Forever Chemicals: PFAS Remediation and Future Outlook

Jad Sobh (00:12)
Welcome back to Groundbreaking, where consulting beats innovation. I'm Jad Sobh

Peter Nabhan (00:17)
And I'm Peter Nabhan. And if you're tuning in for the first time, Jad and I work for ECS Group of Companies, a nationwide engineering consulting firm. On this episode, we will be diving into the more current processes and management of PFAS remediation. Chris Rice is going to be joining us today with our returning guest, Scott Worley.

Scott Werley, P.G. (00:40)
Thank

Jad Sobh (00:41)
We've already had the privilege of introducing Scott once, but we'll do it again. Scott Worley is an environmental principal at ECS's Raleigh, North Carolina office and a principal geologist with 20 years of experience in the environmental field. He specializes in federal, state, and local regulatory negotiations, environmental liability assessments, and due diligence evaluations. As a licensed professional geologist in four states, Scott also leads ECS's internal PFAS team.

bringing extensive knowledge of US EPA regulations and the evolving landscape of PFAS oversight. His expertise helps clients navigate complex regulatory challenges and environmental compliance requirements. Scott, welcome back.

Scott Werley, P.G. (01:23)
Thank you, Jan. Come to the meeting room.

Jad Sobh (01:24)
And new

to the show, have Chris. Chris Rice is a seasoned and strategic leader. He currently serves as the chief commercial officer with Invicta Water Incorporated, with a focus on environmental innovation, particularly around PFAS contamination and sustainable water solutions. Chris brings diverse background in commercial strategy, partnerships, and market growth across both environmental and tech-focused organizations. Chris, welcome to the show.

Chris Rice (01:53)
Thanks very much. Happy to be here.

Jad Sobh (01:56)
Awesome.

Peter Nabhan (01:56)
It's good to have you, Chris. And I think one of the topics that I personally like to talk about a lot is innovation and how does it translate into the environmental realm? So looking at your background, you've got a heavy background in technology and commercialization. I think one of the things we'd like

to ask you about, if you're able to essentially help us frame what does a product life cycle from idea to market look like in this

industry, somewhat of a niche industry, and if you're able to tell us maybe what are some of the top lessons you've learned across the years.

Chris Rice (02:32)
Absolutely, thank you. So when we think about how to bring something forward, the origins of Invicta Water have this real interesting background in material science, chemistry, and process engineering. So put that over to the side a little bit. But when we think about the innovation around the environmental space, OK, we are faced with a problem. What is that problem? What is it made of? What are the components, regulatory, the partnerships that are around it?

And then with our background, we say to ourselves, self, is there something we think we can do to help solve this problem, to play a role in leading the solution, to be a support component? so then what do we do? Do we think we can do something with our background? Then that path goes to, well, maybe we can. So now we've got to find a validation of, well, you know what? At the end of the day, believe we've taken something, we've gotten some validation. Yes, we believe we can solve this problem.

or play a role in it. And then from there, how do we figure out, how do we know that? And so we expand that third party validation efforts to really understand whether it's academic partners or other, hey, from this idea, from this problem, this idea came about, we put some materials together, we put some science together, some chemistry and said, we think we've got this path and then what testing can be done so we know that we can go solve this problem. Now that's the very...

early origin story of thinking of bringing something to market. And then there from it, it's very much a classic entrepreneurial exercise. And can we do this one time? Can we sell it one time? Can we find a partner one time? Okay. Then once we've done it one time, can we do it 10 times? Right. And in that path, the litany of issues, the successes, the questions, the things that didn't work out, that

those things definitely come to the surface pretty quickly.

Peter Nabhan (04:20)
I appreciate you sharing that with us Chris and it does sound like you work maybe with some incubators on the academic side so you can pull some of that I guess science or chemistry behind it and you might be partnering with some universities early on prior to you testing the viability of that product or hypotheses and then you see if it scales or not.

Chris Rice (04:42)
Exactly, exactly. And certainly as a team, we've all had experience working with incubators and universities globally. In this case with Victor Water, we've had experiences with universities from Rice University to Clemson, North Carolina State University, as well as research agreements with the Navy for collaborative research. Those

that work as a group, I would say, helped with that academic and third party validation, which in some, with something like PFAS and in something like in environmental science is incredibly powerful. The, certainly the litany of peer reviewed papers and ideas around PFAS and the solution for them is incredibly long. So certainly we, having that validation on our end is exactly, that's part of the process.

Peter Nabhan (05:24)
Absolutely. And would you say, you have to go through like, did you get funding from, for example, Innovation Core, iCore from the government, or did you go through that lifecycle? Did you go get venture capital funding in your case?

Chris Rice (05:38)
In our case, have we've self funded through friends and family. Not a lot of grant work until we got to the project places I was describing. We want to think we can do something and then we believe we can do something. And once we know we can do something, that's where we can start talking about. Maybe we think grants can be more applicable because we can try. We have grants from the state of North Carolina that are helping fund projects. We've talked to others, but overall also funding it through through individuals.

Peter Nabhan (06:02)
That's great. I appreciate you sharing that with us. Obviously, I know there's a lot of entrepreneurs or lot of people like us sitting in firms and they see problems they'd like to solve. that's going to be helpful information for them. Thank you for sharing that, Chris.

Chris Rice (06:16)
Thanks.

Jad Sobh (06:17)
So that's cool. So we got kind of hit the like the innovation side, like, you hey, there's a problem. How are we going to fix it? So then let's let's talk about that. So, you know, we hear that PFAS is a forever chemical, but how do we remove something like that when it does start to show up in contaminated water or soil? And either one of you feel free to jump in on that.

Scott Werley, P.G. (06:38)
Yeah, hey Jad I'll answer that. you know, typically there's two typical major processes that are currently being utilized for PFAS removal. They include sorption and physical separation, or sometimes referred to as stripping. And we'll discuss both sorption and physical separation processes here just in a second. But essentially, you know, first off, you know, we...

We deal with different media in the environment, liquids and solids. We tend to treat those differently in certain situations. So your variety of options is going to change slightly between projects where you may be treating or remediating a liquid waste stream versus a solid or soil waste stream. For liquid treatment technologies, know,

We talked about sorption. That can be a number of different things. Chris was already mentioning granular activated carbon, I believe, earlier on the call. That's one type of sorption technology. A second one would be powder activated carbon, right? Very similar to GAC, just the actual activated carbon grains are smaller. They're more in powder form than granular form.

And then of course ion exchange, which is referred to as resin ion exchange or IX. These are three different types of sorption technologies that are known to effectively treat PFAS. And I do stress the word treat there because it's not destroying the PFAS compounds themselves. It's absorbing them onto the activated carbon media.

which then produces a concentrated waste stream of its own, which needs to be dealt with. In the instance of resin ion exchange, there are some of those compounds, excuse me, resins that were originally developed for single use. However, there are also a lot of them that can be regenerated similar to a granular activated carbon. But these regeneration processes, they cost money, they take time.

In the case of carbon, after your carbon's been regenerated, its capacity to absorb contaminants in the future when redeployed may be slightly reduced. Another liquid technology for the treatment of PFAS that's not necessarily sorption-based, but does also result in the creation of a highly concentrated waste stream is reverse osmosis.

It's another tried and true technology. It's been effective at treating PFAS, but again creates that own waste stream of its own. And over time, those membranes, which are very costly, and you need a lot of energy and pressure to push the waste stream through that membrane, they'll get fouled up over time. And so they do have a lifespan to them and operation and maintenance costs.

including costs associated with disposal of the membranes and that concentrated waste stream that's filtered out of the rest of the liquids passing through the membrane. A third type of liquid treatment technology, which is more physical separation based, could be foam fractionation. Again, that physical separation, the foam fractionation process works in kind of a stripping capacity.

uses some motors that blow air through water columns creating little micro bubbles that raise the, or lift, I should say, the PFAS compounds to the surface where then they can be stripped off the rest of the stream. So those are three types of liquid treatment technologies that are commonly used today. We'll talk about their potential long-term applicability in the future, I believe a little bit later on.

But we did mention different types of media, including soil or solid waste streams, something else that a lot of us are having to deal with these days. And these are similar in a way that you can also use assortive technology to treat soil. Although that is part of a larger

type of field activity that we may do to remediate or stabilize these contaminants in place. So it's not necessarily a treatment method per se that is occurring at the surface. That would occur more in situ or in ground where the contaminants currently are that you're typically trying to get. So how does that happen? That could be facilitated by either injection events.

or possibly excavations where there are certain amendments that are mixed in and blended with the soil. A lot of times that's called soil mixing. know, what are they blending in with it or what are they injecting to try and stabilize those contaminants in place so they're not migrating or leaching to groundwater? They're going to use things like the granular activated carbon, right, that we know, we just talked about. It treats liquid waste streams by absorbing the contaminants onto it.

effectively immobilizing them. Another soil treatment option obviously would be excavation and disposal, but I can tell you guys that that option is becoming ever more increasingly hard to source. It can be difficult to find an outlet to haul PFAS contaminated soils to. The landfills, or a lot of the landfills just won't accept them anymore.

And so interesting fact there and what's actually happening and we've seen occur is some of those soil waste streams, if they're being excavated and hauled off for disposal, they may be being put in roll-off containers or drums and being sent to a hazardous waste disposal facility who are typically not used to accepting non-hazardous waste. So these, you know, there are some hazardous waste facilities out there that are currently

kind of adapting to some change and accepting non-hazardous waste streams like PFAS containing soil in situations or regions where the landfills won't accept them. One other third, possibly newer but field-tested technology to treat solid waste streams is known as soil washing. Again, it's a physical separation process which it basically uses

water and other physical processes to basically grade out soil particles. you know, as silts and clays tend to be finer soil particles and sands and gravels tend to be coarser particles, they can do this soil washing process and filter out the finer particles that the PFAS compounds tend to adhere to more. And

take a large percentage of maybe that PFAS mass out of the soil so that what's left in it is easier to deal with and manage. That's a little newer and the effluent water coming off that soil washing process may still need to be treated with some sort of classic liquid waste stream technology like granular activated carbon which soars those contaminants onto it itself.

Chris Rice (12:47)
Thanks

Scott Werley, P.G. (13:07)
Third, soil waste stream, think we've all heard about before. Disposal method for PFAS is incineration. It's a long-use technology to utilize for a variety of different contaminants and different media types, including solids and liquids, actually. there's been a lot of research on that front, and I don't know that the story's completely out yet on incineration as a safe PFAS treatment technology.

The fears are is that in the incineration process, there could potentially be PFAS compounds, maybe not the long chain ones, maybe more the short chain ones that break down from their parent products that could be being released through emissions in the air coming from the stacks of those incinerators. So I know a lot to kind of digest there. Chris, anything else you want to add?

Chris Rice (13:51)
Yeah, two things. No, that was great, Scott. Two things I would add just as sidebars to a couple of those technologies. Most recently, the incineration. One thing to make sure to mention is the notion that the Department of Defense has outlawed incineration for its waste stream management. So they're not allowing it because of what you described. And then the second thing is back to the water on reverse osmosis. Not only is there this highly concentrated waste stream that again has to be managed,

There's also a tremendous water loss. With our work in with utility systems, drinking water or wastewater, less so for landfills, the same issue does apply, but there is somewhere between 10 and 20 percent of water loss. So when you think about a water system looking to implement a technology, they're actively now having to process and spend a lot more getting water through the pipes than they in order to treat it through reverse osmosis.

Scott Werley, P.G. (14:44)
Yeah, yeah, really good point, Chris. know that more and more these days I'm hearing about not just water quality issues, but water quantity issues, right? As we grow, know, industry comes back on the shore, people are looking to source more water. the quantity is going to continue to be more and more of an issue, not just the quality aspect of

Jad Sobh (15:04)
So there's plenty of options out there is what I'm hearing. And so, you you may have alluded to this, but you know, when it comes to the treatment, remediation, you know, those sorts of things, is there a blanket industry best practice or is it highly contextualized to like, hey, this is what we're facing, so we're gonna do this?

Scott Werley, P.G. (15:22)
Yeah, I don't know. mean, I think it's looked at a little bit on a case by case basis, at least as far as a remedial project might go. You you're going to look at things like, you know, where is your site located in relation to the nearest potential landfill that may accept PFAS containing soil, if that's part of your remediation plan.

you know, you going to be breaching the water table in some sort of soil removal process? Is there going to be dewatering that may become necessary? And if so, do you need to treat that water? And in fact, that may not even be a remediation project. It may just simply be a construction or redevelopment based product, project, excuse me, that's occurring on a site that may have known PFAS impact. So.

You're going to have to manage that soil and that water that you're disturbing during construction. So, you you may have to do some other work, you know, to figure out how much water do you think you're going to generate during those activities? Does it make more sense to pump and haul to a water treatment facility that would accept it? Or do you need to bring in your own equipment that may be treated on site? As far as the...

specific remediation methods that would be considered industry best practices. I mean, I think we talked a lot about the classic ones that are there. A lot of them are utilized in water treatment, remediation processes for other contaminants. And I don't know that there's one silver bullet that's a best practice.

Chris Rice (16:51)
And I would just add, I think as it relates to PFAS, it's still a relatively new situation and a problem to solve. And when the problem came up so quickly a handful of years ago, I think a lot of people looked in the closet to see what might solve this problem fast.

in certain hot spots in the country. And so now I think that combined with the fact that other technologies are, that problem solving description I tried to describe on the front end, know, that path is starting to run its course so that the EPA and others are saying, okay, there are novel technologies that upon reflection can provide a more efficient treatment. So I think because of the nature of it being early, like a lot of cases of things that are newish,

there's not a standard yet as defined. We know there's drinking water, national drinking water limits now in place from the EPA as of about 12 months ago. That certainly starts to set what would the standard be to achieve that at the most efficient from a environmental standpoint and a cost standpoint. That'll help set that course.

Peter Nabhan (17:39)
Thank

And you do make it.

Scott Werley, P.G. (17:57)
Yeah, and maybe

one more thing for you guys just to kind of tack on to that. Really, you know, the question is more geared to specific remediation methods, but one of the things that from the get go that the EPA PFAS roadmap set in place was, you know, it was a multifaceted approach, right? And one of those facets was reduction, PFAS reduction, just the use of it altogether.

I'm hearing a lot of planning that may be required for certain industries and businesses that might be coming down the pipeline in certain different states to minimize their PFAS. It's being referred to as PFAS minimization planning. But what can you do to reduce your waste stream? In the instance of POTWs, right?

passive receivers. receiving all the household industry and commercial wastewaters coming into their facility that they're needing to treat. They're not necessarily generating it themselves, but they're receiving it. And so they're eventually going to have to comply with those MCLs or drinking water standards that Chris just mentioned. And so where do they look? You know, they look upstream. So, and everybody's looking upstream right now in an effort to get

whoever's sending that PFAS to them to reduce the amount that they're sending to them. So that's gonna continue to be part of what we work with on a day-to-day basis too. Isn't just remediating what's there, but also reducing what's coming down the pipeline.

Peter Nabhan (19:25)
I mean, I appreciate both of you giving us that general idea of how do we get the PFAS out of our existing soil or through water and through different ways. And I did hear you Chris, when you said it's so nascent. So we're still trying to figure things out, but we also have a little bit of room now that where we can actually create some traction with certain innovation and focus.

even though we've got some variables like water's becoming an issue as companies come back to the country, come back to the States. So I think that you did mention, and obviously Scott, you did mention earlier the incineration process as being a way to destruct the PFAS. Would you mind elaborating more on the overall PFAS destruction process? And to add onto that, what are some of the key challenges that people should pay attention to?

Scott Werley, P.G. (20:16)
Right. Well, you know, the main idea behind the incineration technology is that it it burns so hot, it basically mineralizes everything, rendering it inert. But we know, you know, one of the key characteristics of lot of PFAS compounds are their extreme resistance to heat. Just to reiterate why there's a fear that for air emissions related to PFAS incineration practices. But...

How does the PFAS destruction process work? In order to destroy it, essentially you're having to break that bond, that carbon fluorine bond, which we may have touched on in part one of this series, that that's the most electronegative bond in nature. It's really, really hard to break. A bond that strong typically requires a lot of energy to break.

You know, that could be in the form of temperature and pressure. And I think there's a lot of novel technologies out there that some may have heard of that are trying to accomplish that. But they are using high temperatures and high pressures, which...

generates a lot of costs, right? You need a lot of energy to create the high pressure, the high temperature to a point where it's large enough to break that strong carbon-fluorine bond.

Chris?

Chris Rice (21:31)
Yeah, no, the bond itself, the chemistry does what it's supposed to do, which is repel water and do it for a really long time. those bonds, know, the destruction technologies, there's a handful. the good thing, again, this is a nascent area. But if we can destroy those compounds and unzip those carbons all the way down to their elemental form, then we can truly treat PFAS at an efficient level.

without passing it on to somebody else once we've gotten it out of water, soil, air. And so the notion of how we do that, certainly there's technologies that can do it very well, but some require only batch processing. They can do small amounts. There's processes that can do continuous flow. That's part of the innovation we've brought forward. So again, similar to the conversation overall, it's still very new. But when we think about what the goals are,

which is the removal and treatment of PFAS without bringing other costs to the economy or to the environment, that destruction is the goal.

Peter Nabhan (22:31)
Appreciate you sharing that. And I really like how you've simplified it. It's all about the chemistry and mineralizing or taking it down to the lowest form that's inert. So you've got this very strong compound. Make sure to do it in the most efficient way possible where you can bring it down to its smallest element. To change a little bit the conversation is like, so Scott, I know you design PFAS removal strategies for your clients and customers.

What are some of the challenges that we should pay attention to while we're going through a, I guess, removal design?

Scott Werley, P.G. (23:03)
Well, question, Peter. Again, it's going to be kind of on case-by-case basis. We're going to likely develop some sort of conceptual site model, right? We need to understand, fully understand where the PFAS is. You know, is it in a soil media? Is it in a groundwater media? Is it in both? What are the end goals of the project? Are we trying to...

get clean closure or just below a concentration limit in either the soil or water. How big is your site? What constraints does your site have? Size of the site is usually one of the biggest constraints. Some other constraints may be accessibility to the site or possibly the access to existing power or existing water to that site.

possibly all constraints, then how much volume do you plan to generate, be it either soil or groundwater? So you can plan to schedule the amount of proposed work days. How long is this being proposed to take place? How much resources are gonna have to be thrown at it in order to get it done in that scheduled timeframe? So duration is always another thing that we're looking at.

And concentrations, you know, what are the initial concentrations that you're treating? Not just what you want to treat down to, but what are they initially? Both, you know, possibly in the source zone, that's where you're going to have your largest concentrations. That's what you'd want to be most concerned about. And then are there any potential co-contaminants that you're going to have to be aware of that are also going to have to be treated for? You need to know what's going on your site.

before you come up with a remediation plan so you know how to treat it, maybe when to be monitoring for breakthrough. If you're using a classic water treatment technology or PFAS treatment technology like carbon, at some point that carbon, all the surface area on those carbon granules are gonna fill up and they're not gonna have the capacity to absorb any more contaminants onto them. So you need to be aware of that.

and be prepared to possibly do compliance monitoring. If you have a waste stream, right, you're having to check the back end. Is your process that you're employing working? What are your effluent concentrations? Are they in compliance with your permit? A lot of these remedial actions may be permitted actions in certain jurisdictions. So these are all some things that we think about when we're designing a...

PFAS removal strategy.

Chris Rice (25:21)
I would just add, ‚Äì yeah, just a couple items, Rhea, bringing up that notion of the concentrations. Again, certain sites are gonna have naturally much, much, much, much higher levels of PFAS on what they might be, long and or short chain. Industrial sites and brownfield sites versus other sites that might have a much lower concentration. So understanding what the concentration level is, it's gonna play a role in helping navigate

Scott Werley, P.G. (25:22)
Chris may want to add some details there.

Chris Rice (25:46)
how to treat that area. And then the testing components. Testing continues to evolve very fast. 12 months ago, the ability to, the non-detect levels to test for PFAS were certainly a lot different than they are today. We're able to see smaller levels. In fact, we've recently understood that there's some pretty good technology coming forward soon to test for parts per quadrillion.

water limits now are parts per trillion. That seems to get a whole lot of conversation. But the notion of being able to test these contaminants at a quadrillion level is, sounds pretty incredible. We're also familiar with folks that are look, that have the ability to, that are putting technology together that at some point not too far away should be able to do some real time monitoring as well. One of the challenges I think for all the field is, is when you're to get your results back to test for

is my soil sample, my air sample, my water sample. What is the pre what is the post? You know, it's weeks at this point. And if you have a scenario where there's a spill or, you know, an incident, you don't have weeks to sit around waiting. Well, I wonder if PFAS is a problem. So that real-time monitoring, I think, could be really, we've heard it before, could be game-changing.

Scott Werley, P.G. (26:53)
Yeah.

Jad Sobh (26:54)
I to take myself off mute, oops. So appreciate the insight, gentlemen. We've talked about technology a little bit now. So what role do advanced technologies like activated carbon or ion exchange play in PFAS removal?

Scott Werley, P.G. (27:09)
Yeah, thanks, Chad. Good question. You know, honestly, you know, they're playing a big role right now. Probably are largely being used by most, most everyone that's having the need for PFAS removal. So, you know, and why is that? It's because they're known to be effective. Like I said, I think a couple of times already today, these technologies are used for other contaminants. So they're kind of tried and true.

They've been demonstrated to also be effective in removing PFAS. So I believe that they're likely going to continue to be effective and employed as part of one's PFAS removal strategy. At least up until that time, until more novel PFAS destruction technologies become more readily commercially available, these classic advanced technologies, as you called them, going to continue to have to bridge that gap.

Jad Sobh (27:56)
Awesome, so now let's move a little further down the timeline, right? The project life cycle, so it be. So we've done all this work now, how do we confirm that those remediation efforts are still effective?

Scott Werley, P.G. (28:11)
Right, yeah, another good question. know, monitoring is the simple answer. But in any type of remediation project, indoor water treatment project, right, you have to test, you have to test, monitor, and make sure that your strategies are working, right? So, you know, whatever's coming into the system, you generally have data on, so then you also have to test what's coming out of the system. Make sure it's working.

That can be done, you know, a lot of times that's done under some kind of permitted process, like I mentioned, that has some sort of effluent monitoring frequency built into it as a requirement. You know, that could be every so many gallons every day. If you're doing some kind of ongoing continuous flow or perhaps it's just some sort of quarterly or semi-annual type practice that you do if you're more of a, you know, brick and mortar type place that's

having a process that's using PFAS where you just need to treat your effluent before sending it to a POTW. But yeah, really, just to come full circle, it's ongoing monitoring. If that's on some sort of frequency or real time, like maybe coming more commercially available, we'll see. But yeah.

I think that's a...

That's one of the best ways that you're going to be able to know and fully understand if what your process is, is being effective and remaining effective over time.

Chris Rice (29:34)
And we know that the EPA has put in testing requirements now for the first time for PFAS, now and going forward in recent years and going forward. I think you'll find more and more entities. There's lots of conversations about the regulatory elements of testing. Because it is truly the one path to understand, OK, is this a problem for the environment? Have we created a problem? Do we have a problem? How do we solve that problem?

Jad Sobh (29:58)
Awesome. And kind of staying in that future outlook space, where do you guys see PFAS remediation technologies kind of moving to in the next decade?

Scott Werley, P.G. (30:09)
First, you want to take a jab at that one first.

Chris Rice (30:12)
Sure. reiterate, think what I said earlier, you know, when PFOC, this is new, or Peter, as you said, nascent, it's new-ish. And as the world evolved to realize quickly that there are spots in the country that have a PFOS problem, and that moved to, goodness, you know what? They found PFOS in the Australian outback and in the Arctic and in places all over the globe in ways that was...

not understood six, seven years ago. And then in those hotspots, folks looked around and said, well, what do we have that we can even try to use and do this really quickly? The costs involved are extensive. They're very high for some of the treatments we've talked about. So where things will go will undoubtedly, like any industry, the costs will be driven lower. And we think that efficient removal

and destruction of PFAS is going to be the goal. And if that can be done efficiently and at a low cost, then that's going to make this problem become solved like so many others we've dealt with over years quicker than later. So I think that pursuit of efficiency, both on the environmental side, the full destruction, and on the cost and capital side, that's really going to drive a lot of decision making here over the next handful of years, not only for soil and water, but for air.

Jad Sobh (31:20)
Peter, you got next?

Peter Nabhan (31:22)
Yeah, and of course I think one of the things that I did want to ask you about before we go is we've got AI, we've got this huge, I guess still box, black box, but that people are using to consume a huge amount of data. Do you find that to be beneficial for the PFAS practice?

Scott Werley, P.G. (31:33)
Check the tool.

Yeah, interesting question. I'm not one that's used a whole lot of AI so far, but I do know it's going to, from what I'm hearing, it's going to be a big thing. And in many industries, likely, there are consulting industry as well. I'd imagine that, you know, one way AI could possibly help solve the PFAS problem would just be by connecting some more dots.

you know, trying to figure out what compounds may be related to what sources, what daughter breakdown compounds might be being stemmed from, you know, which parent products and things of that nature. You know, we do know some of that already, but I'm sure something as powerful as AI could really connect some dots quickly on that front.

Chris Rice (32:25)
That makes sense, Scott. Yeah. Feed them more data. That makes a lot of sense. know, the EPA drinking water limits are limited to six compounds, six specific PFAS. And we know that there's upwards of 10,000 that are out there that don't have research behind them. that engine, that AI engine, whatever ones emerge, undoubtedly can link what that chemistry and the human body would undertake.

Scott Werley, P.G. (32:25)
We just got to feed it more data.

Chris Rice (32:50)
and in ways that probably will move a lot faster than I think we could have 10, 20 years ago.

Peter Nabhan (32:58)
No, absolutely couldn't agree more. The predictive analysis will be a lot quicker using those tools. And I guess this is we're coming in at the end. So appreciate both of your insights today and talking about PFAS and technologies. And before we sign off, we'd like to finish with one question that we ask of everybody. Scott, since you were on with us last episode, you're welcome to respond again, but

We're going to go with Chris first and you let us know if you want to respond. So Chris, the question is, can you tell us something from your life, personal or professional, that has been groundbreaking for you?

Chris Rice (33:34)
I'm glad you guys get to edit this. I want to think something good. Groundbreaking. You know, for me, groundbreaking.

Scott Werley, P.G. (33:36)
Yeah.

Chris Rice (33:41)
You know, groundbreaking. I've been in a handful of industries that have seen tremendous change. And every time I've seen that happen, I've learned something, sometimes very painfully, but in many ways doing very good things. And I think in this case, the backgrounds I've experienced or experiences in environmental science, I've seen nothing like what's happening with PFAS and the combination of research awareness, the emerging awareness.

and the ability to solve a big problem I think is going to happen or put in place a path to solving a problem. It's going to happen very fast. That sounds like that will be groundbreaking as it takes place. And so I put that up there with other experiences I've had in life is pretty unique.

Peter Nabhan (34:19)
And you're right, Chris, to your point, that is very groundbreaking because I think what a lot of people don't understand is technology is just becoming such a force multiplier for everybody. We're able to do things way faster. We can solve a lot more problems. And that's my welcome to everybody is lean into technology as opposed to being afraid of technology because it's the most powerful tool that you can have, that you can make and change and long lasting impact.

Scott, do you want to go again or we're good with the last episode? Groundbreaking moment.

Scott Werley, P.G. (34:49)
I would say

that one thing that's been truly groundbreaking to me in the recent past is just meeting Chris and learning of his and Invicta's technology. For years following PFAS up until just two years ago, was all doom and gloom before, because I've been around the environmental industry long enough, I know that

Treating things just takes the contamination from one media to another and it's kind of a circular type economy, right? But the technology out there that Chris and his folks have developed was truly groundbreaking to me. It gave me hope that we can just truly destroy this stuff, kind of hit the reset button and not necessarily just generate a lot of more waste by trying to treat one problem.

Chris Rice (35:36)
You're kind. Thank you.

Jad Sobh (35:38)
That's awesome. To both of you, thanks for sharing. Thanks for your time today. It was an awesome episode. Definitely learned a lot. So to everybody out there, we hope you enjoyed this episode on PFAS remediation. Stay tuned for more conversations here on Groundbreaking, where consulting meets innovation. And don't forget to subscribe wherever you get your podcasts. Thanks.