>> **Dr. Torrey:** Good morning again. My name is Jessica Torrey. I'm a materials engineer With the Materials and Corrosion Laboratory in Reclamation TSC. And this morning I'm going to present, as part of our Corrosion Webinar Series, on prestressed concrete cylinder pipe at Reclamation. First off, what is PCCP? So, PCCP stands for prestressed concrete cylinder pipe. You may also hear this as PCP, which would be prestressed concrete pipe. And you can see here in the graphic, this is a concrete pressure pipe. It has an inner core concrete layer. And then typically a thin steel "can," we call it, as our liner, acts as a moisture barrier. And this liner can either be embedded in the core as you see over here on the bottom. Or it can be a line cylinder, so on the exterior of the core. And then to give the pipe its strength, since concrete is not as strong in tension, to give the pipe its compressive strength, a highly-tensioned wire is wrapped around the exterior of the pipe. This is called the prestressing wire. And then an outside layer of mortar. This is typically very thin—so, half inch to an inch, up to an inch and a half—protects the prestressing wire from the exterior. So as I mentioned, you may also hear prestressed concrete pipe, and that's because there's also a non-cylinder option. So it would essentially look like this line cylinder pipe here without the liner. And we do have a couple of those in our inventory at Reclamation. So, this is how it looks like, kind of in schematic. And this is how you would see it manufactured. So these are photos from a trip that I took to a PCCP manufacturing plant. The first step is they spiral weld the steel liner. This is the steel can here. And then you can see it over here standing vertically, ready to go on a pressure test machine. Then they take that out into the yard and they cast the concrete core. This happened to be an embedded cylinder pipe. So, the concrete is cast around that steel can. These are then moved off to a curing yard. Next they are moved over to their winding machine and they wind the prestressed wire around the exterior of the core. So it's hard to see in this photograph, but as they wind the—immediately prior to applying the wire—there is a nozzle that sprays a cement slurry onto the pipe. And then the wire goes onto that. And that's to prevent any voids in the haunches of the pipe which was one of the problems with some of the early manufacturing of the PCCP. This next [image] moves over to the next tower, which is where they spray the mortar coating And again, you can't see it in this picture, but there is actually two nozzles. And the first nozzle that moves from the bottom to the top sprays a cement slurry. So this is a more fluid mixture. And it fills in those voids as well. And then it. Will be followed by a nozzle that sprays the mortar coating. And these are then moved to a yard for curing and storage. And if you know Chris Duke, there's your size reference right there—Chris Duke. I do notice that a couple of people--it sounds like--still have some feedback on their microphones. So could you please check your microphone and put those on mute or silence? Thank you. Historical perspective of PCCP at Reclamation—So Reclamation specified prestressed concrete cylinder pipe from about 1960 to 1990. Currently we have just under 90 miles--I think 89 miles--of active PCCP inventory, and 48 different sections. So 48 different segments. And I'll go through our inventory a little bit later on. In the 1970s, Class II and IV wire were introduced, and there was one manufacturer in particular that produced pipe with poor-quality wire. So there were some issues with the manufacture of the wire. It was used in producing the pipe. And this was especially true with Type IV wire, but also our Class II. And

these had a fairly high probability of failure. So Reclamation had several failures and had some very expensive remediation. And after several of these, Reclamation stopped installing and specifying PCCP in 1990. PCCP manufacturing standards and design standards have evolved since then. And we've been watching that. And they are governed right now by C301 and C304 AWWA. Some of the principle causes of failure tend to start with the prestressing wire. So often, as I mentioned before, we had some cases where there was poor quality prestressing wire. And you can see over here on the right--these are some examples from the Causes and Extents Report that was issued after some failures on the Central Arizona Project. And there were instances of splitting of the wire. This wire—it should not be doing this. There were metallurgical issues with inclusions. Or isues with the—what was believed to be issues with the die when these wires were pulled so that you had striations in the wire, and it caused premature corrosion of these wires. So defective prestressing wire was a big one. Another one is incomplete encasement of the wire with mortar and cement slurry. So initially when these were manufactured, the cement slurry was not part of the process. And so there were voids at the haunches. And so the prestressing wire would get wrapped immediately onto the steel core. You see the last bullet point there is carbonation of the mortar. Or the concrete core. So if a core sat too long in the yard and the conditions were right, you could actually get carbonation. And this is a chemical reaction that causes the pH of the concrete to decrease. And the pH of the concrete is what protects that prestressing wire from corrosion. It passivates it and causes the corrosion reaction to slow down immensely. So when these wires were wrapped immediately onto the core, you often saw line corrosion at the point where the prestressing wire sat on the core. [Overlapping voices]. Becky, if you're on the line, your microphone is still on. Could you please turn that off? Becky, could you please mute your microphone? [I'm trying to find it, I'm sorry.] Okay, thank you. And, maybe Bill Petross, you're coming up as a speaker too. If you could try to mute your microphone. Thank you. So, just to continue. As I mentioned, you can have carbonation of these prestressing wires, and that will lead as well to low pH, which leads to premature corrosion. Often, as you see in this photo from the Ak Chin pipeline—which is an inspection that we did recently—it's hard to tell with the crack comparator here, but this mortar that came off the exterior of this pipe is only a half-inch thick. And so if you think about what we specify for mass concrete, we specify three inches of cover over our rebar. And for prestressed concrete cylinder pipe, which has a really highly susceptible wire, we only specified a half-inch to an inch of mortar coating. So number one, that's highly susceptible to influx of chlorides and other things from the soil environment. And it's also susceptible to cracking once corrosion does start. And then this just accelerates the process. Something else—and this was kind of an anomaly at Ak Chin—we saw a crack in the mortar and this actually extended across joints and to the core. And we believe that this was caused by an overburden event. So at some point after this pipe was buried, this particular section was in an area where they were driving large machinery over the top of the pipe. And we believe this was actually an overburden event. But then this crack in the mortar leads to moisture getting in there, the wire's corroding, and then you basically release all your compression that the wires are applying to the pipe and you can get catastrophic failure. So, some of the failures that we've had at Reclamation. In 1984, the first one was on the Central Utah Project, Reach 3 of the Jordan Aqueduct. This failed only one month after going into service. Defective wire was found to have longitudinal cracks and it was also wound exceeding its specified tensile stress. So that made it more susceptible to corrosion and failure. Remediation in this case was a lining—a steel liner—of 2.3 miles of this aqueduct. And it was a cost of about five million dollars in 1984. The next series of failures or problems that Reclamation experienced was on the Central Arizona Project. In this case, these are the largest prestressed concrete cylinder pipes in Reclamation's inventory. They're 21-foot diameter and they were constructed in the field from 1975 to 1980, about six-and-a-half miles. And they started seeing problems with these fairly early on. 223 sections, or units, were exposed and 40% of those were found to be distressed and in need of repair. 10% needed replacement. So the total estimated cost for implementing these repairs in 1990 was 117 million dollars. So, quite a large expense. And that prompted a lot of research: failure analysis at Reclamation and through outside contractors, metallographic analysis of the wire, petrographic analysis of the concrete. And in 1990, Reclamation stopped specifying PCCP. So more recently, in 2015 and 2016, two failures occurred on Reclamation-built prestressed concrete cylinder pipe. One on the Santa Clara Conduit, on the Central Valley Project. And another on the Kutz Siphon, which is on the Navajo Indian Irrigation Project. That has since been title-transferred to BIA. But we were called in to do emergency—to help with emergency repairs on both those installations. The Santa Clara Conduit failure. Here's some photos on the right. As I said, this type of pipe fails catastrophically. So very often you do not have any warning that it's going to fail. And it does essentially blow up. This occurred on August 1st, 2015. These were ten-foot-long sections, eight-foot diameter. And one section failed, as you can see. But it actually affected the two adjoining sections. The failure mode was determined to be corrosion leading to broken wires. And this section happens to be in an area of corrosive soil. And the mortar was found to have microcracking as well as some carbonation. And here you can see a petrographic analysis of the concrete core and some carbonation. As well as some unusual splitting of the wires. We did do a metallographic analysis of the wires as well. And we found some interesting inclusions in the wires which we couldn't directly link to the failure, but it wasn't something that we would've expected in the metallography of those wires. Again, the emergency repair—they replaced these sections with cement mortar lined and coated steel pipe. You can see here, sections waiting to be installed and them lowering a section into the repair area. The second failure was the Kutz Siphon. This was quite a bit larger pipes. So this was a 17.5-foot diameter section and it affected two--I apologize, that slide is wrong—two 20-foot sections, so 40 feet total. Concrete and water was projected, or blown, about two hundred feet away in this case. And we lost about a thousand CFS of water into the San Juan River. One of the most important aspects of this was it put 75,000 acres of land out of irrigation service. And so there was quite a lot of necessity to return this pipe to service as fast as possible. Again, failure mode was determined to be corrosion, leading to broken wires. And you can see here some of the corrosion staining in some areas of broken wires. In this case because of the large diameter of the pipeline, it was very interesting repair. And they ended up bringing in four ten-foot-long sections of bare steel. You can see this—they actually had to close the highways to bring this in. They had a police escort. And here's these sections being dropped in and welded in place. Here's the final section. Again, an image of the repair. This was filled—in order to get this in service as soon as possible, it was backfilled with CLSM with no corrosion protection. So, this was 40 feet of steel which was electrically connected to the two adjacent PCCP sections. So there was 80 feet of pipe that required corrosion protection. And then about a year later in 2017-2018, they actually came in and lined the steel sections with epoxy. And we designed a cathodic protection system, and a contractor installed that to protect the exterior of the pipe. The steel repair section and the two adjacent PCCP sections. Some of the lessons learned that came out of these recent failures was definitely that prevention is the key. So, know your system, do a risk assessment. We recommend regular electromagnetic inspections for wire breaks. So here I have three to five years. That's if you have known wire breaks. If you've been regularly inspecting your system and you don't have any problem, that can push out to ten years between your EM inspections. But then once you have that information, timely action to address the problems or institute a more frequent condition assessment program is needed. So in the case of both Kutz and Santa Clara, they had had prior electromagnetic inspections that showed problems in the sections that failed with wire breaks. Another method is to install corrosion protection. So, this could include cathodic protection. And I'll talk a little bit about that. There are some issues with cathodic protection. In the past, CP has actually caused some failures because it was turned up too high, essentially, and the wire was overpolarized. That can cause hydrogen embrittlement on the prestressing wire. But it can be an effective means for some additional protection on your pipe. And then—to schedule future repairs and replacements for deteriorating sections. Because as the last bullet says, we know that maintenance and planned repairs are much less expensive than reacting to emergency pipe breaks. Some other lessons learned for preparing for the future emergencies. It can be prudent to have spare replacement sections and butt-straps on hand. So especially if you have unusual sized pipe, like the 17.5-foot diameter at Kutz. Those are not readily available necessarily. And so having those repair sections on hand can really speed up any repairs that need to happen. And being aware of what your designs are and having some design ready for future replacements, as well as an emergency action plan. So, from these lessons learned, and kind of motivated by the recent failures, we undertook several programs at Reclamation. And the first one I'm going to talk about is a program funded by the Science and Technology Office to look at condition assessment repair and replacement options for PCCP. So, out of our 89 miles of PCCP in the Reclamation inventory, you know, most of it is unique. So we really do have to take a look at each section, and there's no just one-off prescription. But some of these condition assessment techniques are applicable to all of our inventory. And this is—I'm going to give the reference for the report that's coming out of this. But by September 30th, we'll be issuing a technical memorandum report with much more detail on all of these condition assessment and repair methods that I'm gonna go through. So, one of the first things that is fairly easy to do is to do a site evaluation. And so this includes topographic or geologic evaluations. So, looking for areas and being aware of areas where you have near-surface groundwater or high corrosivity soils. Or arroyos or washes, for example, where you might have wet/dry cycling throughout a season. And then as well, locate any man-made features that could increase the corrosion potential on your pipe. So this could include electrical transmission lines or foreign line crossings that could cause stray current on your pipe and corrosion problems. As well as roadways where they might use de-icing salts which would increase the chloride content in your soil, and again accelerate corrosion of the prestressing wire. And then, as well, you can do soil resisitivty surveys or soil sampling followed by corrosivity laboratory analysis. And this can help determine the corrosion potential of your soil. Another non-invasive—so these can all be done from the surface—method is to do a potential survey. And there's several papers out there that are referenced in our report that's coming out. This includes pipe-to-soil surveys, also called close interval surveys or cell-to-cell surveys. And these are conducted above the ground. And it looks at the potential gradients in the soil. And based on those gradients, it can indicate whether or not corrosion is occurring. For the close interval surveys, this does require that you have electrical continuity of your pipeline. So, section to section. But the cell-to-cell survey has been done on sections that are not bonded. So there are some options there for doing some surveys looking for corrosion that do not require excavation of your pipe, or dewatering. These next all require, for the most part, some dewatering of the pipe or some other kind of more invasive tools. So, the first one is a visual inspection. This is where you just go walk the pipeline looking at the pipe interior. In particular you're looking for cracks in the core, leaks at the joint. You might see scour. Or you can also have problems—at some of the Reclamation facilities where the water is so pure, it will actually eat away and dissolve the concrete. So a visual inspection can tell you a lot about the condition of the core of your pipeline. Acoustic inspection kind of comes in two flavors. We have the manual soundings. So you're in the pipe and you're actually using a rod or a tap hammer or something to just listen for, you know, tap your concrete core and listen for that hollow sound that's created when there's delamination of the concrete. And this could also reveal ungrouted areas at the joints. Similarly, but a little bit more quantitative, is the impact-echo testing. So this is actually services offered by several commercial companies, and they have more sophisticated transducers—a series of transducers—set up so that when they have a known impact to your concrete, they have an array that can then listen for these delaminations or hollows around the circumfrence of the pipe. This is typically done as a systematic inspection. You know, every "X" many feet, they'll put this array and do a sounding. The second type of acoustic inspection is through free-floating acoustic sensors. So the one that most people know commercially available is the SmartBall technology. So, this is mostly looking for leak detection. And these you do not have to dewater the pipe. So you would need access to the pipe. These are typically inserted via a manhole. And then the flow of the water and the operational pipeline carries these along the pipe, and they listen for acoustic anomalies where you would have water escaping the pipe. And then they are captured at some point, either through a manhole or going out to a reservoir or captured some point downstream. The next condition assessment technique is electromagnetic inspection. This is one of the most widely used techniques to determine how your pipe is performing in the PCCP industry. And this is essentially using the continuity of the wires in an electromagnetic field to look at the continuity of the prestressing wires. So, this will tell you the number and location of the prestressing wires by stick of pipe, essentially. so you look for clusters of breaks. And that's where you become most concerned, is when you have a series of breaks all in sequence. And this technique can be conducted in service or in a dewatered pipe. And here's an example of a photograph that I took on a recent inspection of the Pleasant Valley discharge line. This is the cart. This is a commercial service, and so this is the cart, and there's typically two people. And they move this fairly quickly. So this is at walking speed, up and down the pipe. And you can see that they do have it roped off. You can kind of see the rope here. So this was able to go down—just past where these gentlemen are standing is a downslope. And so they were also able to survey that section of the pipe. And this is what we've most commonly seen as the main tool used on Reclamation PCCP. And the final is acoustic fiber optic monitoring. This is a continuous monitoring technique. So it's an acoustic—a fiber optic cable is installed in the pipeline and left there on a permanent basis. And it listens for wire breaks. And because there's several—the bundle contains several different fiber optic cables. [loud feedback]. And whoever just joined [overlapping voices], can you please put your phone on mute? I think quite a lot of [overlapping voices]. Or your computer on mute? [Feedback]. Okay great, thank you. So the cables are installed inside the pipe [feedback]. I think—David Sosi, if you're on the line, we're still getting some feedback from your computer. If you could please mute yourself. [Okay.] Thank you. The cables can be installed in an operational pipeline as well as in a dewatered pipeline. And they require a monthly or annual monitoring contract. So you essentially contract out to the service provider. And they would contact you if your AFO system starts detecting wire breaks. Some of the more common repair methods that we talk about in our report include interior crack and joint repair. So we reference Reclamation's "Guide to Concrete Repair." This is fairly typical of any concrete repair. So a surface preparation, application of the repair product, and then curing. And it just differs in what products you might use between cracks and maybe possible larger joint repairs if you have spalling. You can also install cathodic protection. As I mentioned earlier on the Kutz siphon, this does require electrical continuity of the sections that are to be protected. So, ideally the pipe is already electrically continuous. It can be retrofitted, but that requires excavation at each pipe joint and installation of bond cables, which can be very costly. So in order to install cathodic protection, ideally those sections are already electrically connected. And then there should be caution that the wires should not be polarized more negative than -1,000 millivolts to a copper-sulfate reference electrode. And this is to avoid hydrogen embrittlement. And there is a NACE standard that outlines some of the needs for cathodic protection of prestressed concrete. The next method which was used extensively on the Central Arizona Project—and there's a picture from a Tucson area pipe repair over here—is wire splicing and tendon wrapping. So this requires—this is an exterior repair method. It does require excavation of the pipeline. So it can also be very expensive. But essentially you use anchor blocks and tensioning devices to either repair small sections of the prestressing wire--so you would remove the coating and remove the existing wire and actually splice in prestressing wire sections. Or, in this case, to install exterior tendons. And this then provides that compressive strength for your pipe that is lost when you have damaged prestressing wire. Another common repair method is the interior structural liner. So this is an interior repair method. And it can also provide the structural support for distressed sections. So some of the common methods are just a steel slip liner. In this picture, you can see carbon fiber reinforced polymer, or CFRP, being installed on a section of pipe. And then as well, there are spray-in-place pipe applications. Some of the newer technologies involve, actually, robotics that can go into the pipe and put in a fully structural carbon fiber with epoxy liner. So as I keep mentioning, we have a lot of current activities going on in the Technical Service Center and in Denver with regards to prestressed concrete cylinder pipe. The main one—and you can see the cover of the report right here—is a Science and Technology Program funded research project. Actually, projects. One is wrapping up right now. And here's the report number. And I have a link later in the document for you to access this once we get it submitted and uploaded. So, this will be on PCCP condition assessment, repair, and replacement strategies. And we go into much more detail on some of the techniques that I've just been talking about. We include kind of a general overview of the method, the logistics of the method, and then we try to give a kind of order of magnitude cost analysis, as well as schedule information for each of the techniques that we talk about. And again, that will be available end of the fiscal year. And then we have a new project that's kind of just wrapping up. We started in FY19, but had some delays in finding pipe. This will be on a PCCP educational demonstration. And we actually are working with Tarrant Regional Water District to bring two sections of 90-inch diameter PCCP to Denver and install them in the courtyard here. So that when some of you may come for our Corrosion School, we can actually have a hands-on demonstration of how to do some of these inspection techniques, including the visual inspections and the soundings. We might look at electrical continuity test, which I didn't mention today but is in the report. So that's pretty exciting. We hope to be getting that pipe in October. And so we'll keep moving forward—that's a three-year project to get that set up and to get some educational materials produced in association with that installation. The second part of the current Science and Technology research project that's wrapping up is to do an inventory of our PCCP at Reclamation. So, in Denver we did not have a detailed GIS inventory of all the Reclamation-owned PCCP sections. And this became a joint effort between the Research Office and the Policy Office, and has resulted in a web-based GIS viewer that I'll be demonstrating in a minute here. And then finally, we have, out of the Policy Office, an effort to do electromagnetic inspections for Reclamation PCCP. So this is funded and awarded contract, again out of the Policy Office, on some of the prioritized Reclamation-owned PCCP installations. And we've started with some of the ones that had never been inspected before. And TSC is helping to coordinate and facilitate those inspections. We hope to be able to compile all of this inspection data into our GIS PCCP viewer database. And, as well as part of that, the Water Conveyance Group is producing a "Risk Analysis for PCCP" report. And I have the report number up there. To start with the inventory. So, we set out to create a tabular inventory of Reclamation-owned PCCP. It started just as an Excel spreadsheet. We collected basic pipe specification information. So age, diameter, length, operating pressure. We started to collect documentation of this. So design data, as-built drawings, specifications, inspection reports. We wanted to know if there was cathodic protection on all of these sections, as well as any details of repair and replacement. The table you see in the slide is a summary of our current active inventory of PCCP at Reclamation. And all of this was then put into a viewer. I'll demo the viewer here in a minute, but some of our goals for this geospatial viewer was, number one, to confirm our start and end locations and alignments. You know, visually, on a map. So, that helps those of us who are either responding to questions about PCCP or if we have to have emergency responses, to visualize those locations. As well, to identify the sections that are in proximity to high risk areas. So we have a lot of—not a lot, but some of our PCCP installations were previously in very remote locations that have now been encroached upon by communities. And so these are becoming higher-risk sections of pipe. We started to populate a master table. So, some of you may have seen our request for information go out where we were asking for some of the details of that pipe. And that allows us then to manually query our database. So we can immediately search, for example, for any pipe with a high maximum operating pressure or a high number of wire breaks. We then tied this master table to our graphic data table, which allows us to bring all of this into a map-based viewer and provide snapshot summary boxes, as well as some tabular information with extra information. We started, as I said, to collect those relevant documents. So those are now linked through the viewer in a database that can be continuously updated as we get more information. And then some future work is: as we do our electromagnetic inspections, we hope to eventually be able to visualize either our wire breaks and/or our risk assessment for each section of the pipe along a pipeline—along an alignment—by section. Color-code those based on their number of wire breaks or risk projections. So, I'm going to try and switch over to our PCCP viewer. Here we go. So hopefully everyone can see that. Let's close this for now. So, first of all I wanted to show the summary over here. So, let me see if I can... alright. You can see a few spots here if we start to zoom in. These red areas are our PCCP sections. We just have a snapshot summary over here. So you can very quickly see, we have 48 sections of PCCP, and here's how they are distributed by state. We're able to put different layers on here. So right now we're looking only at the PCCP layer. We're also able to insert the BORGIS water carriage layers. So you can see immediately that populates some of our canals, primarily, and shows those also on the map. Down here we have our tabular data. So, right now we're looking at our main PCCP tab. You can also narrow it down to our abandoned—we have, on the Central Arizona Project, three sections of abandoned PCCP that could possibly be used in the future I guess, so we don't want to lose the information on those. And then as well, a tab on the active sections. Quickly I'd like to demonstrate some of the features. So there's a bookmark feature. And I just had our database guru make me a couple of bookmarks. First we'll go to the Pleasant Valley discharge line. So, there you can see. On the map it goes right to that section. We'll zoom in, and if we click on that section, it'll do a snapshot window with some of the main features of the pipe. So we can see what region it's in, the area office, the operating entity. This is owned by Reclamation. As well, some of the physical information on the page. So, length, diameter, and a max design pressure. We can also... Add different map layers. So, if we wanted to go to our basemap gallery, we can, for example... Turn on one of our topographic layers. And you can start to see what that pipeline looks like in relation to, you know, there's farmland over here. There's a cattle farm over here, I believe. Some livestock yards. So, you can sort of see now where that falls into with relation to roadways and other features. As well, when you... oh, so if you're on the PCCP tab, it will also immediately go to that Pleasant Valley discharge line... entry in our table. And you can scroll across to see quite a lot more information on the pipe that we've been able to collect. You'll see some empty columns. But, you know, we're continuing—some of those I don't have information. It's not required, it's not applicable. And some of them, we're continuing to work on collecting and updating. As well, we can go to the link here for the document repository. And that will take us to any documentation that we've collected so far. So, for example, here we have... Oh, doesn't want to let me do it. That's a designers operating critera. That's a DOC, if you believe me. And then this is gonna be some as-built drawings. Okay. One of the other features is that we can also run a query. So, for example... If I want to look at—when going through our inventory, we had pipe that we thought was PCCP and it turned out to be bar-wrapped pipe. So, we didn't want to lose all the information that we collected on those sections. So you'll see those as BWCP. That's bar-wrapped pipe. But if we want to go to PCCP, for example, and then, our very large 252-inch diameter and apply that. That will now take us, essentially, to Arizona. And the Central Arizona Project. And I'm gonna turn this back on our... topo layer. And you can see it doesn't look... You know, there's just some very small sections, but these are our siphons. But then if you go and turn on the water carriage layer, you can really see how these are connected by our canals. And you can see how the whole water carriage system is operating. So, I'm just going to zoom in on one pipe, here. This is our Ak Chin pipeline. And... So, another thing... So, that pulls up our Ak Chin pipeline here. And again, you have your document repository. And one of the things that happens to be in here is one of our condition assessment electromagnetic reports. So, hopefully we'll be able to keep updating these as we get more documentation. And this can be a really functional resource for everyone who's dealing with PCCP. And then, just to show a few of the other features. So, we have some analytics features here. So, this one basically will just show, as you zoom in and out, how many... pipes sections we have in that area. So, 29, 7 before, you saw that change. We can also do this quick summary table, which not only shows the count, but also the length and miles. We have some information now on the carriage type. So, is it a discharge line, is it a pipeline, is it a siphon, is it a gravity pipeline? And I think that's all that I was hoping to show you. So, hopefully—I did include a link to this viewer. It unfortunately is only open to Reclamation staff. So, only Reclamation staff are able to access it. And we're working on some of the long-term maintenance and how we plan to sustain this long-term. But it is available and it's up and running. So, as I mentioned, we've got—so, I've got some resources here for you. So, in the TSC Materials and Corrosion Lab, we've been the PI's on the S&T research projects. That would be myself and my colleague, Matt Jermyn. And there's links here to the project pages for both of the research projects. And as we get those final reports submitted and the research office can get them uploaded, those will become available on these websites. In our TSC Water Conveyance group, Kylie Pelzer and Chris Duke are doing most of the work for the inspection and coordination of the electromagnetic inspections. They've as well helped on and been part of the research projects. So, they're a very good source of information. And in our Policy Office, Asset Management Division, Nick Casamatta is the water conveyance manager. And he has been instrumental in the inspection contracts, and then will also be taking over management of the viewer in the future. So, he's a great resource there in our Asset Management Division. And then, finally I put a link down here to our Corrosion Webinar series. So, that will take you to the TSC training website where all of the webinar slides are posted. And hopefully the videos at some point soon. So, with that, I thank you very much and will take some questions, comments, discussion. And here's our Materials and Corrosion staff. So, please feel free to turn on your microphones at this point. Or I've got some of my colleagues monitoring the chat window. And you can type questions in the chat window as well.

>> **Dale Hamilton:** Hi Jessica, this is Dale Hamilton in the Provo Area Office. I was wondering where the link is for the GIS on the PCCP.

>> **Dr. Torrey:** Sure, so that's gonna be, um... Oop, right here. PCCP Viewer Demo. That contains the link to that. And if you want to shoot me an email, I can also send that to you by email.

>> **Dale Hamilton:** Okay, I'll shoot you an email. Thanks.

>> **Dr. Torrey:** Great. Any other questions? Comments? Any questions in the chat window? Alright, well thank you everyone for attending. I'm gonna stay on the line for another five minutes or so. And so if you think of anything or are having trouble somehow unmuting yourself, I'll be here to answer questions.