John O'Neill: All righty. Welcome, everybody. We'll give folks about 30 seconds to trickle in, but we won't wait too long because we've got a pretty packed agenda. Good afternoon, good morning, depending on where you are calling in from. Just another couple seconds for people to trickle in and then we'll get going.

All right. Well, welcome to today's "Industrial Water Reuse Webinar and Clinic." This is part of a series that the Better Plants program and the National Alliance for Water Innovation, or NAWI, are putting on in conjunction together. Today, we're talking about mapping your path toward water reuse, and we've got some great speakers lined up for you today.

So, as I mentioned, this is delivered as part of the Department of Energy's Better Plants program. So, as part of the departments, I sit in the Industrial Technologies Office. My name is John O'Neill. Our office's mission is to support the competitiveness, energy productivity of the industrial sector in the United States. And one of the ways that we do that is through this program called the Better Plants program. As part of the Better Plants Challenge manufacturing organizations commit to improving their energy performance by at least 25 percent over the course of 10 years across their US portfolios. They also commit to sharing their results in the form of case studies, reporting their data on their progress. And in exchange, we sort of provide resources and peer exchange opportunities to help them achieve those goals. Next slide, please.

Within the Better Plants program, we have what's called the Water Savings Network. So, in addition to focusing on energy, we recognize that there's a lot of tie-ins in what we call the energy water nexus. There's a lot of overlap between things that conserve water and conserve energy. And so, we have this Water Savings Network, which is a subset of our partners that work specifically on tracking water savings goals across their portfolios as well. And we convene and share stories across those partners to help support the advancement of water efficiency in the US industrial sector as well.

So, this webinar series is put on by a great team here. So, on the Department of Energy, you've got myself and Andrew Whitlock supporting the development of this content. NAWI is represented by Dr. Peter Fiskd, who's going to be moderating the bulk of this webinar today. And then LBNL, the Lawrence Berkeley National Lab, is also supporting. Thanks to Susana and Prakash and Meena for all of their work to get this thing off the ground as well.

We will be using a platform called Slido today. It is a – go ahead and go to that URL on the screen and enter the code WaterReuse. This platform is really handy to manage Q&A throughout the course of the webinar. We'll use this instead of the native Zoom chat because this has functionality to basically allow you to upvote questions that you like. So, if you see somebody ask something that you're also wondering about, give that a plus one and that'll sort of elevate it to the top of the queue and we'll be able to prioritize questions that a lot of folks are interested in. Feel free to submit those questions at any time as our panelists are talking. Just drop those in the chat and we'll cover them later in the Q&A portion.

All right, without further ado, I will introduce today's moderator, Dr. Peter Fiske. Peter –

Peter Fiske: Morning, John.

John O'Neil: Hey, Peter. Peter is – was the founding executive director of NAWI, brings over two decades of leadership in the water sector under his leadership. NAWI launched more than 80 R&D projects, advancing water reuse, desalination, resource recovery and energy water optimization. Peter's now the Engagement and Technology Transitions Manager at NAWI and he focuses on accelerating the commercial adoption of NAWI-supported technologies across the water industry. And with that, I will hand it over to you. And take it away.

Peter Fiske: Thank you so much, John. Yeah. Everybody, welcome to today's webinar series. Next slide.

And just so you know, NAWI, the National Alliance for Water Innovation, is DOE's Energy Water Innovation Hub. So, we are headquartered in Lawrence Berkeley Lab but we sponsor research around the country. As John said, we have a number of projects completed in applied water research and really trying to lower the cost and ease the implementation of more efficient water use in our industries and our communities. You can learn more at NAWIhub.org. Next slide.

We have a number of great partners on this webinar series. First and foremost, Water Reuse Association. Water Reuse Association is the largest trade association solely dedicated to advancing water reuse and the regulatory framework around water reuse. So, grateful to have them on board.

And another important partner – next slide – is the US EPA, in particular the National Water Reuse Action Plan or WRAP. WRAP is getting engaged in its second incarnation, WRAP 2.0, especially focusing on reuse for industry. So, we've got – glad that we have this community with us here today. Next slide.

Now, next month's webinar, Wednesday, October 21st, we are delighted to have Dr. Naushita Sharma from Oak Ridge National Laboratory. Naushita is going to walk us through some of the great tools that are available to you through the DOE for understanding how your plant uses water, plant water profile, and other things. And so, we're looking forward to that and we hope you can join us October 21st. Next slide.

And for those of you who are going to WEFTEC next week in New Orleans, we will have a booth. The Better Plants has a booth, booth 8128, and Naushita has a talk. On Tuesday, she will actually be walking through how to utilize tools like the Plant Water Profiler. And we also, after Naushita's talk at 4:30 on Tuesday, we're gonna gather everybody. If you happen to be in New Orleans come on down to booth 8128, meet the team. We'll have an informal gathering and we'll also meet the experts. And you can tell us what you like and what you want to see more of in this webinar series.

All right. With that, I am delighted to introduce today's speakers. First, Michelle Maddaus. She's the President and Principal Engineer of Maddaus Water Management. She's a nationally recognized expert in water conservation and efficiency. And her and her team work focuses on commercial, industrial, and institutional water reuse assessments, conservation master plans, et cetera, et cetera. Maddaus Water Management has more than 30 years' experience and has delivered more than 600 projects across 20 states. Founded by Michelle's extraordinary father, Bill Maddaus, MWM is a multidisciplinary team in California, New Mexico, and New York.

And joining alongside Michelle is Darren Dimma, who you may know as part of the Better Plants program. Darren is the Global Energy Efficiency and Innovation Water Lead at General Motors. His team develops and implements global water strategies and innovative methods to conserve and reuse water. And he also is an expert in global water data compilation, verification, and reporting. If you can't measure it, it's hard to make it better.

All right, everybody, please welcome Michelle and Darren. And Michelle, please take the stage and tell us about how to map our course.

Michelle Maddaus: Great. Thank you, Peter. Yeah, I'm really excited to talk to you today about how do you approach and how do you make a successful water reuse project? I'm going to talk a little about practical strategies, a couple proven case studies, and then keys to success. And then, Darren's going to follow behind me and he's going to talk about how he actually did some of these principles at his own facility and some projects.

So, first and foremost, why do we do industrial reuse and why does it belong in your operating plan? It does help in a lot of ways. It helps with your supply resilience. So, it can reduce your exposure during droughts and freshwater supply constraints. Your capacity. It definitely has water and wastewater capacity for production and growth in new facilities. Total cost. Definitely looking at the whole picture, cost is always in there. It avoids treatment, pumping, heating, chemicals, sewer, and discharge costs, depending on how you set up your project. And ultimately, performance. Water supply can be tailored to the process instead of accepting variable water source quality.

So, that is kind of in a nutshell why you want to look at it, but ultimately it can be a sustainable option for you and your facility as things get constrained. And as a bonus, I have up in the corner water savings also can save energy. Being this is a DOE presentation, that's always to keep in mind. Water uses energy and energy uses water, so that's kind of just something that you always want to keep. We're going to be focusing on water today, but definitely the energy part is very important.

So, as we move forward and we look at starting a reuse project, one of the very first things we try and do is look at what you have currently. And one thing you can look at is do we really need all the water use we have right now? Is there a way that we can be more efficient? Is there a way we can avoid it in the first place? And reducing that use can obviously help overall the controls and maintenance and operations.

Then you look at recirculation. Is there a way to kind of add more cycles? So, a cooling tower, for example. Can we increase the cycles of concentration? Is there something we can do to make that more efficient? How old are these systems? Because if you improve systems, you may not need as much reuse or just water

flowing through. It just pays to be efficient before you start a process in the first place. It doesn't pay to be wasteful. And then, obviously reclaiming onsite. That's something to think about. We're going to be talking about that. And then, also alternative water supplies. So, if you need the water, you're definitely going to want to look at your entire system and make sure that you've got it pretty well reviewed before you start dialing into a water reuse project.

All right. So, looking specifically at a reuse project, the way I like to start is looking all the way to the end. What is it that I need to supply? So, go to the receiving source and say, "Okay, what is that I need? What's the volume I need for that? And then ultimately, what's the water quality I need for that use?" Because depending on that is really going to shape my project. So, I don't start at the water source. I started the water – at the end of the pipe, like where are we going to use this water, because that's also going to determine how much I need to treat it. Depending on the receiving end, it could need high water quality or it could use lower water quality.

So, we're going to talk about that. I'm going to break that down. But definitely looking at your supply, looking at what kind of water use it is and ultimately – the lower quality end use or end of the pipe or where the receiving is, the easier your life is going to be for this project. So, definitely you think about that. So, we call that matching sources. So, a good quality income in the receiving end, very, very important and where you start every project.

So, where can we actually use water in a plant? Well, you can use them in a lot of different places. You can have multiple projects on one site, but I would say focusing on the one that makes the most amount of sense for your facility. One mistake I see is a lot of times people will have multiple facilities across the country and be like "Oh, well, I'm just going to do what I did at the other state or the other project." I would say it's best to pause and really think about your individual facility at each site and what makes sense. Cooling towers tend to be, I'll show you in a minute, but one of the easiest ones and the most common that we see. It's a lot of water and it's easy to tend to find a home for it, depending on what you're putting in the water quality for the treatment inside the tower. But that's the most – number one most common project we see.

Boiler and high-quality water utility feed. Process water and rinse, a little less common. That tends to sometimes hit health and food and safety regulations, so that's something to think about, but we

do see it. Landscape irrigation, also a good use. You just have to be a little bit careful with the plants and the level of chemicals or salts that they get. Some plants are very tolerant and some do not like the variants and constituents that you might be putting on the plants and you might harm your landscape. So, definitely something to think about and test always and frequently.

And think about seasonality because sometimes if your water quality varies, then the plants might get different water use. Dust control. That's a good one. Yeah, the water quality doesn't necessarily matter so much. So, if you have that regularly at your site – I'm showing you a normal procedure. If you have a plant producing dust all the time, then that would be a good water use. And obviously, storage and distribution. So, those are very common ways to think about reuse projects.

All right. So, moving on to the water loop. If we're going to do a reliable water balance, there's some elements in it. This is just a conceptual process map. It's very much going to depend on what you're actually doing at your site. But in theory, you're going to have some source of water. You may need to pre-treat it. You may need to soften it or move some of the total dissolved solids out. Depending on if it's groundwater, you tend to have high TDS in that water or you may have some sort of constituent you need to get out before you actually hit your internal processes. Again, it depends on what you're doing, what water quality you need.

But then. you're going to have your main process. Then you can recover some of that water and you may treat it and may send it around again. Depending on how your process works, you may be able to go around this loop multiple times. And again, it's going to depend on your facility and the uses. But there will always be some unavoidable losses. So, as you go through that, there will be evaporation – example, cooling towers – and there could be some residuals and brine to deal with. So, as you get more concentrated, that's something to think about as well.

Okay. So, when you're looking at your facility, one of the very first things I want to recommend is to meter. If you don't have meters, you're going to potentially struggle with figuring out the volumes, the volume coming into your facility, but also the volume you have at a particular process you want to do a reclaimed project on, and then also you're going to struggle with the receiving end. So, I would recommend metering as much as possible before and after your intended reuse project, just – and meter it sooner and actually track it, not just for one or two months, but for like an extended

period of time so that you can reliably figure out the volume in and the volume out of your processes. If you get that wrong, you could either oversize your facility, which would be at extra expense you don't need, or you may undersize it and/or not provide enough water for your end use, which would not be ideal. So, again, metering, metering, metering is your best friend. Unfortunately, I see some projects that don't do that, and then they tend to sometimes run into challenges because their volumes are off either on the start or the end of their project.

So, these are some areas you may want to meter your supply, your major uses, some of your outputs, but ultimately think about metering and get in where you need and track and monitor them. So, not just for one season, because again, your water quality can vary throughout your year. So, make sure you're tracking not only volume, but I would also try and do some water quality testing as well.

So, where are the best use candidates? So, say you're like "Great, this sounds good, but I have a large facility. I have a lot of options. Which ones are the best?" The best, meaning which one is the easiest to do, to put in, which is the easiest to maintain, and which is the cheapest? So, that's what I'm defining as best. Condensate tends to rise to the top because it has a low total dissolved solids, or TDS, and it tends to be kind of predictable and warm. So, you don't have to constantly warm it up or cool it down. It's not like a really hot process. So, that tends to be kind of – I'm having green bar being – green means "go" or "good," and then red at the bottom the least desirable.

As I go down this scale, things are getting a little more challenging to treat and/or a little bit more challenging to maintain the kind of overall water quality in your system. So, that's the thing you want to avoid, is the last one on the list, which is mixed water, wastewater. What do I mean by that? Some people think "Well, I just want to get all the water at my site. I just want to get as much as I possibly can and I want to treat as much as I can and have a really big system." Going to kind of say "Buyer beware" and careful of that. It tends to not work out very well. I'd rather have two different systems that are focused on a single water source and a single end use. It tends to be more successful, more predictable, and you put less in the water. The more you put into the water by mixing streams, the more you have to treat it. And now you're treating a large volume of water. So, I – so, be very careful with mixing a bunch of different water sources together. It tends to

make your life on the treatment side more challenging and your project tends to not be as successful.

So, I'm going to call that matching your water, the start water to your end use. So, again, they call it source-to-end-use matching, is the formal word for it. But it just makes sense to kind of think about what is the starting volume of water I'm working with, and where am I going with that? The treatment direction I'm showing here, again, I'm starting with a clean condensate because that's the easiest. A good receiver would be a boiler. That tends to be a very common thing I see. As I move down the list, you can see I'm adding and paying attention to where I'm starting with the water and where I'm ending up with the water. And my treatment varies based on where I'm starting and where I'm ending.

So, again, defining your project and minimizing, just focused on one use and one receiving tends to work out very well. The more complex the system, the more expensive the system gets and the harder it is to maintain. So, these are just example and screening criteria at a design project level. I haven't built anything yet. I'm just talking in theory, "Okay, when I'm looking at my facility, what is this?" So, this is kind of like not a design level yet. We're just trying to decide looking at a site what's possible and how might we use this water that I have available?

So, moving forward, say, "Okay, that sounds great, but now what?" Okay, so let's say we've got some cooling tower water. Depending on the water source, it's going to determine what water quality action I need to take or what I'm watching for. I've called that a water quality concern. It's not that we can't deal with it; it's just what I'm watching for and treating against. Some of them are easier to deal with than others. Silica tends to be kind of tricky. So, yeah. But these are the constituents I'm looking for.

And then the typical treatment direction. So, what I'm saying earlier in my design and kind of over of all process and discussion starts making sense now because as I'm going down this list, you can see I'm watching for different components. So, the easier it is and the more you isolate, the more this list of concerns get smaller. If I put all of the water in one bucket, now I have to watch for a bunch of things, and that tends to be more complicated. So, again, figure out what your use is and then really focus in on that quality and design your system for that accordingly.

All right. There are eight factors to shape a variable – a viable reuse project. I'm going to kind of quickly talk about them, but I'm

going to hone in on the ones that I see people skip most often and also not do to the level that it tends to be ideal.

Water quality and supply, people tend to do that pretty well. They figure it out. Make sure you test it. Don't just test it in one season. If your water quality is from a water utility and it varies by the year, make sure you're testing it in different seasons. I've seen quite some differences because the water utility may be switching sources throughout the year based on availability. So, therefore, you're receiving water quality at the start of your facility and it might vary quite widely. If you don't know that, that's a good place to start.

End-use requirements. I talked about that. Make sure you know the volume you need. A lot of times people kind of guesstimate that, but I would recommend really dialing that in, having a good idea of the frequency you need it, the quality you need it, but the volume you need it.

Any regulations. So, do you need permits? Is there any health and safety? Is there public concerns. That's definitely not something to be skipped and started sooner rather than later because regulatory can take time.

Treatment technology. Okay, now that we've decided what our concern is, there are different technologies based on the different water constituents that you're focusing on. So, you definitely want to start dialing that in as you're going through this list.

Infrastructure. Okay, where is the water? Where do I need it to go? Do I need some piping or storage to either get the water where it needs to go and/or store it? If it isn't available regularly all day long, then maybe you need to collect it and store it so that you keep a reliable volume at your end-use.

Definitely financial viability. That's a key one. Making sure you dial in on the costs. Some people kind of forget, and I'm going to talk about that next, the total cost of water and the total benefit. So, unfortunately, some projects don't actually get approved or when they should because they aren't actually looking at the whole picture of water and what they can potentially save through this process.

I would say that number one thing that most people skip is the operation and maintenance. Sometimes people will get a firm or an engineering firm to come in and design this and build this, and

then they leave and then you're left operating it. I would say that's a big mistake. I would say taking ownership, being involved, understanding what's going on, so if the company isn't viable anymore or whatever, that you have ownership of your actual facility, I think is a key, and so it's staffed and monitored properly, because the ones that I see fail tend to skip or not think about step seven enough.

And then, risk management, obviously. Health, safety, and environment are always important when we're – and again, it depends on the receiving end-use how much of that is a factor. So, all eight of these are important and they're kind of done in order.

All right. So, now if we're going to start looking at water quality, the source quality is important. What's in the water at the end of the day obviously determines how many of these steps I need to go through. The cleaner the water, some of these steps aren't so hard. And so, again, this is a conceptual flow. It's more of a reference, but basically we need to – if we've got any debris in the water, we need to get that out. We need to look at the pH: Is it acidic or not? What's actually kind of the base load in the water? And is there any chemicals in there? If we've been adding chemicals in your treatment or your production, we need to make sure we know what that is and make sure we are accounting for that in your whole process. Is there any biological matter in there?

So, again, as we're going – I know you can read, as we're going through the system you just want to make sure that you're tracking the water all the way from the beginning all the way to the ends and accounting for these as we go. You definitely are going to want to disinfect it too. You may or may not need to store it, like I said. Sometimes that can give you some buffering time if you need some chemicals to settle, and then you could distribute it. So, again, all of these steps may or may not be required, but a lot of times they're definitely important to think through as you're doing the design if and when you need these steps.

So, again, each step can kind of look at contaminants in the water. So, you can, for example, look at your pH. You can remove any soils or organics. You can polish the water. You can look at your hardness and then use of the water. So, this is just, again, a conceptual flow of one particular, but again, it's going to very much depend on your exact process. But I'm trying to give you the basics so you know kind of what you should be reviewing as you're thinking through your project. Again, as you start getting

into your detailed design, some of these will start becoming very apparent, but definitely important steps to think about.

Okay. So, I do want to say a lot of people shy away from industrial water reuse. They think it's scary. They think it's hard. They think it's complex. They think it's expensive. It doesn't have to be. If you can just streamline and focus on, for example, clean condensate, you can make it a relatively straightforward process. You can capture it, recover the heat, polish it, and use it. So, it doesn't have to be as complex. And again, I was saying, well, maybe just focus on a key area on your site and not try and do everything and get too large, because that starts becoming maybe too challenging and then people just walk away from the project entirely. So, again, depending on which process you pick, you can streamline your overall thing and you can kind of be more successful by being selective with your use.

This is an important point: the true cost of water. So, I've broken this into six layers. I feel like the business case or getting approval for your project really hinges on understanding this. Some people skip some of these pieces and then they don't have enough of a whole picture and therefore they say, "Oh, we're not doing the project because the payback's not there." And it's unfortunate because they skipped a couple key pieces, and that's why I'm kind of trying to lie them out because it is – water has a way of touching a lot of things as it goes through your facility. So, obviously, you have to buy the water first, either freshwater or demand. You need to treat it in some way. You need to move it. And it can also produce heat; you can capture the heat. That's actually a benefit, right? Operating any chemicals and things like that and sampling and discharging it. The sewer and the sewer charges also add up.

So, there's a lot going on here. So, if you avoid the water use, like I said, you can avoid all this, right? So, if you're just efficient in the first place, that's why that was on the top of my list earlier, then you can avoid this whole chain. But making sure you go through each of these and line item them are good for your economics. So, just think about that.

And you definitely want to make sure that you get your kind of volumes and costs right because you don't want to harm your plant and not have the water when you need it where you want it at the right quality. So, that's your risk. So, the more you get this dialed in, the more that won't hopefully happen to you at your facility.

So, economics. I actually like economics. I teach benefit-cost analysis, so if anybody has questions in the chat, feel free to ask me. But you do need to definitely put costs to all this. It doesn't have to be complex. I put some equations in here because they're like "That sounds great. But how do you actually do the math?" So, we're going to kind of step through this.

The annual recovered volume is a simple formula. It's right here. The annual avoided cost, again, it doesn't have to be too hard. That one hinges very much on the volume. So, again, metering and figuring out your volume is very important because it's a big multiplier there. Your annual benefit is your avoided cost. Again, an avoided cost is something you don't have to spend, right? So, think about it that way. Or – and it's a benefit. An avoided cost is a benefit.

And then a simple payback is comparing how much you have to invest in the project versus the benefit you're going to gain. Sometimes projects go in even if they're not benefit-cost-positive because they are necessary for regulation or you need to discharge at a certain quality and you don't have that quality. So, some projects, even if the math doesn't work out, still go through.

But in the end, definitely do a sensitivity check too. Make sure your – what if your water rates fluctuate. What if your residual cost changes? So, make sure you run it, set it together, maybe put it in some sort of program or Excel so that you can change the values and make sure that things – you understand the fluctuations that can occur throughout your project because, for example, water rates keep going up, energy rates keeps changing. So, those are things that you want to maybe run it a couple of times with different assumptions and see how your math works out.

Your scorecard. So, when you're all said and done – I call these gates – you need to pass all five gates. Some people like to skip gates. I don't recommend that. So, what I mean by gate is these are checkpoints. "Okay, we've done a conceptual design. We've thought this through. We've done the math." But make sure all five of these elements are here. If you're missing any of these or you kind of cheat on some of these, you may end up needing to go back through and redoing your math or revisiting things. So, definitely figure out your flow and your operating hours. Make sure you have a match between when you're producing the water and when the water needs to be received. So, if you have a production plant and you have certain hours that you're actually generating the water or receiving the water, make sure they match.

So, for example, if you're operating your plant at certain hours and you're putting it on landscape, that's okay. But if you're operating the plant at certain hours and then your receiving thing needs water at a certain hour, make sure those – there's a match there. Pretty straightforward but make sure. And if your plant goes down or you maintain your plant, make sure you factor that in as well.

Predictable quality. Again, variations can be buffered. If you monitor them and you test the water and you know it's going to fluctuate in the fall because they give you a different water source, that's fine, but you just need a system that can be flexible for that and monitored for that so you know when that change is going to occur.

Demands. Again, match your end use. Make sure that the receiving end is going to like the water that you're providing to it. Make sure you complete your economics. Don't skip that. A lot of people tend to kind of try and not do that to the level that's sometimes needed or go too far. If you're going to do a simple project, you don't need to write a Ph.D. essay on it. So, do the math to the level that's necessary. And then, ultimately, make sure you have a clear pathway. Don't forget your permits. I start the permits really early because that can take quite a lot of time. Once I've kind of got my conceptual project in mind, I start the permitting while I'm kind of still ironing out a lot of the details. And then, you can always fill in the details when you've actually got your permit most of the way through.

And then ownership. Who's going to own it at the end of the day? Who's going to maintain this so that it doesn't just work when you turn it on but for years to come?

So, each stage has a decision to be made and you want to kind of have it ready and approved and make sure you've made the right steps as you go. So, your metered flow map and true cost. Your water balance needs to be solid. You need to look at the water quality. You need to match the water use from the beginning to the end of your pipe and how that's going to look. If you're not sure, I'm going to say this in a minute, but about any element, you can always pilot things. You're going to design things and then ultimately have your project. These are decision gates. You can stop and go back at any point, but this is a typical conceptual flow to make a successful project.

All right. So, say you like this in theory, but you're missing a few pieces of data. I do recommend a pilot if needed. Sometimes you need it; sometimes you don't. But if there's one piece you're not sure about, maybe you're not sure about the volume, the receiving volume, maybe you're not sure about the variance and water quality, if any of those things I mentioned you're just not sure about, you can make a smaller version or a pilot project and then track things. I do recommend that before you go full-scale. If you're going to put in a million dollar, a multi-million-dollar project, make sure you are on solid footing. If you're not, then maybe think about a small-scale or definitely metering or filling any of your gaps and make sure you have that pretty comfortable when you're running your economics or when you're actually going to do your full plant.

So, it should definitely also define success criteria before your testing begins. Before you do your pilot, what are you watching for? What do you need? What are the parameters? And have that pretty well thought through before you actually run your pilot project.

All right. So, you've got that all in mind. What you also need to do is track. If you're going to keep things functioning, you need to have a good handle on quantity, quality, reliability, and cost. All of those things will have you kind of tracking after your project in an appropriate way so that it succeeds, that it gives you the water quality, or they call that on spec water, when it needs it. So, these are the ways that you can track it to make sure that that's going to happen.

And ultimately, you need to kind of have a system in place so that you keep getting the data you need to be able to track this. I put this here and I also put some units. So, total unit costs it typically per 1000 gallons. So, make sure you have a way to track it and track all the units. Label your units. I saw a few that struggled because people weren't putting units in and then they had some unit errors in there. So, make sure you label everything carefully and make sure that data is flowing to the people that need it so that you can make good decisions on your project overall.

All right. Let's talk a little bit about – so, we talked about successful projects. We talked about how to run the numbers, how to find a project, and how to try and match the sources. Where do people struggle so that that doesn't happen to you? I mentioned it before, but I'm going to repeat it a little bit, mixing your streams too early or mixing them at all. If you combine even a small

amount of what I'm going to call dirty water and you put it into something clean, now you've made your whole entire larger dish of water kind of murky. Not ideal. I've seen that a few times and it did cost a lot of water. A large volume of water was harder to treat and cost a lot more money than if we had just treated a smaller volume of water that was less dirty. So, watch for the mixing.

Averaging water quality You're like "oh, on average, we're going to be fine," but yeah, what about that middle period when you get a water quality spike? What's that going to do to your system and what's that going to do to your receiving? Is that a problem? So, it's something to think about and why I said track it for a little while, not just the water quality, but those salts, organics, and the temperature. Some people forget to track the temperature. That's also something very much to watch as well.

So, again, go through all these. Make sure that you have them kind of in mind because these are definitely where people struggle. And no operating owner – a big no, no. A lot of times people put it in and don't condition it or only one person on the team knows, that person leaves and goes to another company, and now you're stuck with a system that you don't know how to maintain. So, have a well-trained multi-diverse group that can actually operate the system day to day. Very much important.

All right. So, let's make a successful project. First and foremost, let's meter. First of all, meter. I can't say that enough. Meter. I've seen so many projects that struggle with that. I've gone to water production plants, I've gone to other places making sure that we have the correct information entering into your site and then as you go through the site. Separate the streams at the source. Match the water quality to the end use. I've said that three or four times. I can't say that enough. And then, definitely pilot if you need to.

Number seven is orange for a reason. You definitely need ownership. So – and what does ownership mean? If there's going to be alarms, how are you going to get alerted if there's a problem? Are you going to get it to a phone? Are you going to get it to alert you that there's an issue? What does that look like? And then, who's responding to it if you do have a problem? So, that's definitely something to go back to your KPIs I was talking about so that you can monitor it successfully. But all seven of these practices are important, but that's the one I see not to forget.

So, your very first step if you haven't done a project before is to have a good solid discussion. Get the right people at the table.

Have them turn around and help you. Just talk in general terms. This is just five questions to start with to get that discussion going. I'm assuming this is early days for you and that's why you're here, but you definitely can go deeper. These are just some kind of basic questions that you can use as a cheat sheet, take it back, get the people at the table that know about your facility, and then have a good solid discussion.

Definitely starting with how much flow is available and when is it available? That's a big one right there. So, these are some basics. I've kind of talked about all these, but this is your cheat sheet that you can use in a meeting, and hopefully that's helpful for you. If you already know some of them, great. You're three steps ahead. If you know four out of the five, great. Go get the missing one and then move forward.

So, what would a project look like? Some projects can move very quickly. Others take a little bit slower, but this is kind of like a 90-day flow that it could look like. You definitely can start by confirming if you have meters. If you have them, great. Make sure you know where they are and are they being monitored and where the data is going and get access to that. Production schedules. You're going to need all this: costs and things. So, if you don't have it, the first 30 days is kind of a gathering exercise.

The next 30 days is to sample the water. I call it your top three streams. Maybe you're considering a couple different projects. That's great. Let's gather the data for those and see which one looks the most positive. Again, you can have multiple at a site that is totally okay and sometimes common. The larger your site, the more probability you might have more than one system.

And then, yeah, again, define what your goals are. And then, you select it. Which project are you going to move forward with? Maybe you start with three projects, you talk it through and you end up with two, but you're not sure which one might be the best. So, that's definitely something to look at.

So, they definitely succeed when the project fits the facility. So, again, don't carbon copy your neighbor. Make sure it actually matches your water quality and your flows. And yeah, you just really need to think about that. I've seen people even in the same industries copy one from one state to another. Not the best. You need to really look at what's on the ground at each individual facility.

So, case studies. Just a couple really quick ones. Frito-Lay in Arizona did processing –

Peter Fiske: Michelle, we want to make sure that we give Darren some time to present his thing.

Michelle Maddaus: Okay.

Peter Fiske: So, what I think we should do is pause the case studies and we're going to move the case studies and that discussion after the Q&A.

Michelle Maddaus: Sure. No problem.

Peter Fiske: Remember, everybody, that we're going to also move into our clinic at the top of the hour, and in the clinic we're going to have a much more informal conversation with Michelle and now with Darren. And also, I'll just remind everybody, I'm watching the Slido. I've seen some great questions but, everybody, I recommend you get on the Slido, look at the questions we've got so far, but also formulate these other questions. And Michelle and Darren and I will kind of start at the top of that stack.

Michelle Maddaus: No problem.

Peter Fiske: Okay. So, great. Thank you, Michelle.

Michelle Maddaus: No problem.

Peter Fiske: Darren. General Motors. I've heard of them.

Darren Dimma: Good. Excellent. Happy to hear that.

Peter Fiske: I'm a happy customer.

Darren Dimma: Perfect. I'm very happy to hear that as well, then. Thanks, Peter. And thanks, Michelle. Great conversation. Great topics. I'm really going to be supporting everything that you just went through, Michelle, in some real life examples. A lot of what you said 100 percent resonates, some in a good way, some in not necessarily a great way. But so, yes, thank everyone for joining. I do want to take you through a few slides here, just talk quickly about our General Motors challenge, our approach that seems to be working for us, some of the roadblocks that we hit with our water and water reuse efforts, and maybe share some ideas of how we can get around those.

The biggest issue, it's a low-cost commodity. So, if you just take into the dollar amount of what shows up on your invoice, not the true cost of water, not the cost of the impact to the communities, the watersheds where we live and work, just looking at the pure dollar note that comes on our invoice, it is still relatively cheap. I am part of a water and energy team, so our pool of funding our projects all get rolled into one. We decide what looks really good, what makes sense to pursue. And typically, unfortunately, the bigger bang for your buck when you look at that ROI is the energy. So, kind of raising your hand, having the conversations, the persuasions, the influences, and taking baby steps sometimes, which can be very frustrating, is the way to succeed and move forward.

So, why do we – why does General Motors look at water reductions and looking at water reuse, other than, of course, the public aspect of it. If you look at the fact that we have a publicly stated water goal, which is a 35 percent reduction in water intensity by 2035, so essentially what all those numbers mean is in 2010 we were using 1500 gallons of water to produce a vehicle; by 2035, we want to use 1000 gallons of water.

So, when you think – well, you might think "I didn't know General Motors uses that much water," we use water to clean the bodies prior to paint. That is our biggest source of water consumption. And then, the additional cooling tower aspect to produce chilled water, to produce compressed air, so the utilities associated with producing that vehicle. The paint shops, not to pick on paint shops, but – they are important – they use the most energy and the most water in our business.

So, if you think of that 500 gallons of water per car, you may think "That's not – yeah, that's an okay amount of water." We build three and a half million vehicles a year. So, three and a half million vehicles times 500 gallons or so per vehicle, you get into the billions of gallons of potential water saved. So, we're kind of excited. We are halfway through that – a little more than halfway through that journey. And our progress is actually in line with that target.

So, probably the same type of barriers and road blocks that you all have seen. Can't fix what you don't measure, and Peter mentioned that right off the bat. Michelle also mentioning "Meter, meter, meter." Same issues in General Motors. If we have a water meter, awesome. "Does it work?" is a good question. And is it in the right

place? So, overcoming that obstacle, I'm going to talk about that on the next slide.

Space constraints, trying to add in additional equipment. Okay, we'll jump to the next slide now. Perfect. Okay. So, your first step is understanding where your water goes through the metering aspect. If you can't do it yourself, which is something that we have come to the conclusion inside of General Motors, we're partnering with a third-party company to provide clamp-on meters. We have a trial running right now that's actually so successful, which I'll talk about in a minute, that we're expanding it to other facilities, where clamp-on meters are placed in critical water-consuming areas or where we think those water-consuming areas are. The information gets reported to a dashboard. They have a subject matter expert that monitors those 15 to 20 or so meters looking at "Hey, before I shut down before a weekend, your water consumption was this. After the weekend, it's this." Or "During production in the paint shop, one of your RO high-purity water rinses was running at 25 gallons a minute and then suddenly it jumped up to 75 and it's been holding at 75. What's going on?"

So, when you have that information immediately at hand with the criteria, your min/maxes, it sets off alarms. People can go and investigate instantly or within a few minutes. So, historically we found, okay, we were running at 25 and everything's great. Now we're running at *[audio distorted]*. We'll find out where that extra 50 gallons a minute went when we have time. Now we have the right people engaged, which is the key part of this. The information is at hand. Here's your actionable item. Let's go look at this now. So, we respond to conditions much, much, much quicker.

So, 20 meters. Yes. So, from a cost perspective, I know I was asked to share that. Depending on the number of meters that you have, and it is an annual subscription program with this third-party company, in this one instance, it is about a $70,000.00 investment for the first year. You do own those clamp-on meters after that first year and then it's just a subscription fee with this company that we're using, this third-party company. You can choose to maintain that subscription, or you can do it yourself. We found that we are very focused on quality, quality paint, safety, compliance more so, I would say, than water, as much as I hate to admit that. But having that third party focus and the folks at the subject plant participate on these calls weekly is definitely a key to success.

The quick example I have here, I kind of touched about – touched on., the 20-gallon minute reduction, just because "Why are you

doing this in this plant? Our other plants don't do this. Let's try to reduce that." And Michelle made the comment of sometimes you take that "Let's save a gallon a minute, let's save two gallons a minute, let's try it, let's have the conversation and see what it does." And that's what we found to be successful. So, next slide, please, Sam.

All right. So, again, this is the example of the plant. Now, this is year – well, I shouldn't say year-to-date. It was year-to-date into July. But we've saved over 12,000 – 12 million gallons, I'm sorry, from 2025 to 2026. Same timeframe, same plant, same type of production schedule. So, all those variables that you could say, "Oh, oh, something's different," consistent variables.

So, that 12 million-plus-gallons savings now by metering is because we understand now fire protection losses, underground infrastructure losses, that we can understand where some of that water is going in our paint shops, in our body shops, in our powerhouses, CUCs. Having those flow meters, we can look at before and afters, we can look at anomalies, we can scratch our hand and say, "Is this right? Does this make sense?" So, we have those tools now to be able to ask the right questions to make the change. Again, importance of metering.

The one thing that I need to touch on, and I know we talk about ROI to death, how do you know how much you're going to save until you have meters, but you don't know what that number is going to be until you have meters and you need the business case. So, cart before the horse. So, there are instances, of course, "Well, I think we can save this. Well, we're guessing at this." And sometimes, like I said, it takes that little, small step of it might be your one *[audio distorted]* beaker safely measuring volumes. It might be your five-gallon Home Depot bucket. It might not be pretty. But sometimes that's what you have to do to start that conversation and keep it rolling. And once you build that traction, then you can continue to build that traction.

If you have a facility or your company is saying, "Hey, I want to save 50 percent of our water by the end of this year," great. If you can do that, tell me how you can do that. I would love to know and I'm sure everybody on this call would love to be able to implement that same course of action.

So, with the success of this water intelligence program, I did mention that we are expanding this to 17 more facilities in North America. So, our US and Canada assembly facilities where we

have a paint shop will receive the same implementation of the water intelligence program. It is a two-year program, and if you look at the 17 facilities, 20 meters approximately per facility, it is a cost over the two years of $1.8 million. However, it's a guaranteed savings. So, in the two years, the company that we're working with has said, "We know we're going to be able to save this much water for you, so we are going to guarantee that investment." So, again, it's should be a no-brainer – it's a lot of money; don't get me wrong, but we're going to see that come back in water savings, which, again, after the two years, you can decide if you want to continue with the program or take it on yourself. So, next slide.

One of the ways that we are looking at water reuse – so, outside of just trying to reduce the volume of water that we're using in our process, one quick example here is through RO, reverse osmosis reject recovery. This might not apply to all the facilities or all the folks on the phone so I don't want to spend too much time here. RO systems by their nature generate a relatively clean-ish water stream. We are capturing that water stream and feeding it into another reject recovery unit as well as a pre- and post-flush on the membranes. So, instead of that water being used once per se through the RO and going to drain and off to wastewater treatment, we're capturing it and reusing it at the same facility actually where the water meters are. And we are putting in these reject recovery units in at least one, if not two facilities in 2027. So, next slide, please, Sam.

Thank you. And then, something that I'm not good at as an individual, but kind of taking credit for success stories and raising awareness to the good things that we do. So, I threw this in here and I'm kind of embarrassed, but we did receive a Better Project award in 2025 through Better Plants. So, thank you for that. We did combine the RO concentrate recovery system with a small project. And I want – this is a great example.

So, we have our paint shops, massive facilities, lots of interesting fun things happening in our paint shops. We made one $500.00 change in every one of our 30 or so paint shops globally, and it was changing the volume of a nozzle. The final rinse of that body before it gets off to be painted, we lowered the volumes from 50 gallons per minute down to 25 or so approximately gallons per minute across our portfolio. Super easy, but it's not something you think of. We want quality; we must need 50 gallons a minute of water spraying on that body. No, we don't. Through testing, through conversations, subject matter experts, through a lot of buy-in and persuasion, we now implemented that and it's to the tune of

120 million gallons of water saved across our portfolio. So, pretty significant.

So, we're pretty proud that we did that. It was so simple. It was $500.00 per facility to save 100 million gallons of water. So, you don't necessarily need to take that big bite of the elephant. Look at what you do. Look again at what you do and ask the question if you need to do it. Next slide, please.

Last topic: treasure hunt. So, completely utilizing the Energy Treasure Hunt process from, again, Better Buildings, the support from there. In our normal energy treasure hunts that GM has been doing for many years, there was always a small component where we talked about water, but the focus has always been energy. So, in 2025, I said, "Okay, great. Let's make a water-specific treasure hunt." So, working with, again, subject matter expert folks, the people who know paint shop activities, central utility complex, cooling towers, RO systems, let's build a specific water treasure hunt process.

And of course, the focus of our treasure hunts, any treasure hunt, whether it's energy and water: identify opportunities for minimizing – for water-specific. Is there somewhere that we can send water? It's great to say we need to recycle, we need to reuse and drive that message, drive that message. Yeah, great. Where are you going to send that? That's awesome. And that gets, again, back to Michelle's topic of understand the water quality that you need. And, again, right now, the mind says we have to have city water. We have to have RO-quality water in all of our buildings. Anything in between is not acceptable. That's false. During the research, the conversations, you don't need as clean a water or city water or as clean a water as RO for things like cooling tower makeup and all those examples that Michelle shared. So, understanding where you can send water is super critical.

Some great successes with this treasure hunt, which – on the next slide, please, we'll talk about that. So, the whole process itself before stepping foot on site was subject matter experts, the folks that are there to help from corporate, if you will, who are actually there to help. And my third point is it's not an audit and I'll touch on that one in a minute. But before stepping foot on site, gather all the information that you can from that site.

Your water balance. Again, if you have water meters or if you don't have water meters, it could be kind of sketchy, but gather as much information as you can: discharge reports, source water

quality. Understand the conditions outside of your four walls. Are there community members that are knocking on your door saying, "Hey, company XYZ, why are you using so much water?" Understand the growth. We have a facility in Spring Hill, Tennessee, that area in Nashville, as we probably know, significant population, residential/commercial growth. We are tuned in in our facility that, okay, the population is growing. There's more reliance going to be on Duck River, providing water to that area. What can we as General Motors do to minimize our withdrawal from that water source?

So, understanding that before you're even stepping foot on site, gathering the information Then we show up. We're here to help. We tour the facility with the subject matter experts, the people that understand what's going on in their facility, understanding that facility. So, again, the message from Michelle, same message that we encountered, you can't just apply the same type of treatment, the same type of approach to every facility.

So, understanding that facility, identifying opportunities, not audit. We are not there to audit. General Motors, I'm sure many of your companies are the same, we run through different types of audits to be prepared for whatever might happen. Our Water and Energy Group, we're there to help. As funny as that might sound and as lame as that might sound, we want to identify opportunities. We're not just identifying opportunities and working with you and understanding what you're doing; we're also trying to provide the resources for you to complete those opportunities, which typically means funding because we're here to help. Hopefully, we have money in pockets, in our pockets that we can spend with the site.

So, review the opportunities from your walkthrough of the treasure hunt. Apply some numbers to those. And then, ideally, share the good, the bad, and the ugly from what you found there to other sites. And I think my last slide is just a final wrap up. Just an example of water savings from the treasure hunt. So, we can skip this slide.

Final thought: measure, recover, reuse, and replicate your water monitoring programs. If you can't do it yourself, there are many companies that can help you identify your water source, create your water balance. Use water more than once. Please use water more than once. Please reuse and replicate treasure hunts. Good, bad, ugly, sharing that. So, yeah, that's it.

Peter Fiske: Outstanding.

Darren Dimma: Thank you for your time. And back to you, Peter.

Peter Fiske: Yeah, you bet, Darren. Thank you so much. And Michelle, come on back. And we're going to run the Q&A. I knew this was going to happen, Darren. You guys have had such a wonderful body of information, we've run long. So, what we're going to do is go through a couple of Q&As and now we're going to push out about five more minutes and then we're going to flip over to the clinic. We'll keep the opportunity to do Q&A, but we've got a really interesting exercise for all of you in the audience when we start the clinic.

So, let's start, you guys. I'm opening up the Slido and looking here. And so, one question for you, Michelle. It's sometimes the case that plant managers assume that they need a higher-quality water for some processes than they actually need. How should a plant manager determine whether a process could actually tolerate, be fine with lower quality water?

Michelle Maddaus: That's a great question. I would say if you have other plants that are doing it, that's a good place to start.

Peter Fiske: Sure, be number two.

Michelle Maddaus: Right? No kidding. That's an easy answer. But the more complex answer is, yeah, so look at the water quality that you're currently using, because it actually has a water quality. I actually was surprised the other day when I was going to use recycled water for a process and I found out, shockingly, that the water quality I was actually using at the end of the pipe was worse than the recycled water. I was like "Wait, what? How's that possible?" But the water quality coming from the utility was groundwater. It was high TDS. The recycled water had actually been generated and it had been cleaned, so it was actually cleaner. So, the long story is just test. And start with testing – if you're going to be replacing recycling, there's probably some water use in there, and then test what you're starting with and test what you have at the end, and then use that as your example.

Peter Fiske: The other thing, I would say, Michelle, also getting back to this community of industrial water reuse people, Water Reuse Association's annual conferences and their past conferences, sometimes in those case studies are some great jewels where people have discovered "Guess what? We were just rinsing surfaces and we actually could tolerate suspended solids. We didn't

even realize it. And in fact, it saved us a lot of money." So, that's another resource that people can consider.

Michelle Maddaus: Don't treat what you don't need to to a higher level. It's just more expensive.

Peter Fiske: Exactly. Exactly. Darren. Clamp-on meters. Having a friend with clamp-on meters. Tell us more, please.

Darren Dimma: Well, I'm not sure how far to get into details. Essentially, they are clamp-on meters. The company that we're using now, and there are multiple companies to choose from, it just so happened that the company that we're using chose Keyence as their meters. There are multiple companies that do this. I'm not specifically calling out Keyence as the best. Just that disclaimer.

We clamp them on. They transmit through Wi-Fi to a hub, to the dashboard. So, that gives us the opportunity to relocate those meters – on the same size pipe, of course, and if there's an electric source – wherever we need to move them to. So, if we gather as much information as we can from that one pipe, perfect. We're going to move that somewhere else and then see what's going on somewhere else. I suppose you could create permanent installations for them if you want. Not really the intention of this program, but maybe after the two-year program they do become a permanent installation. But yes, the ones that we're using right now are Keyence. Multiple other companies that are just as great.

Peter Fiske: And all you water nerds, anybody who's going to be at WEFTEC next week, boy, meter century.

Michelle Maddaus: Lots of them.

Peter Fiske: It's a great place to go and ask those practical pieces of advice. Back to you, Michelle. In considering – you had this nice stack, what I call value propositions, business cases. One of the things I didn't see was some of the broader, more corporate-level concerns about community relations. Many communities are concerned about water use. And as much as they want to see economic growth and industrial development at the same time, there can be a bit of a freakout about how much water are you going to use and is it going to come from us? How often have you seen that what I call license to operate issue is actually driving a plant for considering reuse projects?

Michelle Maddaus: I would say it's starting to become a really big driver, in addition to climate change and all these other things. External factors are very, very important. I would include in your – I said get a circle of people together at your table. Not only do you want the standard people, the ops people, the finance people, pull in your sustainability person. It could be at your facility or globally. They tend to be kind of dialed in. Or your PR team. I think that's actually very smart. And I do tend to include them at the Knights of the Roundtable because they're going to dial in on the local atmosphere and temperature for is that a concern or not?

That will also pop up when you start doing your permit and your regulatory stuff. Also why you start it soon. You want to know that right at kind of the beginning, "Where we at? Is the supply a super constraint here or not? And why or why not?" Getting that on the table pretty quick is very helpful. It tends to actually be positive. Reuse projects tend to – like recycle, reuse take the pressure off of systems, unless it's a new thing you're building. That's different than if it's an existing thing you're retrofitting. So, I would immediately bucket those two and –

Peter Fiske: That's a very good point. Sometimes a retrofit on existing, "Now we'll use less water than we were before," that gives a feeling that somethings' coming back to the community.

Michelle Maddaus: That's a positive PR.

Peter Fiske: As opposed to "I'm going to be taking less in the future than I otherwise would." Yeah. Darren, does that kind of match your experience? To what extent does – what are the biggest, I would say, value propositions driving GM for some of these projects? Is it really a plant-by-plant basis or is it a corporate feeling that you all are promulgating?

Darren Dimma: We have – thanks. And great question to whoever asked that. Anonymous. Absolutely. So, we have the corporate – overall corporate objectives, but we also have the site-by-site objectives as well and the understanding that our Mexico facility is clearly different than our Lansing, Michigan facilities. What's important there is not necessarily important elsewhere. Significant reuse water treatment, wastewater treatment in Mexico. Lansing, Michigan? No, not so much. So, we're working on that.

But yeah, everything Michelle mentioned, absolutely. The consideration of production levels, the regulatory aspect in Mexico from a well water perspective, mind-boggling compared to

multiple other locations. So, understanding those regional locations is definitely critical from a water use perspective.

Peter Fiske: Very good.

Darren Dimma: And one of the things that Michelle mentioned I absolutely agree with is the redundancy. Curtailment. We've had electric curtailments. We've had steam curtailments. We've never had a water curtailment yet. But we know it's coming. So, preparing for that, having the solution that. And that's going to hit us sooner than later.

Peter Fiske: That's a very good point, very good point. Well, everybody in the audience, we're going to shift over to clinic now. Now, what we're going to do is we will – you will still have the opportunity and we'll actually unmute some of you if you're available and you can ask questions directly of Michelle and Darren. But everybody, when we – we're going to invite you to join the breakout room. When you open the breakout room, you'll see a popup on the screen inviting you to join the breakout room. Click "Join" and enter your assigned room. If you don't see the popup, look for the breakout room button in your Zoom toolbar and click "Join." For the best experience, we recommend that you use the latest version of Zoom.

Oops. Well, it's already been an hour, but that's all right. Okay, everybody, let's move over to the breakout room. Are you ready? Let's see if we can do this. Let's see how it goes.

[End of Audio]