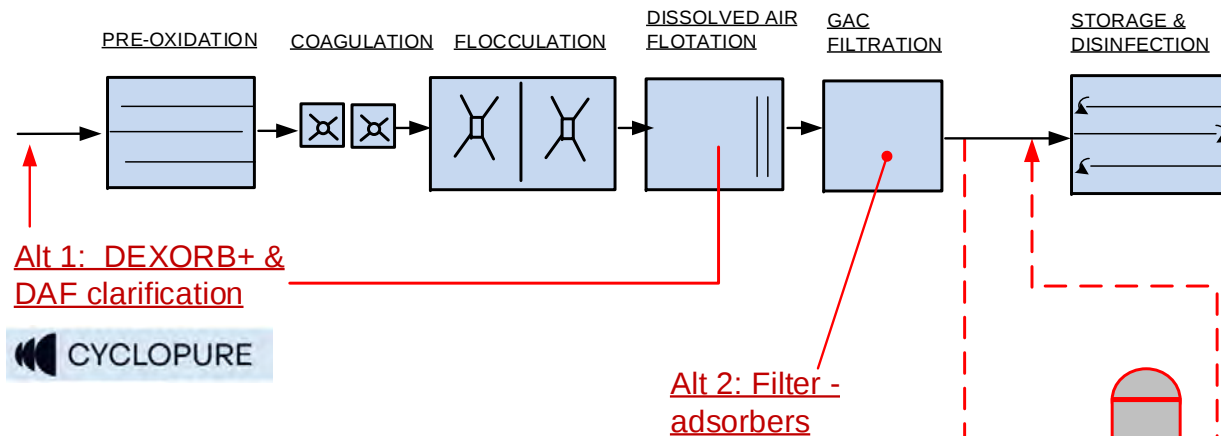
Engineering - \$4million
Capex - \$70million
PFAS6 treated to <20ppt



Proposed DAF and Enlarged Deep Bed Filters for TOC/PFAS Treatment

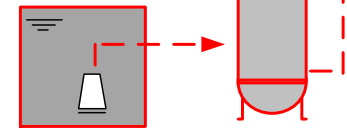


Case Study – PFAS Strategy – Braintree, MA



PFAS REMOVAL STRATEGY TESTING PLAN

Alt No.	Bench Scale - Jar Testing	Bench Scale - RSSCT	Software Modeling
1	X		
2		X	
3		X	
4			X



Alt 3: Sidestream treatment w/ GAC Post-filter absorbers

Alt 4: Side stream treatment w/ion exchange

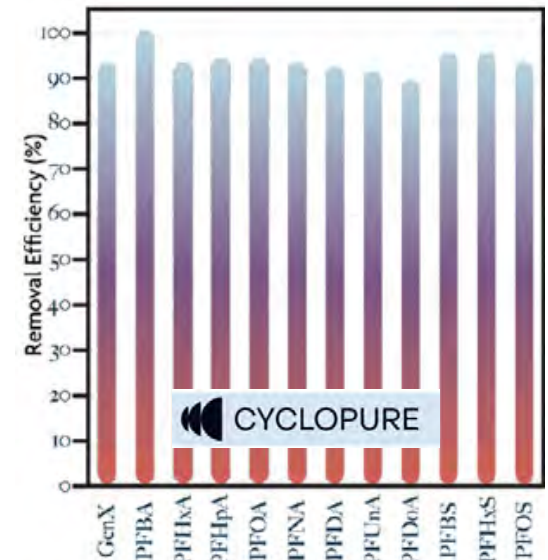


Figure 1. Effective removal of all PFAS

AECOM PFAS Treatment Experience

Operational Plants	Treatment Technology	Location	Status	Source
Plant 1	IX	Colorado	Operational	Potable
Plant 2	IX	Colorado	Operational	Potable
OCWD - Irvine Ranch WD	IX	California	Construction	Potable
Shaw AFB	IX	South Carolina	Operational	Groundwater
Public Water District (PWD)	GAC	Ohio	Operational	potable
Public Water District (LHWD)	GAC	Ohio	Operational	Potable
Public Water District (LWD)	GAC	West Virginia	Operational	Potable
Public Water District (TPWD)	GAC	Ohio	Operational	Potable
Public Water District (BWD)	GAC	Ohio	Operational	Potable
Public Water district (CCWD)	GAC	West Virginia	Operational	Potable
Public Water district (LD)	GAC	West Virginia	Operational	Potable
Industrial Plant	GAC	West Virginia	Operational	Potable
Vienna 1	GAC	West Virginia	Operational	Potable
Vienna 2	GAC	West Virginia	Operational	Potable
Vienna 3	GAC	West Virginia	Operational	Potable
Pennsville	GAC	New Jersey	Design	Potable
Fairchild AFB	GAC	Washington	Design	Potable
Industrial Plant	GAC	West Virginia	Operational	Process Water
Industrial Plant	GAC	Virginia	Operational	Groundwater
Industrial Plant	GAC	New Jersey	Operational	Groundwater
industrial landfill	GAC	West Virginia	Operational	Groundwater
industrial landfill	GAC	West Virginia	Operational	Stormwater
Industrial Plant	GAC	Delaware	Operational	Groundwater
Suez Orange	GAC	New Jersey	Design	Potable
westborough	GAC	Massachusetts	Design	Potable
Tritown	GAC	Massachusetts	Design	Potable
Selfridge AFB	GAC	Michigan	Operational	Stormwater
Industrial Plant	GAC	Michigan	Operational	Groundwater
Aquarion rewak well	GAC	Connecticut	Design	Groundwater
Ann Arbor	GAC	Michigan	Design	Potable
Industrial Plant	GAC	West Virginia	Operational	Stormwater
Industrial Plant	Novel adsorbent	Michigan	Operational	Stormwater
Travis AFB	Novel adsorbent	California	Pilot	Groundwater



Wisconsin PFAS Projects		
Site Name	Site Location	Work Completed to date
Waupaca Foundry - Plant #4	Marinette, WI	- Construction Dewatering - PFAS Treatment System with a WPDES discharge - PFAS Site Investigation
ChemDesign	Marinette, WI	- Construction Dewatering - PFAS and Arsenic Treatment System
Newton Pit & Washington Ave	Manitowoc, WI	- Phase II ESA at two sites to assess PFAS uses at the site
Former Newton Pit	Manitowoc, WI	- PFAS Site Investigation - Soil, GW, surface water, and private potable well sample collection for PFAS - Installed new wells, sampled new and existing wells for "Emerging contaminants" (WDNR grant funded)
Madison Inventory (DNR)	Madison, WI	- Desktop Study - Identify potential PFAS sources within one mile of two water supply wells for the City of Madison - Prepared a GIS map and table with identified and ranked potential sources
WDNR Reactive Waterway Sampling	Wisconsin	- On-call foam sampling - Foam location is verified by WDNR staff then AECOM personnel are mobilized to location to collect samples - Letter report generated with each sampling event
Edgerton Shoe Factory	Edgerton, WI	- Phase II ESA - Temp monitoring well installation - GW sampling for PFAS and other COCs (PFAS was detected in all GW Samples collected)
Stoeger site Phase II ESA	Freedom, WI	- Phase II ESA - TBD if PFAS will be included as part of ESA
General Mitchell Intl. Airport	Milwaukee, WI	- PFAS Site Investigation - Desktop review of past investigation and past use of AFFF at the site - Soil borings and soil samples collected - Install GW monitoring wells, collect GW samples - Collect surface water samples - Second mobilization to site planned for further delineation
Rhineland-Oneida County Airport	Rhineland, WI	- PFAS potable well work plan preparation - Potable well sampling - PFAS site investigation work plan preparation
Chippewa Valley Regional Airport	Eau Claire, WI	- PFAS historical use assessment - site investigation work plan preparation
Industrial Site	Milwaukee, WI	- PFAS historical use assessment - work plan preparation for screening level investigation
Industrial Site	Milwaukee, WI	- PFAS Phase II site investigation
Fincantieri Marinette Marine	Marinette, WI	- PFAS site investigation work plan preparation
Blount Street Substation (Fire Response and Cleanup)	Madison, WI	- PFAS immediate response services - Groundwater dewatering and soil treatment - Site investigation leading to regulatory site closure
Mirro Plant #2	Manitowoc, WI	- PFAS limited groundwater investigation and private potable well sampling
Multiple Sites	Statewide	- PFAS sampling (Sturgeon Bay Coast Guard potable water example)



WI Last 2 years AECOM Potable Water Clients

- ✓ Verona
- ✓ Sheboygan, City of
- ✓ Sheboygan, Town of
- ✓ Plover
- ✓ Weston
- ✓ Appleton
- ✓ LaCrosse
- ✓ Green Bay
- ✓ Whiting
- ✓ Amherst
- ✓ Mosinee
- ✓ Neillsville
- ✓ New London



NA
Approach
to
Pilot Testing

Project Management

Task Development Process

- Select Key Leads
- Define Approach
- Prepare Scope, Budget & Schedule
- Identify QC Reviewers
- Prepare Work Plan
- Execute Tasks
- Communicate Regularly
- Prepare Deliverables
- Review & Improve
- Request Feedback



PFAS Professional Support

PFAS Treatment Technology and Planning of Facilities

- Ion Exchange
- Activated Carbon
- Reverse Osmosis

AECOM Treatability and Feasibility Study & Test Lab

- Testing effectiveness of removal and destruction technologies

Innovative Treatment Technologies

- Novel Absorbents (DEXSORB, Fluorosorb, Co-WERC new Sorbents)
- Advanced Treatment for Reuse
- Separation and Destruction Options

Sampling Programs to Understand Sources and Fate of PFAS

- Focus on Sources
- Wastewater Liquid Streams
- Biosolids



Pilot Testing

Bench-Scale Treatability Studies

- Low cost and quick TAT vs. on-site pilot tests
- Proof-of-concept
- Validation
- Technology screening

AECOM Treatability and Feasibility Study & Test Lab

- Removal and novel destruction technologies
- Treatment of PFAS and other contaminants
- PFAS in drinking water, wastewater, soil and groundwater
- Adsorption and destruction



Pilot testing

Evaluation of adsorptive media

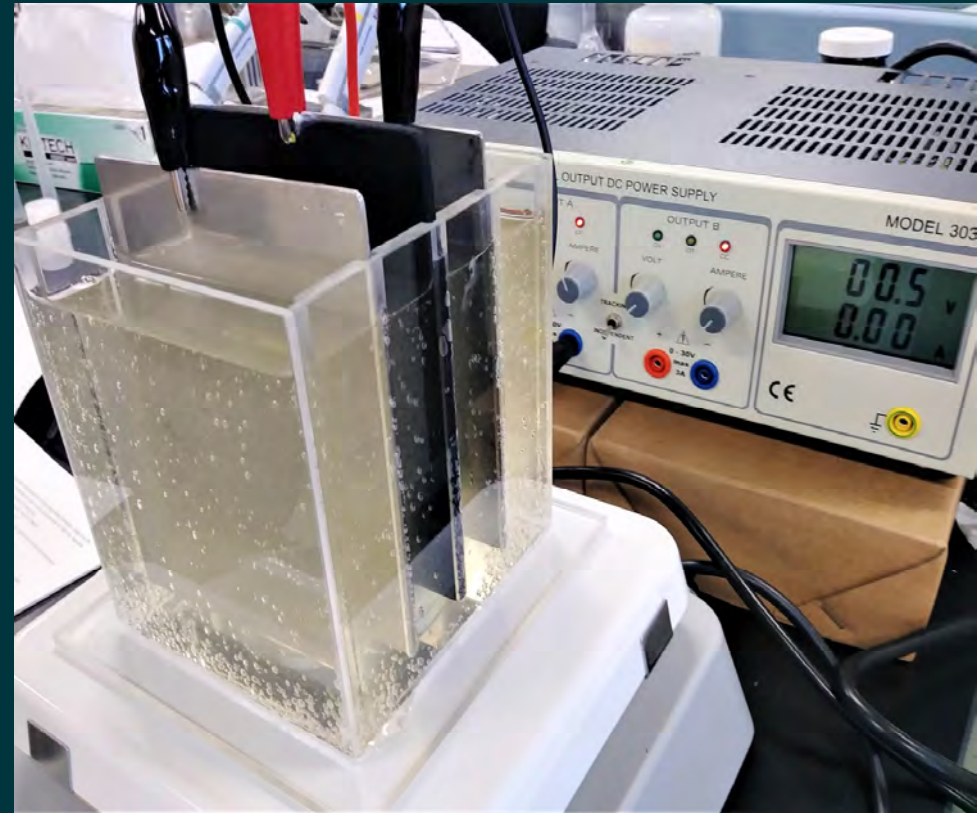
- Granular Activated Carbons
 - From various vendors
- Ion Exchange Resins
 - Single-use vs regenerable
- Novel sorbents
 - Modified bentonites, commercial cyclodextrin, and graphene suspension
 - Newly synthesized cyclodextrins (partnered with academia)
- Batch tests: adsorbent screening and isotherms
- Column tests
 - Large columns
 - Rapid Small-Scale Column Tests (RSSCT)



Pilot testing

Critical parameters from bench-scale tests

- Adsorptive media:
 - Adsorption capacities
 - Adsorption rates (kinetics)
 - Treatable volume or bed volumes
 - Specific throughput
 - Mass transfer (adsorption) zone
 - Empty bed contact time
- Destruction via electrochemical oxidation
 - PFAS degradation rates
 - Energy usage/efficiency
 - Production of daughter products vs complete mineralization
 - Competition from co-contaminants



Pilot testing

In-house capabilities

- Batch tests, from < 1 L up to 20 L
- Column tests
 - Large columns, ~ 1 L bed volume; uses high volumes of water (30-100 gallons)
 - RSSCTs, ~ 0.001 L bed volume; uses lower volumes of water (5-10 gallons)
- Analytical instrumentation
 - Water quality: pH, ORP, electric conductivity, turbidity, alkalinity, TSS and TDS
 - Select volatile organic compounds and hydrocarbons via gas chromatography
 - Anions and heavy metals

Collaboration with technology vendors

- Method and experimental design development
- Tests for technology demonstration and validation
- Lab scale and on-site pilot demonstrations



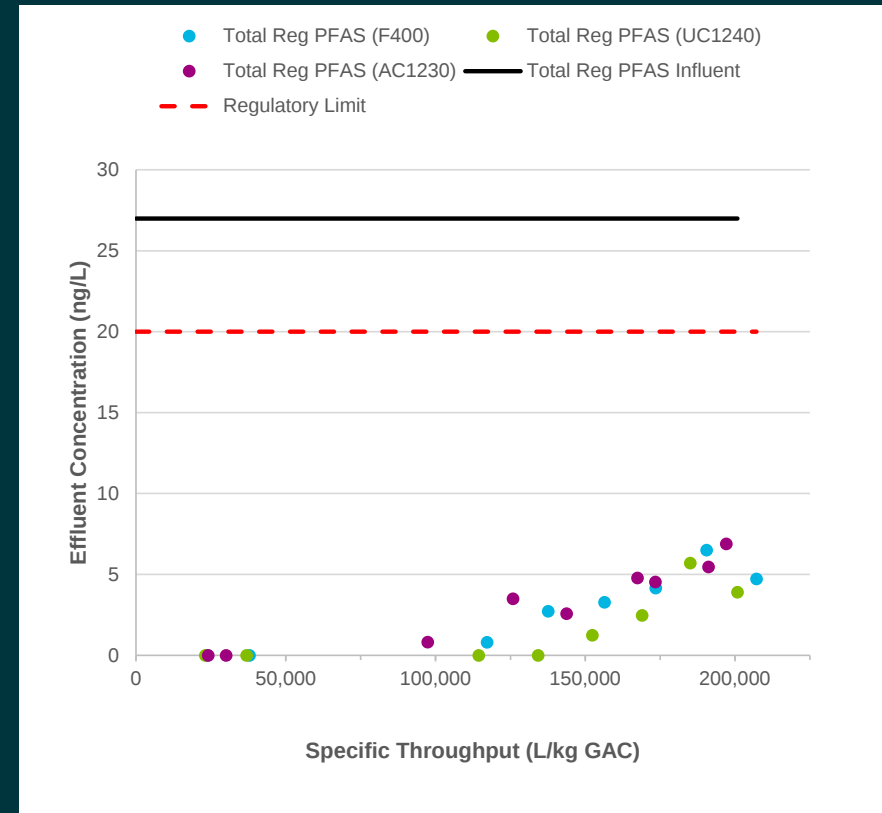
Bench-Scale Tests Experience

Town of Westborough, MA

- PFAS in groundwater source (drinking water)
 - PFAS near 32 ng/L
 - Low organic carbon content
- RSSCT evaluation of three GACs: FiltraSorb 400, UltraCarb 1240, and AquaCarb 1230
- Simulated EBCT of 10.4 minutes
- Tested >75,000 bed volumes (8.6 gallons per column)
- Breakthrough observed for all GACs, but total regulated PFAS remained below 20 ng/L regulatory threshold
- Similar trends and specific throughputs for all GACs

Michener Plating Facility, Jackson, MI

- Groundwater, high organic carbon content and VOCs
- Isotherm evaluation of eight medias: GAC, ion exchange resins, cyclodextrin
- PFAS compounds analyzed: list of 41
- Cyclodextrin showed the highest removal of PFAS, by far



Ion Exchange for PFAS

Water Chemistry

- TOC
- TSS + TDS
- Inorganic compounds
- Competing Anions

Selectivity

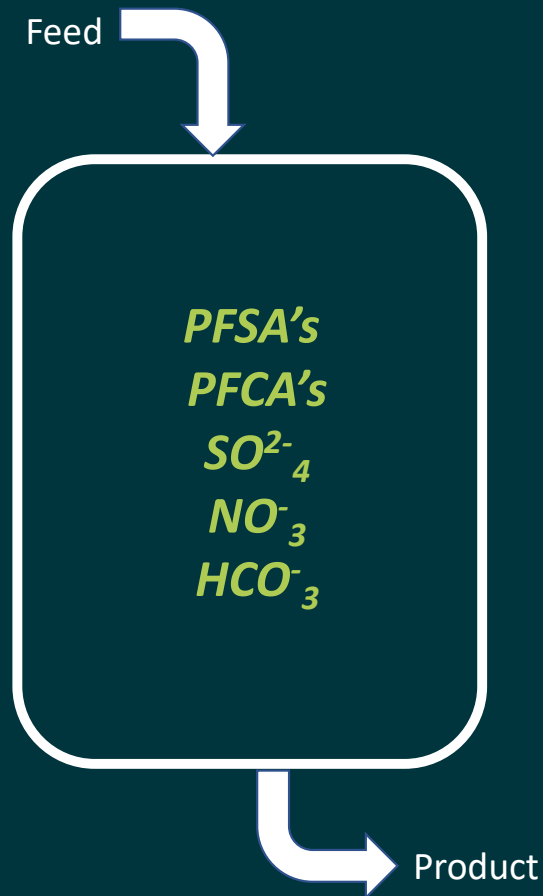
- PFSA's > PFCA's
- Long chain > Short Chain

Fast Kinetics

- Short EBCT
- Small footprint

Operation

- Consistent flow
- Non regenerable



03
Challenges

Concern and Mitigation

Changing treatment objectives and new science findings

- Regulatory limit monitoring
- Health based objectives

Funding

- PSC requirements
- Limitations on design / treatment
- American Made materials

Schedule issues

- Pre-procurement (schedule)
- Early funding application
- Early PSC and DNR engagement

Ultimate disposal

- National experience

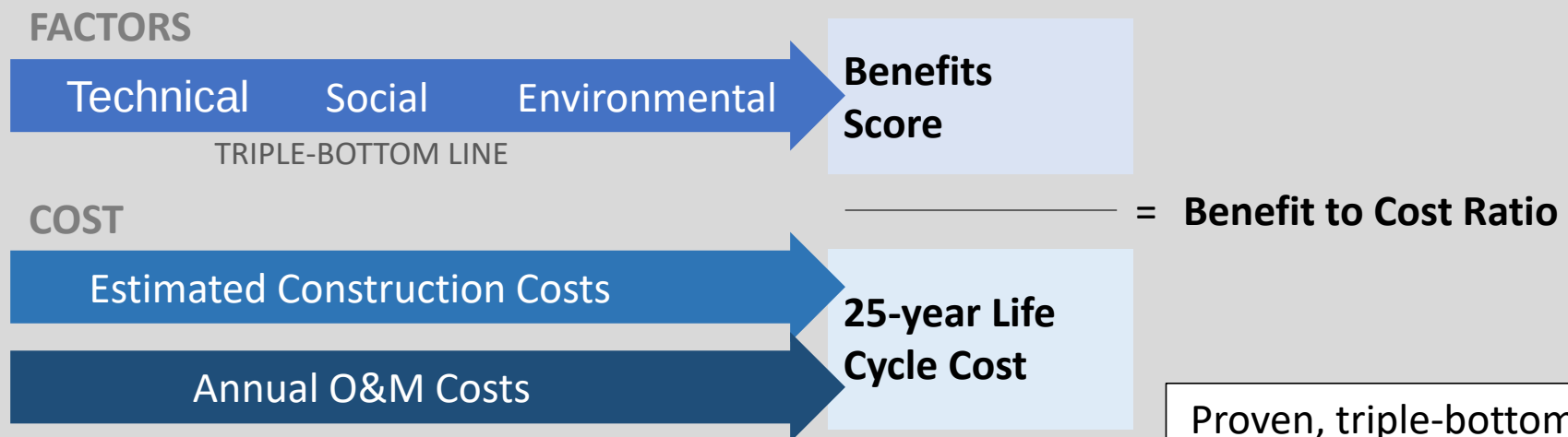
Community Perception

- Community Engagement

Multi-variable Decision Analysis

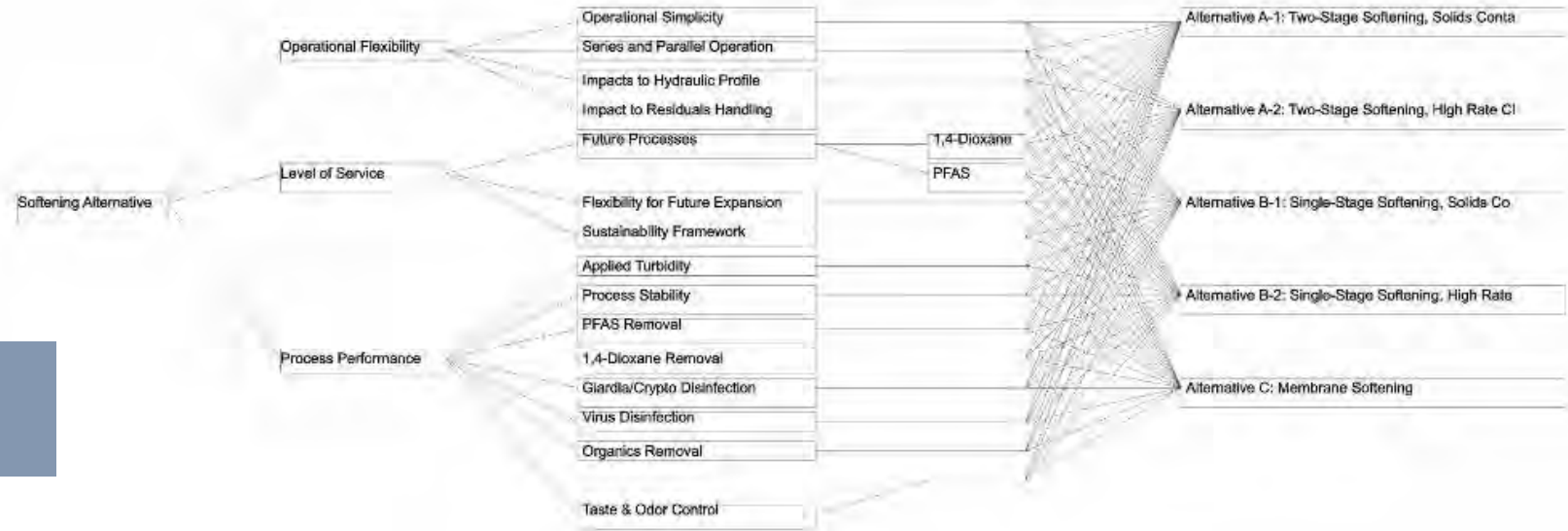
- Decision Model

Approach to Efficient Decision Making



Proven, triple-bottom line decision modeling techniques build consensus among diverse stakeholder teams

Example Decision Model



Example Decision Model Hierarchy

Decision Model Weighting and Scoring

Goal Level	Weights	Rating Set	Level 2	Weights	Rating Set	Level 3	Weights	Rating Set	Attributes	Alternative	Alternative	Alternative	Alternative	Alternative C
Softening Alternative	25.00	Operational Flexibility	Operational Flexibility	40.00	Operational Simplicity	Operational Simplicity		Alternatives	Operational Simplicity	80.00	70.00	60.00	50.00	50.00
	25.00	Level of Service		20.00	Series and Parallel Operation	Series and Parallel Operation		Alternatives	Series and Parallel Operation	100.00	100.00	0.00	0.00	0.00
	50.00	Process Performance		20.00	Impacts to Hydraulic Profile	Impacts to Hydraulic Profile		Alternatives	Impacts to Hydraulic Profile	100.00	100.00	100.00	100.00	20.00
				20.00	Impact to Residuals Handling	Impact to Residuals Handling		Alternatives	Impact to Residuals Handling	100.00	100.00	100.00	100.00	10.00
			Level of Service	30.00	Future Processes	Future Processes	50.00	1,4-Dioxane	1,4-Dioxane	10.00	80.00	10.00	80.00	10.00
				50.00	Flexibility for Future Expansion	Flexibility for Future Expansion	50.00	PFAS	PFAS	10.00	80.00	10.00	80.00	20.00
				20.00	Sustainability Framework	Sustainability Framework		Alternatives	Flexibility for Future Expansion	10.00	90.00	50.00	100.00	30.00
			Process Performance	35.00	Applied Turbidity	Applied Turbidity		Alternatives	Sustainability Framework	90.00	90.00	100.00	100.00	20.00
				30.00	Process Stability	Process Stability		Alternatives	Applied Turbidity	100.00	90.00	80.00	70.00	100.00
				5.00	PFAS Removal	Process Stability		Alternatives	Process Stability	100.00	90.00	80.00	70.00	100.00
				5.00	1,4-Dioxane Removal	PFAS Removal		Alternatives	PFAS Removal	80.00	80.00	80.00	80.00	80.00
				10.00	Giardia/Crypto Disinfection	1,4-Dioxane Removal		Alternatives	1,4-Dioxane Removal	90.00	90.00	90.00	90.00	90.00
				10.00	Virus Disinfection	Giardia/Crypto Disinfection		Alternatives	Giardia/Crypto Disinfection	100.00	100.00	90.00	90.00	90.00
				10.00	Organics Removal	Virus Disinfection		Alternatives	Virus Disinfection	100.00	100.00	100.00	100.00	100.00
				10.00	Taste & Odor Control	Organics Removal		Alternatives	Organics Removal	90.00	90.00	80.00	80.00	100.00
						Taste & Odor Control		Alternatives	Taste & Odor Control	90.00	90.00	90.00	90.00	100.00

04

Funding, Schedule and Community Engagement

Funding – State SDWL

Wisconsin Safe Drinking Water Loan Program

ITA / PERF Due – October 31

Low Interest Loans and Principal Forgiveness Opportunities

Federal Funding Requirements

- Disadvantage Business

- Wage Rates

- Buy American / American Iron and Steel

AECOM's PM has assisted multiple WI clients through the SDWL program most recently, assisting the Village of Plover with project closeout in 2021.

Pricing and Schedule

AECOM would like to enter discussions with City of Wausau on their expectations for pilot testing and provides the following for discussion.

Pilot Testing

\$40,000 - 4 column treatment

\$3,000 – add pre-treatment alternatives to pilot options

\$1,000 – field testing raw and transported water quality for comparability

(2 to 5 typical 4 recommended to incorporate air stripping)

2 weeks for DNR meeting for pilot protocol review

4-5 weeks from receipt of water (complete by end of June)

Includes pilot test summary memo

Pricing and Schedule

PSC, DNR, and Funding Preliminary Submittals -

Up to \$5,000

Two virtual meetings with regulators

ITA/PERF support for SDWL

Other funding source support is not anticipated and would have to be added upon negotiation (example WIFIA).

Scope and Schedule

Alternatives Analysis and Decision Analysis

Incorporates pilot testing findings,

Site visit for data gathering (well pump and other pumps, building construction, backwash options, air stripper review)

Decision matrix used for evaluation assuming 4 non cost criteria,

Capital cost development suitable for level of design

O&M cost development suitable for level of design,

To be completed prior to October 31, 2022 to provide cost for the ITA/PERF funding application.

Optional - PFAS Outreach Support and PFAS Communications Plan

- Collaborate with the City on Communications Plan development
- Stakeholder and community engagement
- Effective communication of complex technical topics
- Virtual Open House and traditional outreach methods
- Language accessibility



The AECOM Advantage



Worldwide Leaders PFAS

Wisconsin staff are experienced in PFAS site investigation and WI regulatory framework

National resource support as needed



Experienced Technical Team with Available Capacity

Staffing depth and industry leading PFAS technical expertise

Responsive and agile to meet project needs

Treatability lab available for immediate water pilot testing evaluations



Performance-Driven Management to Meet Objectives

Proven QMS, SH&E program, and PFAS project approach and strategy

Committed to project success



Local Project Experience

PFAS site investigation, remediation, Wisconsin SDWL funding, PSC submittals, and regulatory negotiations in Wisconsin

Thank you!

We look forward to supporting you!



TO: Wausau Waterworks Commission
FROM: Eric Lindman, P.E.
Director of Public Works & Utilities

DATE: April 6, 2021

SUBJECT: Rain Barrels – Implementation Program

2021 Rain Barrel Event, the proposed 2022 event would be set up the same but begin the process earlier.

As part of the WauterSavvy initiative, a rain barrel program was approved to be developed at the march Commission meeting. Since the last meeting Commissioners Force and Robinson along with myself held a conference call with Rain Barrel Solutions. Rain Barrel Solutions is a 3rd party vendor who manufactures and sells rain barrels and also administers online sales of the barrels directly to residents. Based on our call with Rain Barrel Solutions the program would be set up as follows:

1. Enter into an MOU (attached) with Rain Barrel Solutions (RBS)
2. RBS will set up a website for Wausau residents to order and pay for rain barrels
3. The utility would subsidize the purchase (Ex: if the commission wants to subsidize the barrels then residents would pay the discounted amount online and RBS would bill the utility the difference)
4. RBS takes the orders and sends us the addresses to review and make sure they are in the City limits, if they are then they get the discounted rate and if not then they pay full price for the barrel.
5. We allow for 4-6 weeks to advertise and allow people to purchase the barrels then on a specified date the website would no longer allow residents to purchase and would list the pick-up date.
6. The barrels would be shipped and arrive within a week of the purchase time ending
7. City will set up a day and time for residents to pick up their barrels, the 3rd party would assist with the pick-up and/or volunteer groups could assist for a donation

Looking at a general timeline with RBS the program timing would look similar to the following:

1. Wednesday April 7, 2021 – Begin advertising the website and program
2. Friday June 11, 2021 – Last day to purchase
3. June 19 or 22, 2021 – Pick up day (Saturday or weekday???)

Pick up during the week can be done later in afternoon so residents have time after work or we can set it up on a weekend. RBS stated either works well so we can determine what works best for our situation.

The Commission will need to determine the amount per barrel to subsidize so we can get the pricing established on the website. Based on interest and calls we should plan on selling 500-600 barrels and hope we can meet this goal. RBS stated they typically see the number of barrels sold is about 1% of the population, they feel this is a good rule of thumb.



Wausau has been awarded \$577,718.00 for the year 2022 Private LSL Program. Approximately \$127,718.00 has been allocated already in year 2021, leaving \$450,000.00 for this year. Currently we offer \$3000.00 to residents in street reconstruction areas and those with leaks, and \$5000.00 to those in past construction areas, for private LSL replacement.

We have received calls from plumbers asking if funding amounts will be increased due to rising costs. Materials, fuel, labor, and equipment price increases will push up costs for LSL replacement. Fuel is up 50%, materials are up 30% already and still climbing. The concern is that the costs over and above the funding amount will be the responsibility of the customer, and higher costs on the customer will most likely deter replacement.

Would the commission like to adjust funding levels for private LSL replacements to reflect higher market costs?



Twig's Beverage will no longer bottle our water, Northwoods Mist. Staff was unable to find a replacement copacker in the area. Now may be a reasonable time to discontinue our water bottling.



CITY OF WAUSAU
SOLE SOURCE PURCHASE JUSTIFICATION
REQUIRED FORM PURCHASE OF GOODS OR SERVICES EXCEEDING \$10,000

Purchase of goods or services for no more than \$25,000 may be made without competition when it is agreed *in advance* between the Department Head and the Finance Director. Sole source purchasing allows for the procurement of goods and services from a single source without soliciting quotes or bids from multiple sources. Sole source procurement cannot be used to avoid competition, rather it is used in certain situations when it can be documented that a vendor or contractor holds a unique set of skills or expertise, that the services are highly specialized or unique in character or when alternate products are unavailable or unsuitable from any other source. Sole source purchasing should be avoided unless it is clearly necessary and justifiable. The justification must withstand public and legislative scrutiny. The Department Head is responsible for providing written documentation justifying the valid reason to purchase from one source or that only one source is available. Sole source purchasing criteria include: urgency due to public safety, serious injury financial or other, other unusual and compelling reasons, goods or service is available from only one source and no other good or service will satisfy the City's requirements, legal services provided by an attorney, lack of acceptable bids or quotes, an alternate product or manufacturer would not be compatible with current products resulting in additional operating or maintenance costs, standardization of a specific product or manufacturer will result in a more efficient or economical operation or aesthetics, or compatibility is an overriding consideration, the purchase is from another governmental body, continuity is achieved in a phased project, the supplier or service demonstrates a unique capability not found elsewhere, the purchase is more economical to the city on the basis of time and money of proposal development.

1. Sole source purchase under \$10,000 shall be evaluated and determined by the Department Head.
2. Sole source purchase of \$10,001 to \$25,000 a formal written justification shall be forwarded to the Finance Director who will concur with the sole source or assist in locating additional competitive sources.
3. Sole source purchase exceeding \$25,000 must be approved by the Finance Committee.



Ongoing Sole Source – 365 days



One Time Sole Source Request

1. Provide a detailed explanation of the good or service to be purchased and vendor.

MCEZ9 polymer for the new belt filter presses and MCEP9 polymer for the gravity belt thickeners. Vendor is Midwest Chemical & Equipment

2. Provide a brief description of the intended application for the service or goods to be purchased.

Recommended polymers formulated specifically for the new belt filter presses and new gravity belt thickeners, solids handling systems.

3. State why other products or services that compete in the market will not or do not meet your needs or comply with your specifications.

MCEZ9 and MCEP9 polymers are the manufacturer recommended polymer formulated specifically for the new belt filter presses and gravity belt thickeners. These polymers were specifically selected to meet performance testing criteria and offer the most pounds per dry ton of solids, with the most dewatering capabilities producing the driest sludge. This polymer does not separate like other polymers and doesn't require frequent mixing.

Staff recommendation is to sole source these polymers with Midwest Chemical & Equipment for 1-year with an option to renew a second year for plant staff to optimize equipment and operate most efficiently.

4. Describe your efforts to identify other vendors to furnish the product or services.

The product is proprietary and can only be made or distributed by the vendor owning the rights to these products.

5. How did you determine that the sole source vendor's price was reasonable? Similar products on the market are comparably priced.

6. Which of the following best describes this sole source procurement? Select all that apply.

- ☒ Product or vendor is uniquely qualified with capability not found elsewhere.
- ☐ Urgency due to public safety, serious financial injury or other. (explain)
- ☒ The procurement is of such a specialized nature that by virtue of experience, expertise, proximity or ownership of intellectual property
- ☐ Lack of acceptable quotes or bids.
- ☒ Product compatibility or the standardization of a product.
- ☐ Continuation of a phased project.
- ☐ Proposal development is uneconomical.

Department: *Wausau Waterworks - Wastewater*

Preparer: *Ben Brooks*

Vendor Name: *Midwest Chemical & Equipment*

Expected amount of purchase or contract: *\$190,000.00*

Department Head Signature:

Date:

Finance Director Signature:

Date:



CITY OF WAUSAU
SOLE SOURCE PURCHASE JUSTIFICATION
REQUIRED FORM PURCHASE OF GOODS OR SERVICES EXCEEDING \$10,000

Purchase of goods or services for no more than \$25,000 may be made without competition when it is agreed *in advance* between the Department Head and the Finance Director. Sole source purchasing allows for the procurement of goods and services from a single source without soliciting quotes or bids from multiple sources. Sole source procurement cannot be used to avoid competition, rather it is used in certain situations when it can be documented that a vendor or contractor holds a unique set of skills or expertise, that the services are highly specialized or unique in character or when alternate products are unavailable or unsuitable from any other source. Sole source purchasing should be avoided unless it is clearly necessary and justifiable. The justification must withstand public and legislative scrutiny. The Department Head is responsible for providing written documentation justifying the valid reason to purchase from one source or that only one source is available. Sole source purchasing criteria include: urgency due to public safety, serious injury financial or other, other unusual and compelling reasons, goods or service is available from only one source and no other good or service will satisfy the City's requirements, legal services provided by an attorney, lack of acceptable bids or quotes, an alternate product or manufacturer would not be compatible with current products resulting in additional operating or maintenance costs, standardization of a specific product or manufacturer will result in a more efficient or economical operation or aesthetics, or compatibility is an overriding consideration, the purchase is from another governmental body, continuity is achieved in a phased project, the supplier or service demonstrates a unique capability not found elsewhere, the purchase is more economical to the city on the basis of time and money of proposal development.

1. Sole source purchase under \$10,000 shall be evaluated and determined by the Department Head.
2. Sole source purchase of \$10,001 to \$25,000 a formal written justification shall be forwarded to the Finance Director who will concur with the sole source or assist in locating additional competitive sources.
3. Sole source purchase exceeding \$25,000 must be approved by the Finance Committee.

☐

Ongoing Sole Source – 365 days

☒

One Time Sole Source Request

1. Provide a detailed explanation of the good or service to be purchased and vendor.

Purchase of a tow behind Bypass Pump System for waster operations and emergency response.

2. Provide a brief description of the intended application for the service or goods to be purchased.

Wastewater crews need the ability to bypass wastewater flows while performing inspections, completing maintenance, and for emergency situations. This is an all-in-one unit that is easy to transport, set up and put into operation. In the past we would need to coordinate rental of pumps which tool days and sometimes longer if the right size pumps were not available.

3. State why other products or services that compete in the market will not or do not meet your needs or comply with your specifications.

Writing a specification for all aspects of this build to suit bypass pump system was not practical so staff worked with two different vendors who would be able to provide this system and received the attached prices. These two vendors have the types of equipment we would specify as well as the ability to supply

4. Describe your efforts to identify other vendors to furnish the product or services.

Two vendors were approached to provide costs for the type of system staff would need built.

5. How did you determine that the sole source vendor's price was reasonable?

Two vendors were approached to provide costs for the type of system staff would need built

6. Which of the following best describes this sole source procurement? Select all that apply.

- ☒ Product or vendor is uniquely qualified with capability not found elsewhere.
- ☐ Urgency due to public safety, serious financial injury or other. (explain)
- ☐ The procurement is of such a specialized nature that by virtue of experience, expertise, proximity or ownership of intellectual property
- ☐ Lack of acceptable quotes or bids.
- ☐ Product compatibility or the standardization of a product.
- ☐ Continuation of a phased project.
- ☒ Proposal development is uneconomical.

Department: *Wausau Waterworks - Wastewater*

Preparer: *Ben Brooks*

Vendor Name: *Lincoln Contractors Supply, Inc.*

Expected amount of purchase or contract: *\$68,764.14*

Department Head Signature:

Date:

Finance Director Signature:

Date:

Emergency Bypass Pump Comparison

	Gorman Rupp 74 HP John Deere	Godwin CD150S 60 HP Izuzu
Price \$=	\$57,998.00	\$45,955.00
Hoses & Fittings from LCS=	\$22,809.14	\$22,809.14
Total Price \$=	\$80,807.14	\$68,764.14
Max Capacity (GPM)=	2,360	2,290
Fuel tank size=	104	60
Float set=	Yes	Yes
Solids Passage=	3 Inches	3 Inches
Estimated delivery time=	2-3 weeks	Currently in stock

Bypass pump would be used for emergency bypassing of lift stations, gravity sewer lines, and maintenance at treatment plant while draining or transferring process liquids.

It would be staff recommendation to proceed with the purchase of the Godwin CD150S 60 pump from Lincoln Contractors Supply, Inc. and fund source from OP funds on the 2021-2025 Wausau Water Works – Wastewater Division Capital Plan (Sewer Lift Stations, Backup Generator upgrades) Budgeted amount= \$75,000.

Thank you,

Ben Brooks



brentn@lcswi.com

Valid for: 15 Days

WE PROPOSE THE FOLLOWING EQUIPMENT SUBJECT TO CONDITIONS NOTED BELOW:

CONDITIONS: The prices and terms on this quotation are not subject to verbal changes or other agreements unless agreed in writing by The Home Office of the Seller. All quotations and agreements are contingent upon strikes, accidents, fires, availability of materials and all other causes beyond our control. Purchaser agrees to accept either overage or shortage, not in excess of ten percent to be charged for pro-rata. Purchaser assumes liability for patent and copyright infringement when goods are made to Purchaser's specifications. When quotation specifies material to be furnished by the Purchaser, ample allowance must be made for reasonable spoilage and material must be of suitable quality to facilitate efficient production. Conditions not specifically stated herein shall be governed by established trade customs. Terms inconsistent with those stated herein which may appear on Purchaser's formal order will not be binding on the Seller. All rental rates quoted are for an 8 hour work day, 40 hour work week and a 160 hour month. Additional hours will be charged at 1-1/2 times the quoted monthly rate for a two shift operation and at 2 times the quoted monthly rate for a 3 shift operation.

BY:

Received 2-11-2022



QUOTE

Headquarters
707 Ford Street, Kimberly, WI 54136
t. 920-733-4425 f. 920-733-0211

Minnesota Office
12265 Nicollet Ave., Burnsville, MN 55337
t. 952-444-1949

Number CESQ48793-01

Date Feb 11, 2022

Expires Mar 13, 2022

Sold To

Wausau, City of
Ryan Dwelly
City Hall C/O Sewage Utility
407 Grant Street
Wausau, WI 54401

Ryan.dwelly@ci.wausau.wi.us
Phone 715-261-6940
Fax

Ship To

Wausau, City of
Ryan Dwelly
City Hall C/O Sewage Utility
407 Grant Street
Wausau, WI 54401

Ryan.dwelly@ci.wausau.wi.us
Phone 715-261-6940
Fax

Sales Rep**Fluid Technology Sales**

Travis Walker 920-219-1090

t.walker@craneengineering.net

Distribution Business Unit Manager

Tom Schroeder 920-257-0181

t.schroeder@craneengineering.net

Terms	RFQ	Ship Via	FOB	Crane Order#
n15		Best Way	Warehouse	

Line	Qty	Product	Lead Time	Unit Price	Ext. Price
1	1	ValuPrime Gorman Rupp Engine-Driven ValuPrime Model VPA6A60C-4LE2T FT4 Priming Assisted Centrifugal Pump W/ Autostart, 6" X 6" Flanged, Semi-Open 2-Vane Ductile Iron Impeller, 3" Solids Passage, Isuzu FT4 Diesel Engine, 34 Gallon Fuel Tank, Battery, High Speed Wheel Kit W/ Dot Lights And Electric Brakes, Dual Float Switch Control	2-3 Weeks ARO	\$38,490.88	\$38,490.88
2	1	PrimeAire Gorman Rupp Engine-Driven PrimeAire Model PA6C60-4045T FT4 Priming Assisted Centrifugal Pump W/ Autostart, 6" X 6" Flanged, Open 2-Vane Ductile Iron Impeller, 3" Solids Passage, John Deere FT4 Diesel Engine, 102 Gallon Fuel Tank, Battery, High Speed Wheel Kit W/ Dot Lights And Electric Brakes, Dual Float Switch Control	2-3 Weeks ARO	\$57,998.00	\$57,998.00
3	1	PrimeAire Silent Pump Design Gorman Rupp Engine-Driven PrimeAire Model PA6C60-4045T FT4-ESP w/ Silent Pump Enclosure, Priming Assisted Centrifugal Pump W/ Autostart, 6" X 6" Flanged, Open 2-Vane Ductile Iron Impeller, 3" Solids Passage, John Deere FT4 Diesel Engine, 102 Gallon Fuel Tank, Battery, High Speed Wheel Kit W/ Dot Lights And Electric Brakes, Dual Float Switch Control	5-6 Weeks ARO	\$78,986.00	\$78,986.00

+(LCS Hoses + Fittings)

\$22,809.14

\$80,807.14

Total \$175,474.88

Price does not include tax and shipping charges unless stated above.

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brentn@lcswi.com

ryan.dwelly@ci.wausau.wi.us

[illegible]

CONDITIONS: The prices and terms on this quotation are not subject to verbal changes or other agreements unless agreed in writing by The Home Office of the Seller. All quotations and agreements are contingent upon strikes, accidents, fires, availability of materials and all other causes beyond our control. Purchaser agrees to accept either overage or shortage, not in excess of ten percent to be charged for pro-rata. Purchaser assumes liability for patent and copyright infringement when goods are made to Purchaser's specifications. When quotation specifies material to be furnished by the Purchaser, ample allowance must be made for reasonable spoilage and material must be of suitable quality to facilitate efficient production. Conditions not specifically stated herein shall be governed by established trade customs. Terms inconsistent with those stated herein which may appear on Purchaser's formal order will not be binding on the Seller. All rental rates quoted are for an 8 hour work day, 40 hour work week and a 160 hour month. Additional hours will be charged at 1-1/2 times the quoted monthly rate for a two shift operation and at 2 times the quoted monthly rate for a 3 shift operation.

TO CONFIRM ORDER, SIGN AND RETURN ACCEPTANCE COPY.

BY:

MEMORANDUM

TO: Wausau Water Works
Wausau Transit Commission

FROM: Anne Jacobson, City Attorney

DATE: April 4, 2022

RE: Staff Analysis of Consent to Terminate Redevelopment Agreement between Wausau Joint Venture and City of Wausau Redevelopment Authority

Purpose: To obtain your consent to the Termination of the Redevelopment Agreement between Wausau Joint Venture and the City of Wausau Redevelopment Authority.

Facts:

1. Background

As part of the Second Amendment to Purchase and Development Agreement (Wausau Center Mall) under negotiation with Wausau Opportunity Zone, Inc. ("WOZ"), the City asserts it will, along with those necessary parties in interest, repeal the original Redevelopment Plan (Para. 2) and terminate the original Redevelopment Agreement (Para. 3) by and between Redevelopment Authority of Wausau, Wisconsin and Wausau Joint Venture, dated October 29 and October 30, 1979, respectively, concerning what is known as the "Wausau Center Mall Property."

The **Community Development Authority** succeeded the Redevelopment Authority of Wausau, Wisconsin by ordinance. (WMC 2.76.030, 2.76.050) And WOZ, rather than Wausau Joint Venture, is the current owner of the mall property.

The Redevelopment Plan ("Plan") was executed between the Redevelopment Authority of Wausau and Wausau Joint Venture on October 29, 1979, and subsequently amended, for a Downtown Shopping Center.

The Redevelopment Agreement ("Agreement") was executed between the same parties on October 30, 1979, and amended twice, but a Consent and Joinder was attached to the Agreement, as well as the subsequent amendments, to which the following entities gave their consent:

City of Wausau, Parking Utility, Water Utility and Sewerage Utility and Wausau Area Transit System, Inc.

Wausau Waterworks Commission succeeded the water utility and sewerage utility, to manage and operate the water and sewerage utilities, pursuant to WMC 13.04.010.

Wausau Area Transit System, Inc. was administratively dissolved on 12/21/1995. WMC 2.60.190 created the **Wausau Transit Commission**.

I find no record of a formal parking utility.

2. Recommendation

Both the Plan and Agreement and their amendments remained in effect as of the date of the Affidavit Regarding Title Matters, attached to this Memo.

The City's repeal of the Plan and termination of the Agreement is conditioned upon the consent of the necessary parties to each agreement. The Community Development Authority will have to also first consent to the repeal of the Plan and the termination of the Agreement.

The Wausau Water Works and Wausau Transit Commission will have to consent to the termination of the Agreement.

It is recommended that such authorities grant their consent to the repeal of the Plan and the termination of the Agreement at their respective meetings throughout April, to carry out the terms of the Second Amendment to the Purchase and Development Agreement with WOZ, which it is expected will be considered no later than May.

773861

City of Wausau

225 PAGE 729

Office of
ERNEST J. CHERNEY
CITY CLERK
(715) 845-5279



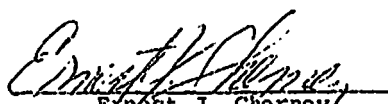
CITY HALL
407 Grant Street
Wausau, Wisconsin 54401

CERTIFICATION

I, Ernest J. Cherney, do hereby certify I am the duly qualified and acting City Clerk of and for the City of Wausau, Marathon County, Wisconsin. Acting in that capacity, I do further certify the accompanying Redevelopment Agreement is a true and correct copy of an Agreement adopted by the Common Council of the City of Wausau on the 30th day of October 1979.

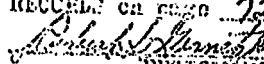
City of Wausau, Marathon County, Wisconsin.

Dated this 25th day of November, 1980.


Ernest J. Cherney
City Clerk
Wausau, Wisconsin



REGISTER'S OFFICE
Marathon County, WI } 86
'80 DEC 31 PM 2 12

Volume 327 of RECORDS
RECORDED on page 729-869

REGISTER

773861

1400 chg 4/10/81

1.321 730

REDEVELOPMENT AGREEMENT

Waukegan, Wisconsin

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EXHIBIT 1 Ground and Air Rights Lease

REDEVELOPMENT AGREEMENT

THIS AGREEMENT is made as of this 30th day of October, 1979, by and between THE REDEVELOPMENT AUTHORITY OF THE CITY OF WAUSAU, Wisconsin, a statutory authority authorized by the laws of the State of Wisconsin (hereinafter called "Authority") and WAUSAU JOINT VENTURE, an Ohio general partnership consisting of Richard E. Jacobs and David H. Jacobs (hereinafter called "Developer").

W I T N E S S E T H:

WHEREAS, The City of Wausau (hereinafter called "City") and Jacobs, Visconsi & Jacobs Co. (hereinafter called "JVJ"), an affiliate of Developer, entered into a Memorandum of Intent dated March 16, 1979 (hereinafter called the "Memorandum") for the redevelopment of a portion of the downtown area of the City; and

WHEREAS, pursuant to paragraphs 6 (A) and 6 (B) of the Memorandum, the City has provided voters of the City with factual information concerning the proposed redevelopment, and has held a referendum with respect thereto on April 3, 1979; and

WHEREAS, over 60% of the voters of the City voting in said referendum assented to the proposed redevelopment; and

WHEREAS, pursuant to paragraph 7 (A) of the Memorandum, JVJ has provided City with a report entitled "Economic Impact Analysis Wausau Downtown Shopping Mall" prepared by Touche Ross & Co.; and

WHEREAS, the Memorandum contemplates "a definitive agreement" between the City or one or more of its agencies and JVJ or the Developer to more fully define the proposed redevelopment and the role of the parties thereto;

NOW, THEREFORE, in consideration of the performance by Authority and Developer under the Memorandum, and to carry out its spirit and intent, the mutual and bilateral agreements and covenants herein contained, and for other good and valuable consideration, Authority and Developer hereby covenant and agree as follows:

I. DEFINITIONS AND RECOGNITION OF DEVELOPMENT PROCESS

A. DEFINITIONS

As used in this instrument, the following terms, when having an initial capital letter in the text of this Agreement, shall have the following meaning:

Agreement: This Redevelopment Agreement, taken and construed as a whole, as amended and supplemented from time to time.

Air Rights: The air space described on Exhibit A of the Ground Lease.

CBD: The central business district of the City exclusive of the Site.

Delivery Date: The date upon which the Authority delivers Developer possession of the Shopping Center Site, or so much thereof as is required for Developer to commence substantial construction thereon if title of the whole Shopping Center Site shall have then been acquired, with such of the utility and other improvements to be provided by the Authority in accordance with paragraphs III-A-9 and V-A as are necessary for Developer to commence construction, substantially in place.

Department Store Sublessees: Penney, Prango and Sears or such other department store or stores of comparable type and quality approved by Authority, which approval shall not be unreasonably withheld.

Ground Lease: The Ground and All Rights Lease attached hereto as Exhibit "1" and incorporated herein (the "Ground Lease"), which is in form and substance satisfactory to the parties but which the parties acknowledge may have to be modified prior to execution thereof to the extent required to satisfy the reasonable requirements of the Department Store Sublessees and/or Developer's first leasehold mortgagee of land comprising the Shopping Center Site, which modification shall be in form and substance satisfactory to both parties.

Local Funding: Municipal debt instruments to be issued by the Authority or the City, as they select, in an amount sufficient for the Authority and City to carry out the Redevelopment Plan, but not more than \$15,750,000.

Outside Funding: A total of not less than \$5,000,000 received by the Authority or the City, or for which the Authority or the City has received commitments (acceptable to the Authority or the City, as the case may be) in the form of nonrepayable grants from the United States, the State of Wisconsin, or any subdivision (other than the Authority or the City), agency or department of either of them, or under any federal or state law, or from any other public (other than the Authority or the City) or private source for performance of the obligations in this Agreement on the Authority's part or behalf to be performed. The foregoing sources include, for example and without limitation, the grant programs administered by and/or under the Economic Development Administration (EDA Title I); the Upper Great Lakes Regional Commission (Title V); the Department of Housing and Urban Development (Community Development Block

Grants, "Small City Program"; Urban Development Action Grants); the Department of Transportation (Federal Aid Highway Program, "Urban Systems Projects").

Parking Facilities: Parking Structure No. 1 and Parking Structure No. 2 (described in paragraph III-A-9) located on the Parking Facilities Sites.

Parking Facilities Sites: The real property upon which the Parking Facilities will be constructed and situated and described on Exhibit B of the Ground Lease.

Penney: J. C. Penney Company, Inc.

Prange: H. C. Prange Company.

Redevelopment Plan: The Plan of Redevelopment to be prepared in accordance with paragraph III-A-2, as amended and supplemented from time to time.

Sears: Sears, Roebuck and Co.

Shopping Center: A major retail shopping area consisting of approximately 500,000 square feet of floor area, including retail department stores to be operated by the Department Store Sublessees (Penney, Prange and Sears to have approximately 90,000 square feet, 95,000 square feet and 85,000 square feet of gross building floor area, respectively), mall shops and an enclosed mall to provide access to the mall shops and the retail department stores, substantially in accordance with the Site Development Plan.

Shopping Center Site: The real property, including the Air Rights (as described on Exhibit A of the Ground Lease) leased to Developer under the Ground Lease, upon which the Shopping Center will be constructed and situated.

Site: The Shopping Center Site and the Parking Facilities Sites, which is an eight square block area in

334 sec 733

the City bounded on the north side by the south right-of-way boundary of Washington Street; on the east side by the west right-of-way boundary of Fifth Street; on the south side by the north right-of-way boundary of Forest Street; and on the west side by the east right-of-way boundary of First Street, together with such portions, as may be approved by both parties, of the right-of-way of such dedicated streets as may be necessary for development of the Shopping Center.

Site Development Plan: The following drawings prepared by JVJ, as amended from time to time with the consent of the parties:

- (a) Site Development Plan (South Side), Drawing S, dated March 16, 1978, revised June 13, 1979
- (b) Site Development Study, Drawing S, dated June 9, 1979
- (c) Parking Deck I and Parking Deck II, Section A-A, Section B-B (3 sheets), dated June 7, 1979

Subleases: The respective documents by which Developer will sublease portions of the Shopping Center Site to the Department Store Sublessees for construction and/or operation of the retail department stores. The Authority, as overlessor, shall join in the execution of the Subleases approved by the Authority, for the purpose of evidencing the agreement of the Authority that (i) upon the expiration or earlier termination of the Ground Lease, the Authority will recognize the Sublease to the Department Store Sublessee and the Department Store Sublessee shall attorn to the Authority provided that the sublessor's obligations under such Sublease are being fulfilled; (ii) the Authority approves the terms and conditions of the Sublease and, in case of conflict between the Ground Lease and a Sublease approved by the Authority,

agrees that the Sublease shall prevail; (iii) the Sublease is not subject or subordinate to any mortgage granted by the Authority and that the Department Store Sublessee will have quiet enjoyment of its subleased premises so long as the Department Store Sublessee fulfills its obligations under its Sublease, free from any claims or rights as to which the Authority's covenant of quiet enjoyment in Section 4.1 of the Ground Lease extends; and (iv) the Department Store Sublessee shall have the same options to terminate its Sublease as are granted to Developer pursuant to Section 2.2 of the Ground Lease.

Tenant Subleases: The documents by which Developer will sublease portions of the Shopping Center Site to tenants (other than the Department Store Sublessees) selling goods and services at retail within the Shopping Center.

B. DEVELOPMENT PROCESS

The parties acknowledge and agree that redevelopment of a downtown business district is a complex process which is divided into several stages:

- (a) The Development Planning Stage
- (b) The Land Assemblage Stage
- (c) The Construction Stage
- (d) The Operation Stage

Each stage described is dealt with in greater detail hereafter. The parties recognize, however, that neither is obligated to proceed hereunder until all of the components of the Development Planning Stage have been accomplished, but that once the Development Planning Stage has been accomplished, the parties are bound to fulfill their respective obligations under the Redevelopment Plan, this Agreement and the Ground Lease.

The parties further acknowledge that duties provided for in this Agreement and in the Redevelopment Plan are a part of a process and will be subject to facts not now known and events which have not yet occurred, and therefore agree that the Site Plan, the Redevelopment Plan, this Agreement and the Ground Lease may be supplemented and amended from time to time in important respects as facts become known and as events occur prior to completion of the Development Planning Stage.

II WT & TERM

Authority hereby grants Developer, during the term of this Agreement, the exclusive right to develop the Shopping Center on the Shopping Center Site substantially in accordance with the Site Development Plan and Redevelopment Plan and in accordance with the terms of this Agreement and the Ground Lease. Unless earlier terminated as hereinafter provided, this Agreement shall continue from the date hereof until each of the parties has fulfilled all of its obligations hereunder.

III. DEVELOPMENT PLANNING STAGE

A. DUTIES OF AUTHORITY

1. Authority Budget. Authority agrees to establish a budget of not less than \$300,000 for the performance of its obligations during the Development Planning Stage, inclusive of expenses already paid or incurred by the City or Authority. It is presently anticipated that such funds would be obtained by the Authority or the City from Outside Funding, from transfers of funds from existing budget items, from short term borrowings in anticipation of issuance of bonds and/or from other sources.

2. Redevelopment Plan. The Authority agrees to prepare or cause to be prepared, in accordance with all applicable laws, a Redevelopment Plan covering the Site for presentation at a public hearing and adoption by the Authority under authority granted by Section 66.431, Wis. Stats. It is presently anticipated that the Redevelopment Plan and all public hearings thereon will be completed by Authority no later than October 31, 1979. Authority agrees to engage the services of an independent consulting firm with experience in redeveloping central business areas to assist it in the preparation of the Redevelopment Plan, and with the hearings and presentations required prior to its formal adoption. The Redevelopment Plan and any amendments thereto shall be approved by Developer prior to adoption by the Authority, which approval shall not be unreasonably withheld.

3. Relocation Plan. The Authority agrees to adopt, in accordance with all applicable laws, a Relocation Plan covering the Site for incorporation into the Redevelopment Plan. The Vector Company has been engaged to prepare such Relocation Plan, and the plan which it heretofore prepared has been approved by the State of Wisconsin.

4. Land Assembly Plan. Authority will prepare a plan for the orderly and timely acquisition of fee simple title to the Site. Authority agrees to engage legal counsel of Authority's choice and to carry out all land acquisition proceedings in a prompt and efficient manner to be commenced not later than the completion of the Development Planning Stage. Authority also agrees to continue the services of The Vector Company or an equally competent independent consulting firm with relevant experience to assist

the Authority in carrying out of the approved Relocation Plan.

5. Financing. The City has applied for Outside Funding in an amount of not less than \$10,000,000, and will pursue such applications, providing additional information as necessary, in good faith and with diligence. It is understood and agreed that Authority may, at its option, decline to proceed beyond the Planning Development Stage and terminate this Agreement unless Authority and/or City has received such funding or binding commitments, under terms acceptable to Authority and/or City, in an amount of not less than \$5,000,000.

It is anticipated that the cost of performing the Redevelopment Plan and this Agreement by Authority will exceed the Outside Funding. Authority and/or City shall plan for (and issue when appropriate) municipal debt instruments in an aggregate amount (not to exceed \$15,750,000), which is estimated to be sufficient to finance such differential, and to apply the proceeds thereof to the performance of the Authority's obligations hereunder.

6. Management. Authority agrees to interview candidates for, and engage the services of (a) a management consulting and planning firm or person with the view of preparing a plan for Authority's management and performance of its role in constructing and completing the improvements to be provided by Authority (described in paragraph III-A-9) and monitoring and coordinating its effort with Developer's performance of its obligations with respect to the Shopping Center Site; and (b) an experienced firm or person to serve as project manager whose sole job will be to coordinate and

carry out Authority's role hereunder and to protect its interests. Such project manager and such management consultant may be independent contractors or employees of the Authority and/or City.

7. Survey. Authority has engaged the services of a surveyor licensed by the State of Wisconsin to survey the Site, and to develop a legal description for the Site, the Shopping Center Site and the Parking Facilities Sites.

8. Transit and Traffic Plan. Authority agrees to prepare initial plans and specifications and a timetable for necessary abandonment, vacation, relocation and improvements to public streets, alleys and sidewalks within and adjacent to the Site, and to prepare general plans for vehicular and pedestrian traffic to best serve the Site following completion of construction thereupon, all in compliance with the Redevelopment Plan and its purposes, and to stimulate the redevelopment, growth and vitality of the CBD. To that end, the City has obtained approval of its application for UMTA planning funds.

9. Improvements to be Provided by Authority.

(a) Soils Consultant. Authority shall retain a soils consultant, satisfactory to Authority and Developer, to perform the following duties on the Site at the expense of Authority, except as otherwise hereinafter specifically provided:

- (i) Perform preliminary soils investigations, including borings, if necessary;
- (ii) Prepare report outlining demolition procedures and procedures and criteria for preparation of graded Site, including such information as may be required under subparagraph (b) below of this paragraph 111-A-9;

- (iii) Provide all necessary in-field testing and observation so as to be able to certify that the procedures and criteria recommended pursuant to clause (ii) above and approved by Authority and Developer have been fulfilled; and
- (iv) Make recommendations, at the expense of Authority, for foundation design of Parking Facilities and, at the expense of Developer, for foundation design of the Shopping Center buildings.

(b) Site Preparation. Authority agrees to prepare, for approval by Developer, plans and/or specifications (described more fully in the Ground Lease) and a timetable for performance of the following work to be performed on the Site by Authority, at its expense, except as otherwise hereinafter specifically provided:

- (i) Demolition and removal from the Site of all structures and basement walls, floors, foundations, pavements and utilities, to the extent deemed necessary and appropriate by the soils consultant, to provide a satisfactory base for the support of the Parking Facilities and Shopping Center buildings;
- (ii) Placement and compaction of suitable fill material in basement areas and other depressions in a manner prescribed by the soils consultant;
- (iii) Sufficient quantity of approved fill material from Parking Structure No. 1 shall be stockpiled on the Site in order to provide backfill for Parking Structure No. 1 and to bring the remaining portion of the Site to grade with surplus (if any) and unsuitable material to be removed from Site and additional fill (if required) brought to Site;

- (iv) Temporary parking for the existing Sears store shall be provided during the period prior to completion of Parking Structure No. 2, at a location approved by Sears;
- (v) Removal and replacement of portions of pavement of existing perimeter streets where necessary and installation of new curbs;
- (vi) Relocation of utility lines, poles and hydrants where necessary; and
- (vii) Provide utility connections at the curb line.

Authority and Developer shall share the charges of the soils consultant for the services described in paragraphs III-A-9-(a)-(i), (ii) and (iii) and the cost of placing and compacting stock-piled material to bring the Site up to required subgrades, such charges and cost to be shared by Authority in that proportion which the number of acres on the Parking Facilities Sites bears to the total acreage of the Site and by Developer in that proportion which the number of acres of land within the Shopping Center Site bears to the total acreage of the Site. The parties shall be entitled to rely upon the recommendations of such soils consultant in the performance of such work, and shall not be responsible to the other or any other person for any errors or omissions on such soils consultant's part or for work performed in accordance with such recommendations.

(c) Parking Facilities. Authority agrees to prepare, for approval by Developer, plans and specifications (described more fully in the Ground Lease) and a timetable for construction of the Parking Facilities to be constructed on the Parking Facilities Sites by Authority, at its expense except as otherwise hereinafter specifically provided:

(i) A two-level parking garage, including a partial third level south of the department store to be located substantially within the Air Rights and all necessary exterior ramps required for vehicular ingress and egress to the various levels ("Parking Structure No. 1") which shall include, inter alia, the following special items:

(aa) Structural beams and slabs at the third level as necessary for the support of the department store and the sidewalk area north of the Air Rights;

(bb) Elevators, including the doors at the mall level;

(cc) Foundations and columns increased in carrying capacity to support the department store loads;

(dd) Stairwells sized and located in accordance with the department store exiting requirements;

(ee) Exterior enclosure at First Street and Forest Street shall be designed to be architecturally harmonious with department store building exterior design; and

(ff) Provide retaining wall, ramps and stairs at the Washington Street entrance ramp as required by Penney.

Developer shall pay Authority the sum of \$600,000 as reimbursement for the cost of the structural beams, slabs and other support for such department store and the elevator shafts and doors above such department store floor at mall level.

(ii) A four-level parking garage located adjacent to the other two department store buildings on the Shopping Center Site, which shall be designed to support

and permit the addition of a fifth parking deck ("Parking Structure No. 2").

The Parking Facilities shall consist of a total of approximately 1,574 parking spaces substantially as shown on the Site Development Plan. In connection with the preparation of such plans and specifications, Developer recognizes that Authority reserves the right to include commercial space at various first-floor points within the Parking Facilities, which shall face the outside of the Parking Facilities (any retail usage of such commercial space shall be subject to the Developer's approval and shall not be competitive with retail uses in the Shopping Center), and the right to use the Air Space over Parking Structure No. 2 (such Air Space rights to include support and access rights) for additional parking (including a possible skywalk to the Marathon County Court House) and such other uses as shall be approved by Developer; provided, however, that any such construction within such Air Space shall have been substantially completed prior to opening of the Shopping Center for business with the public and provided, further, that Authority shall provide such additional parking spaces within the Parking Facilities as may be required under applicable zoning ordinances and regulations to serve such additional uses.

Authority and Developer agree to work together to explore methods by which construction of the Parking Facilities and construction of the Shopping Center can be coordinated and more cost effective, including potential use of a common contractor (including Developer or a construction company affiliated with Developer) or common construction manager. Consideration will also be given to the organization of a

non-profit corporation to construct the Parking Facilities (with proceeds of tax exempt bonds) and lease them to Authority and/or City, or the contracting by Authority and/or City to sell and repurchase from the Developer the Parking Facilities Sites and purchase from the Developer the Parking Facilities upon completion of construction thereof by Developer.

Authority agrees to prepare the necessary Planning and Feasibility Study required to obtain financing and legislative action for construction of the Parking Facilities, substantially as shown on the Site Development Plan. Authority agrees to prepare or cause to be prepared the necessary plans and specifications for construction of the Parking Facilities, as aforesaid, following preparation of the Study referred to in the foregoing sentence and approval thereof by Developer and to develop a timetable for construction.

10. Preservation of Existing Municipal Parking; Public Transportation. The parties are desirous of additional development in the CBD and acknowledge that the minimum capacity of the Parking Facilities, which are presently deemed adequate to serve the traffic expected to be generated by the Shopping Center, was determined, inter alia, by giving consideration to the current existing City municipal parking areas within the CBD. Accordingly, the Authority agrees with Developer and will obtain a commitment from the City that from and after the date hereof until the expiration or earlier termination of the Ground Lease, the Authority and/or the City will not permit the use of any of the municipal parking areas within the CBD for other than parking purposes without providing or causing to be provided municipal parking spaces at least equal in number to those

which would be lost by reason of such other use, at a location not less convenient to the Site than those parking areas to be devoted to such other use. Furthermore, the parties acknowledge the necessity of adequate public transportation during the hours of operation of the Shopping Center, and the Authority agrees with Developer and will obtain a commitment from the City and/or the Transit Authority that from and after the Opening Date (as defined in the Ground Lease) and continuing thereafter until the expiration or earlier termination of the Ground Lease, public transportation at least equal in terms of routes and frequency of service to that presently serving the Site shall be provided and, further, that the hours of operation of such public transportation shall be extended, if necessary, to serve the Site daily commencing at least one hour before and ending at least one hour after the hours that the Shopping Center is open for business with the public.

B. DUTIES OF DEVELOPER

1. Plans and Specifications. The parties acknowledge and agree that the plans and specifications to be prepared by the parties hereto and the work to be undertaken thereunder, must be harmonious. Accordingly, the parties agree to cooperate with and advise each other concerning the preparation of all of the foregoing plans, specifications and timetables. Developer further agrees that its preliminary and/or final layouts, drawings and renderings shall be consistent with the Site Development Plan.

2. Progress Schedule. Developer agrees to use the Critical Path Method ("CPM"), the Program Evaluation

and Review Technique ("PERT") or comparable method for the construction work on the Shopping Center Site, and has prepared a preliminary Progress Schedule for both the Shopping Center and the Parking Facilities which is attached as Exhibit C to the Ground Lease and by this reference is made a part hereof. The parties acknowledge that the preliminary Progress Schedule was prepared by assuming opening of Kausau Mall in October, 1982 and working backward with estimates of the minimum periods required for completion of construction of the various phases. It is understood that any delay in the fulfillment of any of the conditions referred to in the Progress Schedule will necessitate at least an equal extension of the date provided for fulfillment of subsequent conditions. The parties agree to update the Progress Schedule from time to time to reflect changes and progress to date and further agree that the timetables above referred to shall be consistent with the Progress Schedule, as amended. The Progress Schedule and timetables shall be updated as of the date the Land Assembly Stage is completed and shall thereupon become binding upon the parties hereto, subject only to delays of the type described in paragraph VII-E.

3. Department Store Sublessees. Developer agrees that simultaneously with the execution of the Ground Lease by the parties hereto, it will enter into the Subleases with the Department Store Sublessees, obligating such companies to build or lease and, in either event, continuously operate retail department stores under their respective names within the Shopping Center for at least ten (10) years following the Opening Date, and restricting use of the subleased areas and the improvements constructed thereon during the entire

term of the Ground Lease to retail, service or other uses customary in a regional shopping center, or such other uses as shall be approved in advance by the parties hereto, and containing such other terms and conditions as Developer deems necessary to construct and operate the Shopping Center. Such Subleases shall be contingent upon (a) the Authority fulfilling all of its obligations under paragraphs III-A-6, IV and V-A, (b) approval of title and zoning and (c) fulfillment of other customary closing conditions which shall include the opinion of the City Attorney that the Authority and the City will be bound by the agreements made by Authority in its capacity as landlord of the Ground Lease and as overlessor of the Subleases to the Department Store Sublessees and by the City pursuant to its consent to this Agreement.

4. Minimum Investment; Financing. Developer covenants and agrees to expend or cause expenditure of an amount of not less than \$30,000,000 for developing or causing to be developed the buildings and improvements (including the Department Store Sublessees' buildings, improvements and trade fixtures, and leasehold improvements in the mall stores, including tenant improvements and trade fixtures of sublessees under Tenant Subleases, and all hard and soft costs incidental thereto, including fees of Developer, but excluding the Parking Facilities and inventories of Department Store Sublessees and sublessees under Tenant Subleases) comprising the Shopping Center.

Developer agrees, at its expense, to obtain such construction and permanent financing as Developer deems necessary to perform its obligations under this Agreement.

and the Ground Lease, which shall include commitment(s) from Institutional Lender(s) (as defined in the Ground Lease) for minimum construction and long-term financing for the Shopping Center of not less than \$10,000,000 in the event that the Department Store Sublessees construct their own buildings or not less than \$16,000,000 if Developer is required to construct the buildings for Penney and Sears. Developer shall have the option of fulfilling the foregoing requirements for commitment(s) for construction and long-term financing by providing the Authority with (i) a single commitment for the amount of such financing from an Institutional Lender (as defined in the Ground Lease) for an Interim Term Loan for a term of not less than four (4) years or (ii) a commitment (to be replaced not later than the date of commencement of construction of Parking Structure No. 1 if Developer has received at least ninety (90) days advance notice of such commencement; otherwise ninety (90) days after Developer receives notice of such commencement) for the amount of such financing executed by Richard E. Jacobs and/or David H. Jacobs, in his or their individual capacities, agreeing to provide or cause such financing to be provided, which commitment shall be accompanied by written verification from Touche Ross & Co. or other national accounting firm that the current net worth of the signatories is not less than three hundred percent (300%) of the amount of such commitment. At the request of the Authority, made not more frequently than annually, the Developer shall deliver to the Authority, within ninety (90) days after receipt of such request, a then current verification of net worth as above required by a national accounting firm. The Developer shall be obligated

to provide a take-out commitment for long-term permanent financing at least twelve (12) months prior to the maturity of any Interim Term Loan or give any other reasonable assurances that the Interim Term Loan will be satisfied on its maturity date or such maturity date will be extended. Developer shall perform all terms of such financing commitments so as to keep them in force and draw down funds thereunder. The obligation of Developer in the immediately preceding sentence shall survive any termination of this Agreement unless specifically referenced in any termination agreement.

In connection with obtaining such financing, the Authority shall provide Developer and its proposed lender(s) with the assurances set forth in the Ground Lease. No financing of the Developer shall become an obligation of Authority, and the terms of any financing by Developer shall so confirm, and the same shall be structured so that no such financing shall constitute an indebtedness of the Authority. In the event that Developer's total financing benefiting from the Authority's assurances shall exceed the Developer's total development and construction costs (hard and soft costs, including fees of Developer and its affiliates and construction allowances payable to its sub-tenants for leasehold improvements) for the Shopping Center, including all amounts paid to Authority by Developer in accordance with paragraph III-A-9 as reimbursement for certain improvements to be provided by Authority, which costs shall be certified to the Authority by a firm of independent certified public accountants, the Authority shall share in such excess proceeds of financing as provided in the Ground Lease.

5. Project Manager and Budget. Developer agrees to appoint a qualified project manager for the Shopping Center, and at all times during the term hereof to have such a project manager. Developer shall establish a budget of not less than \$300,000 for the Shopping Center during the Development Planning Stage, inclusive of funds already paid or incurred by JVJ or the Developer, including expenditures for tasks included in subsequent Stages.

6. Cooperation. Developer agrees to consult with and obtain the advice and counsel of the Authority and City with respect to, and to work with Authority and City in integrating, the Shopping Center with the CND.

7. Assistance in Obtaining Outside Funding. Developer agrees to assist the Authority and City in obtaining Outside Funding for the Project and, upon request, to furnish the Authority and City with information reasonably required for any applications for Outside Funding. Without limiting the generality of the foregoing, Developer agrees to assist the Authority and City in seeking funds from the Department of Housing and Urban Development, the Economic Development Administration, and the Upper Great Lakes Regional Commission.

8. Leasing Plan. Developer agrees to prepare a preliminary leasing plan for the mall shops within the Shopping Center, which is to include proposed merchandising of space to provide a well balanced tenant mix of local and national tenants and the array of goods and services necessary to compliment those offered by the Department Store Sublessees. Upon request of Authority, made not more frequently than bi-monthly, Developer shall provide Authority with its most current leasing plan.

C. OBLIGATIONS OF THE PARTIES TO PROCEED

It is understood and agreed by the parties hereto that this Agreement embodies the framework upon which the parties agree to proceed. The obligations of the parties to proceed, however, are dependent upon the occurrence of each of the matters set forth in paragraphs III-A and III-B. If any of the matters set forth in paragraphs III-A or III-B above shall not have been fulfilled or satisfied for any reason (except bad faith by any party hereto) on or prior to six (6) months from the date of execution of this Agreement (subject to the provisions of paragraph VII-E below), the party who is not in default of its obligations to fulfill or perform such matters may:

1. Give to the other written notice of its intention to terminate this Agreement stating the contingency or condition which has not been fulfilled or satisfied, and this Agreement shall then terminate automatically sixty (60) days after the giving of such notice unless within such period such contingency or condition shall be fulfilled or satisfied or shall be waived in writing by the other;

2. Postpone the time for the fulfillment or satisfaction of such contingency or condition for such period of time as the parties may agree, at the end of which period this Agreement shall terminate automatically if such contingency or condition has not been fulfilled or satisfied, unless the parties then waive in writing the fulfillment or satisfaction of such condition, or agree in writing to a further postponement; or

3. Waive in writing the fulfillment or satisfaction of such contingency or condition.

D. ESTOPPEL CERTIFICATE

At any time and from time to time, each of the parties hereto agrees, upon request in writing from the other, to execute and deliver to the addressee designated by the requesting party, including Developer's Institutional Lender(s) (as defined in the Ground Lease) a statement in writing, certifying as to the fulfillment or satisfaction of each of the matters set forth in paragraphs III-A and III-B, and if such matters have not all been fulfilled and satisfied, an enumeration of those matters which remain to be fulfilled or satisfied; that the responding party knows of no default under this Agreement by the requesting party, or if there is a default, the nature thereof; and that there are no offsets under this Agreement of which the responding party has knowledge against the requesting party, or if there is an offset, the nature and amount thereof. Neither party shall be required or obligated to furnish more than one certificate to any designated addressee in any twelve (12) month period unless for each additional certificate requested to the same addressee in such time period a payment of \$25 is made by the requesting party to the other party.

IV. LAND ASSEMBLY STAGE

In view of the size and complexity of the project covered by this Agreement, the parties recognize that once the Development Planning Stage has been completed, the Land Assembly Stage and the Construction Stage (Article IV and V) of various parts of the Site may overlap and run concurrently. The parties further agree that once the Land Assembly Stage is commenced by the Authority and the Construction Stage is

commenced by the Developer, the damages to the Authority, the CBD and the electorate of the City and the damages to the Developer, as the case may be, are incapable of measurement and, therefore, each party confirms that the other party shall be entitled to specific performance of the defaulting party's obligations under this Agreement.

Authority agrees to acquire the Shopping Center Site and Parking Facilities Sites in accordance with the Land Assembly Plan referred to in paragraph III-A-4. In connection therewith, Authority shall implement the Relocation Plan referred to in paragraph III-A-3, file a relocation order and also make a finding of necessity, serve notices of appraisal, commence negotiations for purchase of and proceed with condemnation proceedings to acquire fee simple title to, the real estate which comprises the Shopping Center Site and Parking Facilities Sites. To the extent and when requested by Developer, Authority agrees to advise Developer concerning the progress of the foregoing acquisitions, and to seek the advice and counsel of Developer in connection therewith. Developer agrees to cooperate with Authority in connection with its duties under this paragraph. In the event that the Authority fails to complete acquisition of the Shopping Center Site and Parking Facilities Sites on or prior to thirty-six (36) months after the date of execution of this Agreement, Developer shall have the same rights as are conferred upon Developer under paragraph III-C in the event of failure by the Authority to fulfill or satisfy its obligations under paragraph III-A.

V. CONSTRUCTION STAGE

A. DUTIES OF AUTHORITY

Authority, at its sole cost and expense, agrees to

undertake and perform the work and construct the improvements to be provided by the Authority as described in and indicated by the plans and specifications referred to in paragraph III-A-9, subject to reimbursement by Developer of the amounts specified therein, and to complete the same on or before the dates provided in the Progress Schedule. Authority agrees that it shall pay any special assessments which may be levied for the improvements to be constructed by Authority under this Agreement.

B. DUTIES OF DEVELOPER

Developer, at its sole cost and expense, agrees to construct the Shopping Center, including new or replacement sidewalks around the Site, in accordance with the Ground Lease, pursuant to the plans and specifications referred to in paragraph III-B-1, and to complete the same on or before the dates provided in the Progress Schedule.

VI. OPERATION STAGE

A. SHOPPING CENTER

Developer agrees to operate the Shopping Center in accordance with the Ground Lease.

B. PARKING FACILITIES

Authority agrees to operate or cause to be operated the Parking Facilities in accordance with the Ground Lease, and Developer shall reimburse Authority for a portion of any operating deficit from such operation as provided in the Ground Lease.

VII. MISCELLANEOUS

A. Authority agrees to request and the City agrees to timely vacate such streets and alleys, issue such permits, make such changes in the ordinances of the City, and do such

further and necessary steps as may be required to carry out the purposes of this Agreement and the Ground Lease and the performance of the parties hereunder and under the agreements referred to herein. This paragraph requires the Authority and the City to take any necessary legislative action and to obtain any necessary legislative action of its agencies required from time to time to authorize the actions of the City and/or Authority in accordance with this Agreement and the Ground Lease; and to obtain all of the necessary local governmental permits, authorizations and other approvals required for the Authority to fulfill its obligations under this Agreement and the Ground Lease, except as otherwise herein specifically set forth.

B. Developer and Authority agree, and Authority agrees to obtain agreement of the City to enter into all the necessary legal documents and agreements to develop the Shopping Center and to take all other necessary action to develop the Shopping Center and the Parking Facilities consistent with this Agreement and the Ground Lease.

C. An environmental impact statement presently being prepared shall be completed. Authority shall obtain all governmental permits or licenses required for the portions of the Project which Authority is obligated to construct hereunder. Developer agrees to reimburse the Authority and/or City for the reasonable costs so incurred by Authority and/or City relating to the Shopping Center. All other costs shall be at Authority's sole cost and expense.

D. It is understood and agreed by the parties hereto that all dimensions and quantities of square feet set forth herein and on the exhibits hereto, and all locations

of structures and other improvements set forth on the exhibits hereto, are preliminary and tentative. Before the legal descriptions of the various parcels comprising the Site are finalized, as set forth hereinabove, each party reserves the right to make minor changes in the dimensions, quantities and locations to best accommodate and facilitate design, construction and operation, upon written notice to, but without the need for consent from, the other parties to this Agreement.

E. In the event that any party hereto shall be delayed or hindered in or prevented from the performance of any act required hereunder for any cause specified in Section 13.6 of the Ground Lease, then performance of such act shall be excused for the period of the delay and the period of the performance of any such act shall be extended for a period equivalent to the period of such delay and so reflected on the Progress Schedule.

F. Developer shall have no right to assign this Agreement and its rights and obligations hereunder other than any permitted assignment by Developer or permitted transfer of an interest in Developer under the terms of the Ground Lease. It is recognized by both parties to this Agreement that the continuous involvement of one or more of the Developer's principals in the development, construction, leasing and operation of the Shopping Center as provided in the Ground Lease is a sine quo non of this Agreement.

G. In the event any notice is desired or required to be delivered hereunder, it shall be given in writing, and shall be delivered personally or shall be deposited in the United States mails, postage prepaid, certified or registered,

return receipt requested in which latter event it shall be deemed given five (5) days after the date mailed. If it is to be sent to the Authority, it shall be addressed as follows:

The Redevelopment Authority
of the City of Wausau
City Hall
Wausau, Wisconsin 55401

Attention: Chairman

with separate copies to the Mayor, City Clerk and City Attorney, City of Wausau at the above address;

If it is to be sent to Developer, it shall be addressed as follows:

Wausau Joint Venture
c/o Jacobs, Viscensi & Jacobs Co.
35425 Center Ridge Road
Cleveland, Ohio 44145

Attention: Richard E. Jacobs

with separate copies to any Institutional Lender of Developer, as defined in the Ground Lease, provided the name and address of such Institutional Lender has been provided to Authority in the manner provided above.

Each party may (i) change its address to which notice is to be given by like notice and (ii) provide the other party by like notice with the names and addresses of not more than six (6) other persons to whom copies of all notices are to be directed. Each party shall give the other party a copy of any notice received which affects this Agreement or the performance of the parties hereunder.

II. This Agreement may be executed in any number of counterparts, each of which shall constitute an original. This Agreement is the "definitive agreement" referred to in the Memorandum.

I. This Agreement may be supplemented or amended only by written instrument executed by the parties affected by such supplement or amendment.

J. Whenever the consent or approval of any party is required under this Agreement, such consent or approval shall not be unreasonably withheld.

K. This Agreement shall inure to the benefit of and be binding upon the parties hereto.

L. This Agreement shall be governed by the internal laws of the State of Wisconsin. If any term or provision of this Agreement, or any exhibit hereto, or the application thereof to any person or circumstance, shall to any extent be invalid or unenforceable, the remainder of this Agreement and exhibit, or the application of such term or provision to persons or circumstances other than those as to which it is invalid or unenforceable, shall not be affected thereby, and each term and provision of this Agreement shall be valid and be enforced to the fullest extent permitted by law.

M. This Agreement is contingent upon approval of an Urban Development Action Grant to the City of not less than \$5,000,000 from the United States Department of Housing and Urban Development and will terminate and be of no further force or effect without such Action Grant or other public funding.

N. This Agreement shall supersede the Memorandum of Intent between the parties hereto, dated March 16, 1979, which shall be of no further force or effect from and after the date of execution hereof.

VIII. OTHER CITY AUTHORITIES

Various of the provisions on the Authority's and City's part contained in this Agreement are on subject.

within the purview of various authorities. For example, certain of the City's responsibilities herein expressed may be performed by the City, its Parking Utility, and by the Water Utility and/or Sewerage Utility, and such authorities have joined in the execution of this Agreement for the purpose of evidencing their agreement to be bound in respect to the performance of such responsibilities which are within their respective purview and control.

IN WITNESS WHEREOF, the parties have caused this Redevelopment Agreement to be duly executed as of the date first above written.

Witnesses:

THE REDEVELOPMENT AUTHORITY
OF THE CITY OF WAUSAU

Thomas J. Mallon

By Bryan E. Bronston, Jr.
Bryan E. Bronston, Jr., Chairman

Stanley J. Hyslop

Attest Constant C. Chilicki
Constant R. Chilicki,
Executive Director

(CORPORATE SEAL)

WAUSAU JOINT VENTURE

Charles Jacobs

By Richard E. Jacobs (SEAL)
Richard E. Jacobs, General Partner

Margie Jacobs

By David E. Jacobs (SEAL)
David E. Jacobs, General Partner

CONSENT AND JOINDER

To the extent that the duties ascribed to the Authority under the foregoing Redevelopment Agreement are statutorily mandated to be, or are customarily undertaken by the undersigned, the undersigned covenants and agrees to perform such obligations herein set forth to be performed, and joins in and executes this Agreement to bind itself in every respect for the performance of such obligations and agrees to perform in accordance with its terms, all pursuant to such bilateral or multilateral contracts and funding agreements which such parties have entered into or will hereafter make in connection with their respective performance of the duties imposed upon them herein.

Dated at Wausau, Wisconsin, this 30 day of October, 1979.

Witnesses:

CITY OF WAUSAU

Richard A. Meyer

By John L. Kannenberg
John L. Kannenberg, Mayor

Barbara C. (L.) Vintz

Attest Ernest J. Cherney
Ernest J. Cherney, City Clerk

(SEAL)

CONSENT AND JOINDER

To the extent that the duties ascribed to the Authority and/or City under the foregoing Redevelopment Agreement are statutorily mandated to be, or are customarily undertaken by the undersigned, the undersigned covenants and agrees to perform such obligations herein set forth on the part of the Authority and/or City to be performed, and joins in and executes this Agreement to bind itself in every respect for the performance of such obligations and agrees to perform in accordance with its terms, all pursuant to such bilateral or multilateral contracts and funding agreements which such parties have entered into or will hereafter make in connection with their respective performance of the duties imposed upon them herein.

Dated, at Wausau, Wisconsin, this 30 day of October, 1979.

Witnesses:

PARKING UTILITY

Burt M. Rinaldi By John G. von Gierke
Mayor of Wausau, Wisconsin Chairman
J. J. J. J. Attest West M. Herney

CONSENT AND JOINDER

To the extent that the duties ascribed to the Authority and/or City under the foregoing Redevelopment Agreement are statutorily mandated to be, or are customarily undertaken by the undersigned, the undersigned covenants and agrees to perform such obligations herein set forth on the part of the Authority and/or City to be performed, and joins in and executes this Agreement to bind itself in every respect for the performance of such obligations and agrees to perform in accordance with its terms, all pursuant to such bilateral and multilateral contracts and funding agreements which such parties have entered into or will hereafter make in connection with their respective performance of the duties imposed upon them herein.

Dated at Wausau, Wisconsin, this 20 day of October, 1979.

Witnesses:

WATER UTILITY
SEWERAGE UTILITY

John L. Kannerberg Each By John L. Kannerberg
John L. Kannerberg, President

David H. Hesse Each Attest Robert J. Hesse

City of Wausau

773862

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Office of
ERNEST J. CHERNEY
CITY CLERK
(715) 845-5279



CITY HALL
407 Grant Street
Wausau, Wisconsin 54401

CERTIFICATION

I, Ernest J. Cherney, do hereby certify I am duly qualified and acting City Clerk of and for the City of Wausau, Marathon County, Wisconsin. Acting in that capacity, I do further certify the accompanying First Amendment to Redevelopment Agreement is true and correct copy of an Agreement adopted by the Common Council of the City of Wausau on the 12th day of May, 1980.

Dated this 25th day of November, 1980.

Ernest J. Cherney
Ernest J. Cherney
City Clerk
Wausau, Wisconsin

REGISTER'S OFFICE
Marathon County, WI } 50

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RECORDS ON FILE 870-981

Robert J. [illegible]
RECEIVED

SEAL

773862

113.00 city NOTED

116.324 871

FIRST AMENDMENT TO REDEVELOPMENT AGREEMENT

THIS AGREEMENT is made as of the 12th day of MAY, 1980, by and between the REDEVELOPMENT AUTHORITY OF THE CITY OF WAUSAU, Wausau, Wisconsin, a statutory authority authorized by the laws of the State of Wisconsin (hereinafter called "Authority") and WAUSAU JOINT VENTURE, an Ohio general partnership consisting of Richard E. Jacobs and David H. Jacobs (hereinafter called the "Developer").

W I T N E S S E T H :

WHEREAS, the Authority and Developer heretofore entered into that certain Redevelopment Agreement dated October 30, 1979 (hereinafter called the "Agreement") providing for the redevelopment of portions of the downtown area of the City of Wausau (hereinafter called the "City"); and

WHEREAS, the City heretofore applied to the United States Department of Housing & Urban Development (hereinafter called "HUD") for an Urban Development Action Grant (hereinafter called a "UDAG"), which UDAG monies are to be used by the City for funding of a portion of the costs of the Authority's obligations under the Agreement, including those contained in the Ground and Air Rights Lease (hereinafter called the "Lease") which is Exhibit 1 to the Agreement; and

WHEREAS, HUD's award of a UDAG for the Project was conditioned upon modification of the Lease to grant the Authority an increase in the Additional Rental; and

WHEREAS, the parties wish to further amend the Agreement and the Lease so as to provide for payment of title evidence costs in a manner favorable to the Authority, and to clarify several of the Lease provisions;

NOW, THEREFORE, in consideration of the performance by the Authority and Developer of their respective obligations under the Agreement, and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Authority and Developer hereby covenant and agree to amend the Agreement and Exhibit 1 to the Agreement (to-wit, the form of Lease) as follows:

ARTICLE I

(A) Section 5.2 of the Lease which appears on pages 27, 28 and 29 thereof is modified so as to:

(i) Delete therefrom the portion beginning with the phrase "in excess of \$578,115.00" (which appears in lines 6 and 7 on page 27) ending with the phrase "for the Fixed Minimum Rent" (which appears in the 12th and 13th lines on page 27); and

(ii) Delete therefrom the last three sentences of the first paragraph and all of the second paragraph of Section 5.2

(B) Section 10.3(a) of the Lease is hereby amended so as to delete the phrase "and Base for Additional Rental" from the last line of Section 10.3(a) as page 62.

ARTICLE II

The parties confirm that it has always been their intention that the rental payment option contained in Section 5.1(a)(ii) of the Lease is not to increase the cost to the Developer of the Fixed Minimum Rent for the Initial Period over the cost which the Developer would incur if the Fixed Minimum Rent were paid in the manner specified in Section 5.1(a)(i). On the basis of tax research done by the Developer after October 30, 1979, it now appears that the Developer's cost under the Section 5.1(a)(ii) rental payment method will be greater than its cost under the Section 5.1(a)(i) rental payment method due to the effect of the Internal Revenue Code, unless the required pledge of Securities is deleted from Section 5.1(a)(ii). Sections 5.1(a)(ii) and 16.9 of the Lease are hereby amended so as to delete therefrom the required pledge of the Securities and all reference to the Securities.

ARTICLE III

The Agreement and Lease are presently silent on the matter of title evidence. The parties recognize that sound business practice and prudence dictates use of title insurance on real estate developments of the size of the Project, thereby relieving both parties of the risks attendant to defects in or failures of title. Accordingly, the parties agree as follows:

(A) The Authority shall provide a leasehold policy of title insurance under a master policy issued to the Developer by a responsible title insurer selected by the Developer and approved by the Authority, insuring title to the Leased Premises to be in the condition called for by the Lease. Developer hereby selects Pioneer National Title Insurance Company as the title insurer, and the Authority approves such title insurer; provided that such selection and approval is based upon such title insurer's (i) current financial information, (ii) reinsuring all coverage from \$25,000,000 to \$40,000,000, with Title Insurance and Trust of California, and (iii) reinsuring all coverage over \$40,000,000 with a title insurer approved by Developer and Authority. Such reinsurance treaties shall afford the insureds direct action against the reinsurers in addition to the insureds' rights against the insurer. On the basis of current financial information, the parties hereby approve the following reinsurers: American Title Insurance Company, Chicago Title Insurance Company, Commonwealth Land Title Insurance Company, First American Title Insurance Company, Lawyers Title Insurance Company, Safeco Title Insurance Company, St. Paul Title Insurance Corporation, Title Insurance Company of Minnesota, Transamerica Title Insurance Company and Western Title Insurance Company.

(B) Such master policy shall provide for the issuance of ALTA title insurance policies as "take off" on such policy, as follows:

(i) An Owners Policy (Broad Form B) to the Authority, in the aggregate of the purchase price paid for the Site by the Authority, the fair market value on the date of transfer of the portions of the Site donated to the Authority by the City, and the investment by the Authority, the City and/or its Parking Utility in the construction of the improvements on or under the Site to be constructed by the Authority, the City and/or its Parking Utility under the Lease or the Agreement;

(ii) A Leasehold Policy to Developer in an amount to be specified by the Developer;

(iii) Subleasehold Policies to the Department Store Sublessees in amounts to be specified by the Developer;

(iv) A Mortgage Policy to Developer's mortgage lender(s) on the Project to be specified by the Developer;

(C) The Authority shall be obliged to pay the first \$8,675.25 of the title insurance premiums for such master policy (and all take off policies), and all premiums in excess of such amount shall be paid by Developer.

(D) Developer agrees that such title insurer's insurance over any title matter shall be satisfaction of the Authority's obligation with respect to such title matter.

This Article III constitutes an amendment of the Agreement and of the Lease.

ARTICLE IV

The parties acknowledge that, due to the present uncertainty respecting other or spin-off developments in the balance of the CBD, the area covered by the City's recent change in parking requirements for new development (mentioned on page 60 of the Lease) may cover too small an area, and agree that the traffic consultant survey mentioned in Section 9.6 of the Lease should be expanded to include the subject of appropriate parking requirements for new developments of greater than 15,000 square feet in the CBD. Both parties agree to review and take action based upon such survey's recommendations respecting parking. The Authority agrees to work with Developer to the end that new development in the remainder of the CBD, prior to completion of such survey and any indicated responsive action, include on-site parking facilities of at least the magnitude contained in the parking requirement set out in Section 9.5 of the Lease. In addition, the Authority agrees that the Developer's approval, which shall not be unreasonably withheld, is required if the Authority elects to construct additional parking spaces off the Shopping Center Site under the last sentence of Section 9.6 of the Lease.

This Article IV amends Sect. 9.01 and 9.03 of the Lease.

ARTICLE V

The City's Common Council at its February 12, 1980, meeting authorized execution by the City of that certain UDAG Grant Agreement (herein called the "Grant Agreement") between the City, as the Recipient, and the Secretary of Housing and Urban Development acting by and through the Assistant Secretary for Community Planning and Development, as representative of the United States of America, as the Secretary. The Developer acknowledges receipt of a copy of the Grant Agreement, as executed by the parties thereto.

The following representations, warranties and assurances are required by the Grant Agreement and are hereby added to the Agreement and the Lease:

(A) The parties confirm that all "UDAG Funded Activities" (defined in the Grant Agreement) are to be performed by the City or the Redevelopment Authority, and none are to be performed by the Developer. In the event that the Agreement or the Lease is hereafter amended to provide for the Developer to perform UDAG Funded Activities, then the Redevelopment Authority and Developer agree that the Agreement and the Lease shall be further amended to include the additional assurances contained in Sections 9.01, 9.02 and 9.03 of the Grant Agreement.

(B) The parties confirm that the Developer is not to receive, directly or indirectly, any of the funds granted the City under the Grant Agreement, and that such Funds are to be made available to the Redevelopment Authority for the performance of UDAG Funded Activities, pursuant to the Cooperation Agreement previously executed by the City, its Redevelopment Authority, its Parking, Water and Sewerage Utilities and the Wausau Area Transit Board, Inc. The Developer acknowledges receiving a copy of such Cooperation Agreement. If the Agreement or the Lease is hereafter amended to provide for the Developer to so receive any such funds, then the Redevelopment Authority and Developer agree that the Agreement and the Lease shall be further amended to include the additional provisions contained in Sections 9.07 and 9.09 of the Grant Agreement.

(C) In satisfaction of the City's obligation under Section 9.08 of the Grant Agreement, the Agreement and the Lease are hereby amended to include a provision to the effect that each Participating Party agrees that any duly authorized representative of the Secretary shall, at all reasonable times, have access to any portion of the Project in which such Participating Party is involved. Such representatives shall comply with all safety programs and requirements for the Project. The period of such right to access shall be the same as that set forth in Section 9.07 of the Grant Agreement.

(D) In satisfaction of the City's obligation under Section 9.10 of the Grant Agreement, the Agreement and the Lease are hereby amended to include a provision that during the term of the Grant Agreement such contracts shall not be amended in any material respect, without the prior written approval of the Secretary, and that an amendment shall be deemed "material," within the meaning of such provision, if it cancels or reduces any development, construction, job creating, or financial obligation of any Participating Party by more than ten (10%) percent, or if it changes the situs or character of any development activity, or if it increases any time for performance by any Participating Party by more than ten (10%) percent; provided, that an increase in any time for performance which does not exceed thirty (30) days, shall not be deemed "material."

(E) In satisfaction of the City's obligation under Section 9.11 of the Grant Agreement, the Agreement and the Lease are hereby amended to include an acknowledgement by all parties thereto that nothing contained in the Grant Agreement, or in such contracts between the parties, nor any act of the Secretary, or of the City, or of any of the parties, shall be deemed or construed by any of the parties, or by third persons, to create any relationship of third-party beneficiary, or of principal and agent, or of limited or general partnership, or of joint venture, or of any association or relationship involving the Secretary.

(F) This Article V, and the assurances and provisions added to the Agreement and Lease shall be effective only during the term of the Grant Agreement, i.e., until completion of all close-out procedures respecting the UDAG covered thereby and final settlement and conclusion of all issues arising out of the Grant Agreement or such UDAG.

ARTICLE VI

The parties confirm that a number of additional corrections or clarifications in the form of Lease attached as Exhibit 1 to the Agreement are desirable, and hereby agree to the same.

In order to guard against confusion in the future, attached hereto as Exhibit A is a copy of the approved form of the Lease as restated and amended by this First Amendment to Redevelopment Agreement.

ARTICLE VII

The six month period mentioned in Article III-C of the Agreement is hereby extended from April 30, 1980 to September 30, 1980, subject to HUD's agreement to extension from May 12, 1980 to October 12, 1980, of the date specified in Part 1 of Exhibit F of the Grant Agreement by which the City of Wausau is required to furnish HUD with the evidentiary materials required in Exhibit E of the Grant Agreement. The Authority has reported

5/6/80

VC. 324 PAGE 876

To the Developer that the Authority has performed all of the obligations on its part to be performed which are contained in Paragraphs 1 through 8, inclusive, and 10, of Article III-A of the Agreement. The Authority has requested the Developer to provide the Authority with a list of any soil consultants or architectural/engineering firms which the Developer would recommend for the work described in Paragraph 9 of Article III-A of the Agreement, and the Developer will promptly respond to this request.

ARTICLE VIII

The Authority confirms that it will not object to a Sublease with a Department Store Sublessee for the reason that such Sublease grants the Department Store Sublessee the right to terminate its Sublease upon the expiration of an initial 25-year period commencing with the Opening Date of the Shopping Center or, if later, the date upon which such Sublessee's Department Store opens for business in the Shopping Center. Except as in the immediately preceding sentence provided, the Authority's approval rights with respect to Subleases with Department Store Sublessees is continued as presently provided in the Agreement and the Lease.

ARTICLE IX

This Agreement shall not be effective until approved by HUD.

IN WITNESS WHEREOF, the parties have caused this First Amendment to the Redevelopment Agreement to be duly executed on the date first above written.

Witnesses:

THE REDEVELOPMENT AUTHORITY OF
THE CITY OF WAUSAU

End A. Bruggen
Caroline M. Seppel

By

David M. Torko
David Torko, Chairman

By

Constant Chilicki
Constant Chilicki, Executive Director

WAUSAU JOINT VENTURE

Richard E. Jacobs
Margaret J. Jacobs

By

Richard E. Jacobs
Richard E. Jacobs, General Partner
David H. Jacobs
David H. Jacobs, General Partner

3/6/80
Rev. 5/6/80

pg. 324 PAGE 877

CONSENT

The undersigned hereby consent, to the extent, if any, that such is required, to the foregoing First Amendment to Redevelopment Agreement.

Dated at Wausau, Wisconsin, this 19th day of May, 1980.

Witnesses:

Joyce B. Gieffers
Ernest J. Cherney

CITY OF WAUSAU

By John L. Kannenberg
John L. Kannenberg, Mayor
Attest Ernest J. Cherney
Ernest J. Cherney, City Clerk

[SEAL]

Dated at Wausau, Wisconsin, this 19th day of May, 1980.

Witnesses:

Ernest J. Cherney
Ruth A. Schneider

WAUSAU PARKING UTILITY,

By John L. Kannenberg
Attest Ernest J. Cherney

Dated at Wausau, Wisconsin this 19th day of May, 1980.

Witnesses:

Joyce B. Gieffers
Joyce B. Gieffers

WAUSAU WATER UTILITY
WAUSAU SEWERAGE UTILITY

Each By John L. Kannenberg
John L. Kannenberg, President
Each Attest Ernest J. Cherney

APPROVAL

The undersigned hereby approves the foregoing First Amendment of Redevelopment Agreement, and the undersigned hereby confirms:

(1) That all "Environmental Conditions" (defined in the Grant Agreement) have been satisfied by the City of Wausau, and the undersigned is contemporaneously herewith issuing his environmental releases;

5/6/80

NO. 324 PAGE 873

(2) The City of Wausau heretofore filed with the undersigned a duly adopted motion satisfying the requirement of Section 5.01(2) of the Grant Agreement;

(3) The evidentiary materials required by Part I of Exhibit E of the Grant Agreement were heretofore filed with the undersigned by the City of Wausau, and the Cooperation Agreement among the Redevelopment Authority, the City of Wausau, its Water, Sewerage and Parking Utilities and the Wausau Area Transit System, Inc., is hereby approved for such purposes;

(4) The foregoing First Amendment of Redevelopment Agreement is accepted as the evidentiary materials required by Paragraphs (a)(1) to (a)(7), inclusive, and (a)(9) of Part II of Exhibit E of the Grant Agreement;

(5) The City of Wausau has filed with the undersigned proof that it has on hand funds, in addition to the action grant funds, in an amount of more than \$11,531,000 committed to and available for completion of the public portion of the Project; and

(6) The period of time for the City of Wausau to furnish the remaining evidentiary materials called for in Parts II and III of Exhibit E of the Grant Agreement is hereby extended until October 12, 1980.

THE SECRETARY OF HOUSING AND
URBAN DEVELOPMENT

By _____
Date: _____

773863

City of Wausau

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Office of
ERNEST J. CHERNEY
CITY CLERK
(715) 845-5279

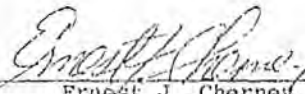


CITY HALL
407 Grant Street
Wausau, Wisconsin 54401

CERTIFICATION

I, Ernest J. Cherney, do hereby certify I am the duly qualified and acting City Clerk of and for the City of Wausau, Marathon County, Wisconsin. Acting in that capacity, I do further certify the accompanying ^{Second} ~~First~~ Amendment to Redevelopment Agreement is a true and correct copy of an Agreement adopted by the Common Council of the City of Wausau on the 12th day of May, 1980.

Dated this 25th day of November, 1980.


Ernest J. Cherney
City Clerk
Wausau, Wisconsin

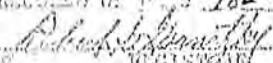
SEAL

REGISTRAR'S OFFICE }
Marathon County, WI } 96

'00 DEC 31 PM 2 14

VOLUME 324 OF MICRO.

RECORDED ON FILE 982-788


REGISTRAR

773863

Ernest J. Cherney

SECOND AMENDMENT TO REDEVELOPMENT AGREEMENT

THIS AGREEMENT is made this 25 day of November, 1980, by and between THE REDEVELOPMENT AUTHORITY OF THE CITY OF WAUSAU, Wausau, Wisconsin, a statutory authority authorized by the laws of the State of Wisconsin (hereinafter called "Authority") and WAUSAU JOINT VENTURE, an Ohio general partnership (hereinafter called the "Developer").

W I T N E S S E T H :

WHEREAS, the Authority and Developer heretofore entered into that certain Redevelopment Agreement dated October 30, 1979, and that certain First Amendment to Redevelopment Agreement dated May 12, 1980 (hereinafter, as amended, called the "Agreement") providing for the redevelopment of portions of the downtown area of the City of Wausau (hereinafter called the "City"); and

WHEREAS, the City heretofore applied to the United States Department of Housing and Urban Development (hereinafter called "HUD") for an Urban Development Action Grant (hereinafter called a "UDAG"), which UDAG monies are to be used by the City for funding of a portion of the costs of the Authority's obligations under the Agreement, including those contained in the Ground and Air Rights Lease (hereinafter called the "Lease") in the restated form attached as Exhibit E to the First Amendment to Redevelopment Agreement; and

WHEREAS, HUD's award of a UDAG for the Project was conditioned upon modification of the Lease to include certain assurances; and

WHEREAS, the parties wish to further amend the Agreement and the Lease;

NOW, THEREFORE, in consideration of the performance by the Authority and Developer of their respective obligations under the Agreement, and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Authority and Developer hereby covenant and agree to amend the Agreement and Exhibit A to the First Amendment to Redevelopment Agreement (to-wit, the form of Lease) as follows:

ARTICLE I

The City's Common Council at its February 12, 1980, meeting authorized execution by the City of that certain UDAG Grant Agreement (herein called the "Grant Agreement") between the City, as the Recipient, and the Secretary of Housing and Urban Development acting by and through the

Assistant Secretary for Community Planning and Development, as representative of the United States of America, as the Secretary. The Developer acknowledges receipt of a copy of the Grant Agreement.

The following representations, warranties and assurances are required by the Grant Agreement and are hereby added to the Agreement and the Lease:

"(A) In satisfaction of the City's obligation under Section 9.04 of the Grant Agreement, the Agreement and the Lease are hereby amended to include a provision in the nature of a representation and warranty by each 'Participating Party' (which phrase is defined in the Grant Agreement and includes both the Redevelopment Authority and the Developer) that such Participating Party has obtained, or has reasonable assurance that there will be obtained, all Federal, State and local governmental approvals and reviews required by law to be obtained by the Participating Party for the Project.

"(B) In satisfaction of the City's obligation under Section 9.05 of the Grant Agreement, the Agreement and the Lease are hereby amended to include a representation on the part of each Participating Party that such Participating Party acknowledges that the Secretary, in selecting the City for the award of a UDAG, relied in material part upon the assured completion of the activities to be undertaken by the Participating Party in connection with the Project in accordance with the terms of the Agreement and Lease; and that the Participating Party assures the Recipient that such activities will be completed by the Participating Party.

"(C) In satisfaction of the City's obligation under Section 9.06 of the Grant Agreement, the Agreement and the Lease are hereby amended to include the assurance from each Participating Party that such Participating Party will use its best efforts to create or cause to be created, within a specified time not exceeding forty-eight (48) months after the date of this Agreement, a specified number of new job opportunities for persons who, at the time of their employment, will be persons of low and moderate income, such specified numbers being set out in Exhibit A to the Grant Agreement. In order to assist and enable the City to report to the Secretary, as the Secretary may require, each Participating Party agrees to report to the City, as the City may from time to time require, on the numbers and kinds of such jobs created or caused to be created and filled. These assurances shall contain such other provisions as may be required by the City to enable the City to comply with any reporting requirements of the Secretary and to cause the assurances to be legally binding and enforceable to the maximum extent available under the applicable law.

"(D) This Article I, and the assurances and provisions added to the Agreement and Lease shall be effective only during the term of the Grant Agreement, i.e., until completion of all close-out procedures respecting the UDAG covered thereby and final settlement and conclusion of all issues arising out of the Grant Agreement or such UDAG."

ARTICLE II

The parties have mutually agreed upon a substantial number of amendments to the Lease, which are too numerous to spell out in individual detail in the body of this document. Attached hereto as Exhibit A is a copy of the approved form of the Lease as restated and amended by this Second Amendment to Redevelopment Agreement.

ARTICLE III

This Agreement shall not be effective until approved by HUD.

ARTICLE IV

The parties confirm extinguishment of any right on their part to terminate the Agreement under Article III-C of the Agreement.

The Developer confirms its approval of the Redevelopment Plan previously adopted by the Authority.

IN WITNESS WHEREOF, the parties have caused this Second Amendment to the Redevelopment Agreement to be duly executed on the date first above written.

Witnesses:

THE REDEVELOPMENT AUTHORITY OF
THE CITY OF WAUSAU

David H. Fleck
Byron E. Branstetter

By David M. Torko
David Torko, Chairman

By Constant Chilicki
Constant Chilicki, Executive Director

WAUSAU JOINT VENTURE

By _____
Richard E. Jacobs, General Partner

By _____
David H. Jacobs, General Partner

"(D) This Article I, and the assurances and provisions added to the Agreement and Lease shall be effective only during the term of the Grant Agreement, i.e., until completion of all close-out procedures respecting the UDAG covered thereby and final settlement and conclusion of all issues arising out of the Grant Agreement or such UDAG."

ARTICLE II

The parties have mutually agreed upon a substantial number of amendments to the Lease, which are too numerous to spell out in individual detail in the body of this document. Attached hereto as Exhibit A is a copy of the approved form of the Lease as restated and amended by this Second Amendment to Redevelopment Agreement.

ARTICLE III

This Agreement shall not be effective until approved by HUD.

ARTICLE IV

The parties confirm extinguishment of any right on their part to terminate the Agreement under Article III-C of the Agreement.

The Developer confirms its approval of the Redevelopment Plan previously adopted by the Authority.

IN WITNESS WHEREOF, the parties have caused this Second Amendment to the Redevelopment Agreement to be duly executed on the date first above written.

Witnesses:

THE REDEVELOPMENT AUTHORITY OF
THE CITY OF WAUSAU

By _____
David Torko, Chairman

By _____
Constant Chilicki, Executive Director

WAUSAU JOINT VENTURE

By Marg Lou Gray _____
Richard E. Jacobs, General Partner

By Margaret Kettner _____
David H. Jacobs, General Partner

CONSENT

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The undersigned hereby consent, to the extent, if any, that such is required, to the foregoing Second Amendment to Redevelopment Agreement.

Dated at Wausau, Wisconsin, this NOV 28 day of November, 1980.

Witnesses:

CITY OF WAUSAU

David H Fleck
Josephine Tush

By John L. Kannenberg
John L. Kannenberg, Mayor
Attest Ernest J. Chorney
Ernest J. Chorney, City Clerk

[SEAL]

Dated at Wausau, Wisconsin, this NOV 28 day of November, 1980.

Witnesses:

WAUSAU PARKING UTILITY

Michael D. Johnson
David H Fleck

By John L. Kannenberg
John L. Kannenberg, Mayor
Attest John L. Kannenberg

Dated at Wausau, Wisconsin, this NOV 28 day of November, 1980.

Witnesses:

WAUSAU WATER UTILITY
WAUSAU SEWERAGE UTILITY

David H Fleck
John van Gerecht

Each by John L. Kannenberg
John L. Kannenberg, President
Each Attest John L. Kannenberg

Dated at Wausau, Wisconsin, this NOV 28 day of November, 1980.

Witnesses:

WAUSAU AREA TRANSIT SYSTEM, INC.

Roger L. Otto
Ernest H. Burgeson

By Burt H. Donald
Burt H. Donald, President
Attest John L. Kannenberg
John L. Kannenberg, Secretary

APPROVAL

The undersigned hereby approves the foregoing Second Amendment of Redevelopment Agreement, and the Exhibits thereto.

The undersigned hereby approves the First Amendment to Redevelopment Agreement dated May 12, 1980 identified in the foregoing Second Amendment to Redevelopment Agreement, and the Exhibits thereto.

Dated at Washington, D. C., this ____ day of _____, 1980.

THE SECRETARY OF HOUSING AND
URBAN DEVELOPMENT

By _____

NOTED FOR RECORD
DEC 1 1980
2:42 p.m.
ROBERT G. GERNETZKY
Register of Deeds

STATE OF WISCONSIN - MARATHON COUNTY
RECORDED
12/22/2010 1:48:41 PM
MICHAEL J. SYDOW, REGISTER OF DEEDS

AFFIDAVIT REGARDING TITLE MATTERS



DOC# 1586651

Michael J. Sydow

Recording Area

Name and Return Address

Office of the City Attorney
City Hall - 407 Grant Street
Wausau, WI 54403

(Charge to City of Wausau)

30-

PIN: 37.291.4.2907.362.0240,
37.291.4.2907.362.0250, 37.291.4.2907.362.0260,
37.291.4.2907.362.0270, 37.291.4.2907.362.0280,
37.291.4.2907.362.0300



DOC# 1586651

AFFIDAVIT REGARDING TITLE MATTERS

STATE OF WISCONSIN)
) ss
COUNTY OF MARATHON)

The undersigned, being first duly sworn on oath, states as follows:

1. I am the Chairman of the Community Development Authority of the City of Wausau, a Wisconsin housing and community development authority (the "Community Development Authority").
2. The Community Development Authority is successor in interest to the Redevelopment Authority of Wausau, Wisconsin by Ordinance of the City of Wausau, Wisconsin.
3. The Community Development Authority is the owner of certain real property located in the City of Wausau, Marathon County, Wisconsin more fully described in Exhibit A, which is attached hereto and incorporated herein by reference (the "Wausau Center Mall Property").
4. The Community Development Authority is a beneficiary of that certain Redevelopment Plan, as amended October 29, 1979 for the Downtown Shopping Center Redevelopment Project Area, recorded in the office of the Register of Deeds for Marathon County, Wisconsin, on February 8, 1980 in Micro-Record 309 on page 545, as Document No. 762327; and Amendment to the Redevelopment Plan recorded in said Register's office on December 31, 1980 in Micro-Record 324 on page 726, as Document No. 773860 (the "Redevelopment Plan").



5. The Redevelopment Plan remains in effect on the date hereof, and all parties having an interest in the Wausau Center Mall Property are hereby put on notice of this Redevelopment Agreement.

6. The Community Development Authority is a party to that certain Redevelopment Agreement by and between the Community Development Authority of Wausau, Wisconsin and Wausau Joint Venture, dated October 30, 1979, and recorded in the office of the Register of Deeds for Marathon County, Wisconsin on December 31, 1980 in Micro-Record 324 on page 729, as Document No. 773861; and First Amendment to Redevelopment Agreement dated May 12, 1980 and recorded in said Register's office on December 31, 1980 in Micro-Record 324 on page 870, as Document No. 773862; and Second Amendment to Redevelopment Agreement dated November 25, 1980 and recorded in said Register's office on December 31, 1980 in Micro-Record 324 on page 982, as Document No. 773863 with respect to the Wausau Center Mall Property (collectively, the "Redevelopment Agreement").

7. The Redevelopment Agreement remains in effect on the date hereof, and all parties having an interest in the Wausau Center Mall Property are hereby put on notice of this Redevelopment Agreement.

8. The Community Development Authority is a party to that certain Ground and Air Rights Lease, as amended and Restated as of November 1, 1980 between the Community Development Authority of the City of Wausau (Landlord) and Wausau Joint Venture (Tenant), recorded in said Register's office on December 31, 1980 in Micro-Record 324 on page 989, as Document No. 773864; and as amended by First Amendment to Ground and Air Rights Lease dated February 1, 1981 and recorded in said Register's office on April 6, 1981 in Micro-Record 329 on page 120, as Document No. 776944; and as amended by Second Amendment to Ground



DOC# 1586651

and Air Rights Lease dated March 1, 1982 and recorded in said Register's office on September 14, 1982 in Micro-Record 351 on page 191, as Document No. 793634; and as amended by Third Amendment to Ground and Air Rights Lease dated October 1, 1982 and recorded in said Register's office on December 9, 1982 in Micro-Record 355 on page 838, as Document No. 797036; Assignment of Lease by Wausau Joint Venture to Wells Fargo Bank, N.A., dated December 6, 1982 and recorded in said Register's office on December 16, 1982 in Micro-Record 356 on page 41, as Document No. 797235; Financing Statement #522669, recorded in said Register's office on July 14, 2003, where CBL & Associates, is Debtor to New York Life Insurance Company; Continuation #1503716, recorded in said Register's office on March 10, 2008 (the "Ground and Air Rights Lease").

9. The Ground and Air Rights Lease remains in effect on the date hereof, and all parties having an interest in the Wausau Center Mall Property are hereby put on notice of this Redevelopment Agreement.

FURTHER THE AFFIANT SAYETH NOT.

Dated this 21st day of December, 2010

David A. Piehler, Commission Chair

STATE OF WISCONSIN)
) ss.
COUNTY OF MARATHON)

Signed and sworn to before me on December 21, 2010 by
David A. Piehler

[Seal]

Lisa A. Paruch

Notary Public, State of Wisconsin

My commission expires: 7/22/12

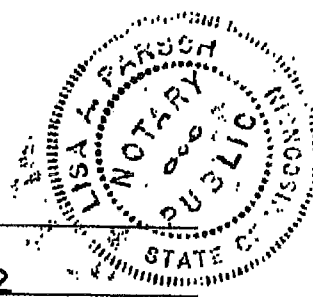


EXHIBIT A

That part of the Northwest quarter (NW ¼) of Section thirty (36) and of Government Lot five (5) in Section thirty-five (35), all in Township twenty-nine (29) North, Range seven (7) East, in the City of Wausau, Marathon County, Wisconsin, described as follows:

Commencing at the Southeast corner of Lot 1, Block 3, Original Plat of the City of Wausau; thence South 85° 05' 40" East, 66.00 feet; thence South 05° 03' 54" West, 56.10 feet to the point of beginning of this description; thence South 85° 05' 40" East, 175.39 feet thence North 82° 54' 20" East, 87.06 feet; thence South 85° 05' 40" East, 557.00 feet; thence South 40° 05' 40" East, 22.63 feet; thence South 85° 05' 40" East, 317.35 feet to a point lying on the Westerly right-of-way line of Fifth Street; thence along said Westerly right-of-way line of Fifth Street, South 04° 55' 49" West, 566.00 feet to a point which is 0.41 feet South of the Northerly right-of-way line of Forest Street; thence North 85° 05' 04" West, 413.10 feet to a point which is 1.61 feet South of the Northerly right-of-way line of Forest Street thence North 04° 54' 20" East, 1.61 feet to a point lying on the Northerly right-of-way line of Forest Street; thence along said Northerly right-of-way line of Forest Street, North 84° 57' 11" West, 563.69 feet; thence departing from said Northerly right-of-way line of Forest Street, North 85° 05' 40" West, 175.42 feet; thence North 05° 03' 54" East, 560.90 feet to the point of beginning of this description.

291.4-2907.253.0606 - Lots 1, 2, 3, 4 BK 6 #7660
.253.0263 - Lots 5, 6, 7+8 BK 6 #7660
.362.0250 - Lot 1, 2, 3, 4, 5, 6, 7, 8 BK 11 #7660
Lot 1, 2, 3, 6, 7+8 BK 20
Lot 2, 3, 4, 5, 6+7 #6815
.362.0240 - Lot 3, 4, 5, 6, 7+8 BK 10 #7660
Lot 1+2 #6815
.362.0260 - Lots 1 thru 8 BK 12
Lots 1 " 8 BK 19 #7660
Lots 1 thru 4 BK 11
Lots 1 " 4 BK 20
.362.0270 - Lots 1 thru 8 BK 24 #7660
Lots 5 thru 8 BK 23
.362.0280 - Lots 1 thru 5 BK 10 #7660
Lots 1 thru 8 BK 9
.362.0300 - Lots 1 thru 8 BK 23 #7660
Lots 3 thru 6 BK 20



* Type name below signatures.

That part of the Northwest quarter (NW ¼) of Section thirty (36) and of Government Lot five (5) in Section thirty-five (35), all in Township twenty-nine (29) North, Range seven (7) East, in the City of Wausau, Marathon County, Wisconsin, described as follows:

Commencing at the Southeast corner of Lot 1, Block 3, Original Plat of the City of Wausau; thence South 85° 05' 40" East, 86.00 feet; thence South 05° 03' 54" West, 56.10 feet to the point of beginning of this description; thence South 85° 05' 40" East, 175.39 feet; thence North 82° 54' 20" East, 87.06 feet; thence South 85° 05' 40" East, 557.00 feet; thence South 40° 05' 40" East, 22.63 feet; thence South 85° 05' 40" East, 317.35 feet to a point lying on the Westerly right-of-way line of Fifth Street; thence along said Westerly right-of-way line of Fifth Street, South 04° 55' 49" West, 566.00 feet to a point which is 0.41 feet South of the Northerly right-of-way line of Forest Street; thence North 85° 05' 04" West, 413.10 feet to a point which is 1.61 feet South of the Northerly right-of-way line of Forest Street; thence North 04° 54' 20" East, 1.61 feet to a point lying on the Northerly right-of-way line of Forest Street; thence along said Northerly right-of-way line of Forest Street, North 84° 57' 11" West, 563.89 feet; thence departing from said Northerly right-of-way line of Forest Street, North 85° 05' 40" West, 175.42 feet; thence North 05° 03' 54" East, 580.90 feet to the point of beginning of this description.



DOC# 1590139

291.4.2907.362.0240 ✓
BK 10 Lots 1, 2, 3, 5, 7 + 8 # 7660
Lots 1, 2 + 3 # 6815

291.4.2907.362.0250 ✓
BK 11 Lots 1 - 8 # 7660
BK 20 Lots 1, 2, 3, 6, 7 + 8
Lots 2 thru 6 # 6815

291.4.2907.362.0260 # 7660
BK 19 1 - 8
BK 12 1 - 8
BK 9 Lot 7 + 8
BK 11 Lots 1 - 4
BK 20 Lots 1 - 4

291.4.2907.362.0270 # 7660
BK 24 Lots 1 - 8
BK 23 Lots 5 - 8

291.4.2907.362.0280 # 7660
BK 9 Lots 1 - 8
BK 10 Lots 1 - 5

291.4.2907.362.0300 # 7660
BK 23 Lots 1 - 8
BK 20 Lots 3 - 6