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Stonework for Trails
Thursday, February 26, 2026
10:00AM - 11:00AM Pacific

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>> CANDACE: Thank you, everyone, for joining us for this free, live webinar, Stonework for Trails. My name is Candace Gallagher, Director of Operations and Webinar Coordinator for American Trails. This is our 305th webinar in the American Trails "Advancing Trails" webinar series. This is the first of three webinars in a series that we are hosting this winter/spring in partnership with the Professional TrailBuilders Association. This webinar is being recorded and includes real-time closed captioning in English and also offers learning credits. This live webinar is free for anyone to watch for up to 24 hours. American Trails members can access the recording and learning credit quiz on the webinar's web page. I just shared a link to the quiz in the chat box. Members just need to enter their e-mail for access, and if you're not yet a member, once you sign up, you can gain immediate access to the quiz as well as all of our archived webinars. And a special thank you to VZP Digital for providing captions and a transcript for this webinar. If you're ever in need of another language for the captions or transcript, please just let us know. And we hope you will consider donating or becoming a member of American Trails if you're not yet to keep these webinars produced weekly and free to everyone. You can visit americantrails.org/join for membership and donation options. A special thank you to our Trail Champion Members who are noted on the screen. And I want to thank our webinar partners today that include iZone Imaging, Professional TrailBuilders Association, Terrabilt Wayfinding Systems, the Department of Interior, Bureau of Land Management, National Parks Service, and U.S. Fish and Wildlife Service. We also want to thank the GrizBurger Fund, a donor-advised fund that belongs to two regular, working people who really love trails. They encourage everyone to learn more about donor-advised funds and how to use them to increase support for American Trails and the education that we provide. And I'm happy to introduce our presenter for today. We have willie Bittner, owner of Great Lakes Trailbuilders. Before I pass it to Willie, I will pass it over to Aaryn Kay to share more about PTBA.

>> AARYN: Thanks, Candace. We are the non-profit association for the trail industry and represent the trail sector industry and those who build trails worldwide. Our mission is to advance the trail industry by promote quality and professionalism, strengthening the workforce pipeline, elevating member companies, expanding training and education like this webinar, grows visibility, and positioning trails as essential infrastructure for communities worldwide. Next slide, Candace. I just want to highlight it's our 50th anniversary. So PTBA was started in 1976 with eight companies; and then 50 years later, today, are 153 member companies worldwide and employing thousands and shaping trails around the globe. Next slide, Candace. And I just wanted to let you know about the 2026 Sustainable Trails Conference. We're excited to head to Boise on April 14 through 16. We hope you will join us for two-and-a-half days of

education, networking and hands-on learning. And I just wanted to flag a couple resources on what PTBA have been involved on. Trailskills.org. You can check out competency and breakout and create a profile. It's just a really amazing resource managed by American Trails. And then just a few other resources that we have on our website. So we have been growing these resources as we try to support growth and professionalism in the industry. So you can go to trailbuilders.org and check out, you know we have trail project life cycles, details on trail contractors. We have webinars PTBA has been a part of, we have on our website as well; information about starting a career in trails; starting your own company. Then we have a fundamentals video series. And I just wanted to flag that because today we got the exciting news our second video is coming out this week. So we'll do a six-part video series really on the fundamentals of trails. So they're just short, five to six minutes, but we're pretty excited to be developing this resource that could be integrated into trail trainings or just used on their own for basic education. With that, those are the things going on with PTBA now. Willie Bittner is the president of the board of PTBA and am excited for him to do this webinar on stonework.

>> WILLIE: Thank you, everyone. Great to see you all out there. This is a change for me doing a webinar. I like to do hands-on presentations and training, so I'm excited to be able to do this webinar to be able to have all this information out there for people. It's really focused on stonework for trails, just like it said. Background: I have been doing trails almost 30 years now and fell in love with stone from the very beginning. I my work has taken me coast to coast, internationally from starting conservation corps, being a member of a company on the East Coast with Peter Jensen, and starting Great Lakes Trailbuilders in 2008. I love stone -- you know, probably ooze out of me in this presentation. I'm excited to share a lot about it with you guys. So starting the presentation off. We'll go to the next slide, Candace. So understanding stone. As far as like trails go and talk about stone, you have to start at the very basis of it, so a little lesson here, science lesson to start off, talking the three types of stone we have in this world. We have igneous stone, molten, cooled rock with some of my favorite stone to work with, granite. We have basalt and obsidian. They get challenging as they get further town the line Basalt is a fine-grain volcanic rock found all over the world and can be challenging to read the grain compared to granite. Obsidian is glass-like. Sedimentary is compressed sediments. I deal with that in the Midwest a lot. Candace is putting a poll on this slide to see what rock you deal with in the area. I'm excited to see what kind of the main rock that you guys deal with. Underneath sedimentary you have the sandstone, which if you're in the Desert Southwest in the U.S., you're dealing with sandstone. That's what you have. It's really great traction and workable. Other areas you wouldn't really touch sandstone if you could. You have limestone, a wide variety of durability and construction. You have dolemite, which, in the Midwest, if I can find that in my area, that's what I'm working with. And then you have conglomerate stone and sedimentary. If you can avoid that at all cost, man, your project will be better. You have the metamorphic stone changed by heat and pressure. You have slate in certain areas, which is really great for flagstone work. We'll talk about that on trail. You have marble. It's workable and softer and sometimes in areas where that's what you have to use. Then you have some of the hardest stone to deal with, which is quartzsite. It's durable but taxing on equipment and body when working with it. Then it schist. Nobody likes

working with that but have to in the areas. You have schist. Nobody likes working with that, but you have to. Look at you. Granite is going heavy with limestone and sandstone in there. Some people don't have stone; so yeah, really great to see where you're all coming from there. Candace, we can head to the next slide. So as you're kind of looking at your project and stuff like that, we're gonna talk about the stone versus wood comparison. Stone, you're looking at a lifespan of 100-plus years. It's fire resistant; maintenance is pretty low. Your initial cost is higher, and the long-term cost comes lower. So compared to timber, you're looking at 15 to 25 years, poor fire resistance. Maintenance -- you know, actually moderate to high because you're looking at replacing. The initial cost is lower, which a lot of people like; but then you look at the long-term cost of higher. On the photo on this slide here, it's a staircase and the boundary water. The one on the right is in wood, done 30 times by an engineer who put that in place. The replacement put in there is a stone to the left. It's a perfect example of wood-stone comparison in the field before I had to rip out the wooden staircase there. So kind of continuing along now, like what makes a good trail stone? You know, you're looking at the density of stone, the shape of it. If I can find all my stone right near the project that you're doing, that's great! Then stone is, you know, readily available. Does it match the stone in the area? That's really nice. It's not always done. The CCC, when they did all their work in the U.S., if you're attending from the U.S. around here, they like to use certain quarries in areas so you can see some stone doesn't match the stone in the area. They found a quarry up or down from that, that they use in a lot of their projects. A good example is Northshore of Minnesota. You see the same stone in every state park along there, and it's -- but you're not seeing that stone all along the Northshore where it is. So different things. Fracture planes are in there. That can be working with it, with the stone. We'll give some examples coming up here further. We'll head to the next one. So stone selection in the field. When you're looking for stone, you're looking at kind of the projects. You're looking for, you know, the natural faces that it might have and looking for riser, tread stone. We're kind of in the section of weight versus stability. You want to set as big a stone as you can, but make sure it's stable. That's really hard one to describe to you guys over the thing right now. It's something that's a little bit easier down in the field as you're weighing it out. Avoiding that layered fracture stone -- if you're seeing fractures already in the stone as you're assessing it in the field, you want to avoid it because once you get that, you're rolling to the trail or the weather on the trail is really gonna affect the quality of that stone in the long all of it. So we're going to go over photo of some field selection stuff of some stone. We can go on to the next slide, Candace. So this slide here are two different examples. One is at a project where I was able to slice this piece of stone 15-foot sections by 2 feet by 8 inches and get, you know -- I got six stones out of each of those slabs there and went down on a high line to work on the project. It was great looking at New York State there for that project, Mountain State Park. On the right, the local availability of this stone, this is in Argentina, a project that OBP TrailWorks and I saw last spring. This is redesigning the trail going to one of the more popular vistas in Chelten, all the stones there. insanely thrilled about it and is in the field and don't have to move it there or anything. We'll go to the next. Sometimes in here as you're getting a spot that you actually just shake the stone that's the bedrock that's in there. This is on the state park in Northern Minnesota. They're actually just shaping the stone into a step right there during a training. So we'll hit the next slide here. Another

sample of in the field. They're able to get this stone right in the field. You can see on the left side we're able to take the top off and get a nice face of the stone there for, to be able to work with in the field. On the right-hand side you're looking at a giant stone that had some rifting, and that was actually during a stone-splitting demonstration at a PTBA conference in Tennessee. So you don't always have the, you know, stone that's in the field. You know, sometimes you're actually looking at bringing it in from the quarry because the project that you have requires that. So dealing with the quarry, each quarry is different. So identifying the terminology within the quarry through actual samples. that's one thing I will try to put out here in this webinar. There's some things you guys can pick up as land managers or other professionals about some, you know, things that take on. Choosing the correct size out of the quarry. Make sure you're on the same page and getting the correct size ordered because if you have stuff too big and need to do additional shaping, you know, it can really add to the time of the project. Avoiding in that quarry, avoiding like blasted stone. If you're in a quarry and they're blasting all the stone out of there, that's something that we're really wanting -- you know, you're really wanting to avoid. You get a lot of small cracks and fractures in the rock, which can really break down the quality over time. Sometimes you don't have the option, but if you can be able to get good photos or actually get into the quarry, that's really great to be able to do. Go to next slide here. That's a stone coming out of a quarry that was able to split seven steps from the stone. So the sizing, that came from a quarry was significantly off, but the nice thing is as I was able to manufacture the stone right in the field for the project. We can go to the next one. Managing stuff coming out of the quarry. Another quarry here -- this is a project, a neat project that I worked on with Peter Jensen and Associates on the East Coast. The quarry was basically created on site for the project, and we were able to work with the stone out of the quarry and shape it ourselves and did accessible trail and a lot of stone work along the accessible trail system on the project. That was in New Hampshire. Go to the next one. So both -- this stone is actually coming out of a quarry and delivered to the project site. Once it was delivered to the project site, it was shaped into things. We're dealing with basalt here. It's solid, some of the best I have worked for. This was a volunteer training event. Okay. One more thing. So, you know, comes out of a quarry, you can get some really nice stone. This here is a piece of granite. This is at a CCC event in the early 2000s, and there's actually a couple of CCCers at it, which is really neat to kind of talk with them about the stuff they learned, you know, back in the late '30s, early '40s and will be able to put some of that to work. We can go to the next one. Oh, sorry. Oops. Types of stone structures. Now I will talk to you about stone steps, retaining walls, some step stones, drainage dips and views platforms and causeways. I will give good examples of each of those and talk through that as we're continuing on with this presentation here. So we're going to talk about -- go to the next slide. We'll talk about some of the stone steps or specification -- oops, sorry; back, Candace, to "Stone Step Specifications." Sorry about that, guys. The stone step guidelines, you're looking for a 6-to 8-inch rise in height, 2- to 4-foot depth, 12 to 18 inches of tread. That's pretty standard on that. You get above or below that 6- to 8-inch mark and you will start getting people avoiding your staircase. I'm sure a lot of people on the call or a lot of people have seen staircases people aren't using. I'll talk more about that as we continue on with the presentation. It really is in the depth of the stuff, you're looking at that tread to be able to get a good foot based on. Now all

these can range a little bit, but that stone height, you want to stay within that 6 to 8. The Forest Service guidelines I think can go 6 to 10, but above 8 inches, people can really tell. And the different terrains have a big effect on that, too. Let's go to next slide, Candace. I want to talk about the proper anatomy of the stone step here. Sorry I don't have access to my cursor on this as I'm going because I can't share my screen today, but the rise is the face of the step. It's what you're looking at. The tread is what you put your foot on. Behind and underneath you're putting in crushed rock and back file. You're trying to make it look native and natural. On the outside edge of the stone, there is a gargoyle, sometimes called a capstone like the word "gargoyle" keeping people on the trail. You can see two stones placed outside the gargoyles to channel people to go on the trail there. Okay. Next one. So setting the base stone. Last year the Professional TrailBuilders Association worked closely with the U.S. Forest Service to change trail maintenance guidelines, some of the stuff and wording in it, since the update last done in 2007. One of the things I was most excited about was setting the base stone and getting that on stone staircases. The first stone of the staircase you're setting your bearing in the ground almost fully so it's like a platform and anchor, the base of your whole staircase. That is so important, the base stone on it, if you set your first step and get that 6 to 8 inches there, over time that soil, if you don't have a base stone in there, compacts. That 6 to 8 inches starts to go 8 to 12 inches. Once the first step is too big, you ruin the flow of the train, and people try to avoid staircases. It's a lot of work, and there's money involved in staircases, so you have to make sure you're starting it off from the beginning. In all my trainings now, I really push home the setting the base stone. This is something I learned. I did a project, you know, 20 years ago, and I wish we would have set base stones on every staircase go up that trail because that first step now is really showing it on that project. So it's excavating out the depth. You're leveling the base stone. You want crushed rock to lock the outside edges. That base stone was the start of the stone for the Boundary Waters Project. Actually, I split that base stone in half and was able to use the other half of the stone further up on it. So you go to the next one, backing, back fill and locking. Next slide, Candace. We'll show you crushed material. That's ideal crush we're getting from a quarry and is in play and not having to have a crew crush it all up. It's beautiful and no mineral soil in it. It's just pure crush and get that behind and underneath your stone. That allows for water to move around the stone and allows for frost heaving to happen and really makes a better staircase. So you're going to want to make sure that if you have a big hole behind it you don't want to put in products of crush. You want to layer and compact. Put a half bucket and compact. Then another half and compact it. Make sure that you're really compacting and getting ALL those little airholes and voids in as you're compacting the rock around there, making sure you're really locking so you have no lateral movement. With this stair, you can definitely see it's locked in. On the next slide, you'll see that that step was in place and actually required that had to chisel out the stone in there to be able to lock that stone in place. You can see that is all chiseled out. You're also noticing that you can see a generator there. That was really able to help with the work, the generator and rock drill, on that. It's locking the stone in place. Let's go to the next. So here we get our step stones, and they are feature on the trail that is a hard feature to get people to use consistency. When you're varying in height around 5 feet to over 6 feet for people, as individuals using the trail, their pacing will be different. So you can have one person walk the step stones

paced out nice. The next person is not going to hit them. You're really like getting those step stones in place using some -- you'll see some, on the next slide, some log that fell across the trail to help guide people through it. If you go to the next slide, Candace, that's people helping out with that. If we go to the next slide, it's a wide-open area, and that's just step stones to get across water flow there. So the step stones are great feature to use in trail. We'll go to the next slide for step stones after the one in Argentina there. This is actually the same park in Argentina through a wetland area. This set of step stones here was -- you know, it doesn't look like it's needed in that area but is a very sensitive environment and working with people down there, they proved to be able to use step stones. It's one of my favorite areas; and five years later, people hike this trail again and no one is cutting around the grass in this. The pacing and perfection on it is awesome. So we'll head to the next slide. So causeway. Causeway feature on a trail is stone feature that is utilized. The causeway is very similar to a turnpike. A turnpike is built out of wood; a causeway is built out of stone and elevated trail. A section of the causeway allows the water to flow through the stone. You're seeing compacted dirt on top and water flowing through. This is an old logging road in Massachusetts where the water was seeping out of the hill at the base where the logging road was and the trail needed to go across this. We opted to put in a causeway here while the stone was found on site. We crushed it all on site and took a bit of time as they do, but they're really worthwhile. Low-line, flat areas. You will see them on portages, on water trails, causeways. We'll go to the next slide. This a picture of a causeway in Argentina at a park. There's no soil over the top of this one because there just wasn't really soil in that area. It's just kind of blown and dusty around, but this is -- again, this is a one step, a causeway, one step over an intermittent seasonal stream that comes through here. It's not mucking up what you would see in that stone-paved area before and after the approach. Okay. Doing well. Let's go to stone waterbar. Here's a feature that is ALL over trails on the East Coast, the Midwest, West Coast of the U.S. that utilizes insanely popular feature for years on trails and still in place in that lot of things. It's kind of being eliminated out of things. That being said, in steep fall line trails, they're still needed. You know, you're getting the water off the trail. Stone waterbars are also really nice feature. It's also a nice feature to have before you get to a staircase. So just below this stone waterbar is a staircase. This water is actually getting drained off before the staircases were going down. Okay, we'll go to the next one. So this is a stone step with a platform. So some things with stone steps with platforms -- you can see the stone that is built right in the center and the nice gargoyles on the side. This was Old Willys Jeep Road Trail in North Carolina going up to a fire tower converted almost 800 stone steps added to this trail and had a lot of fill that needed to be filled in. So we had a wide trail that needed to get narrowed and you're looking at a 4-to-5 foot step with gargoyles on the outside. The thing with stone steps with platforms to keep in mind is look at an equal distance inbetween so the cadence should be similar as you're going through there as you're pacing. One big thing with stone steps with platforms is making sure that you're not getting that surfacing grade above 5% because if you get that surfacing grade above 5%, it's probably going to wash out, and that 6- to 8-inch step will gain in height and will get people cutting around the trail. You're also getting that water slightly, you know; so either it's crowned or shedding to the low side of the tray. Also, overfiling those boxes from the beginning, because they will felt out. That's one thing to keep in mind as you're having someone to do construction

and you guys are managing it that you look at overfilling those boxes. We'll go to another one. This is another stone step with platforms. These, again, is eroded-out ATV trail, hiking trail cut. This is in Minnesota. Again, this was done during a skills training; but again, you're looking at stone step with platforms. Here, though, instead of singular stones, you're looking at four stones on the first step. You can see three on the second step and can see a variety of three to four the rest of the way up with gargoyles on the outside. Then you have the natural surfacing with the, trying to feather in the trail and make it a little tighter of a corridor here. Okay, we'll go -- oops -- go to the next one, too, Candace. Sorry. So this is fundamentals of retraining wall. You just want to talk about some of these, and then we'll hit retaining wall where I can show you a little bit more. You want to bury that first course at least a third, even fully if you need to. The patter back into slope will be in play. I will show you on the next slide a little better. Tie stones going into the hill. You can see some of the stones running the length of the trail. The tie stone going in is, should be going instead of parallel with the trail, perpendicular with the trail. Sorry; I can't have my cursor working for you. And then you can see the crushed stone which is drainage behind the wall. You want to make sure that wall is going to be able to drain out. The nice thing about doing retraining walls out of dry stone is you have a lot of areas for the water to go inbetween the stones and for the wall to be able to move around with that dry stack method. That's what we're talking about throughout the day here. Okay, jump on to the next one. Another one of the quick stone staircase here -- sorry to layout. I seen a second one. This is one that I will have in like design stuff and shows you, again, like the stone staircase. Those red marks there is the outside contact. You really want, when you're standing on that, there's no wiggle. You're really making sure that's solid, that step. You can see the gargoyles in this stone staircase are really blended well with the stone and are getting high, outside contact on those gargoyles. You're keeping the fill behind the steps from being able to come out. We can go to the next one, Candace. So this is just like a little small staircase but good example of how you protect your staircase. This is a trail that just had two steps in it and was eroding out. The two steps here, there's a base step buried in front you can't really tell and there's water. There's the drainage behind it. So kind of like the stone waterbar, that's just a drainage behind it and taking water off the trail. You protect your stone staircase. We'll go to the next one. So here is more retaining wall. We can kind of talk about this a little more here. So here is a project worked on with Peter Jensen and Associates on the East Coast in Vermont, a complete blow to the trail. They wanted replacement instead of a bridge coming in there so it ended up being like multi-tier retaining wall, as you can see. It was close to 16 feet tall just getting up to that blue arrow side. And then the back retention there and constant waterflow. The section blew out because the road got redesigned above it, and the watershed changed and really blew out this section of frail. But the nice thing is here is you get a good example of the batter. That's the black line. That batter is going into the hill there. The crib wall setting, you're looking multiple points of contact on the stone on that front edge as you're building this up. This, the crib wall, the base of this, is set on a rock ledge, what happens a lot in crib wall construction and trails. If you're not being able to bury that stone because you're setting off rock here, we weren't able -- notch rock is very hard. We set in 1-inch stainless steel pins we set this whole thing off and there's over a dozen stainless steel pins that went into place there. You're seeing the green dots on the outside. The water flow where the blue arrow is coming

across the trail is a constant flow of water on this section. It's an example of a crib wall. Most materials are captured on site here and was only a short section of trail but spent a good month in on that project. Go to the next one. So check dams. Check dams can happen in a series of ways. This is a check dam actually in and above the project of the crib wall from just before, and this is slowing the water down. You can see some of the stainless steel pins that we placed in the water charging up. We wanted to slow the water down. This happens a lot more commonly on trails where it's actually eroding out the soil, and you're create the check dams with stone or sometimes wood, too, because that's available; but you're trying to slow the water flow across the trail. These are always happening on topside of the trail so before the water actually gets to the trail. When the sediment fills these in, it becomes an area that can be revegetated and sometimes gets a lot of the natural flora -- you know, florae, faunae coming back into the area. In areas again where it's really steep, you might be looking at a series of check dams. We'll go to the next one. This is just a unique feature here. This is actually stone steps that are built over where the water is flowing out. On the right side, you can see a rectangle of shade there. That's actually where drainage is coming out off the slope. Those four, those five gargoyles above are going from ledge to stone, and there's a little gap underneath. A colleague recently went there and said this did get on that. So some of the access challenges. You know, getting the stone into those areas, you're looking at the materials transport to getting it there. That can be an overland way or can be in an airway. Every location, they're getting the materials. Sometimes you have strict wilderness restrictions so you're not ability to, you know, get materials in or be able to use things with the mechanical advantage. Sometimes you're hand-splitting the stone because of the woodlands regulations. You're not able to use any sort of power tools. And then you have the rigging time. You know, moving stone by rigging, as fun as it is, is also very time-consuming process and just adding, why stone can cost more on a prong. Just getting the access in there and the challenges that. This project, all the stone was readily available but was actually a fern species that can only be identified in the lab that only allowed us to use stone that was in the trail corridor here, redoing some CCC stonework. So, you know, the protections in place can be really strong at points. Let's go on to the next slide, Candace. We're on rigging and moving stone. Here you have the griphoist and what you need for rigging and moving stone. You have the griphoist and rock bars. I have been using rock sleds a lot, moving stuff over the ground with ice fishing sleds retrofitted, highlines in place. You have crafty ways people are moving stone around. In the photo you're seeing right now, that's a step on a highline that is a project in Bear Mountain State -- no, that's Chapel Ledge climbing area in Massachusetts. We're able to really drop stuff right in place for that be. So go to the next one. That's what you can see. That is actually Bear Mountain State Park in New York, and those stones were dropped off a 300-foot highline virtually right into place there, which ended up being a really fun project to tackle. You can see those stones on up hillside. A lot of those have shifted around to make that look like the stones were taken right out of the or were chiseled right out of the stone in place. It was GREAT stone to work with. It was a project that was done with volunteers, really neat one. A lot of you may have heard about it, over a thousand stone steps, won a lot of neat awards. I was happy to be a part as a trainer, volunteering to get it up and learning and learned a lot from volunteers in that. So I will go over some examples. I got about like ten minutes before I hit some questions here and will go over a

series of examples of projects and kind of talk through some of the challenge about them. Then we look forward to answering you guys' questions afterwards. So here is Superior Hiking Trail staff and Volunteer Training Project. Native stone shaped on site with hand and power tools. We moved everything around with rigging and highline, and everything needed to be completed in existing trail. On the left-hand side you see what it looked like before the scramble. Then you see the right-hand side of what the volunteers and staff were able to put in place during their week of training. That's on the Bean and Bear Hike Loop in Minnesota. You can go to the next one. Okay, this is a little "before." This is a project that was done last year in my hometown here. I ended up going a solo project and tackled this solo. You see the staircase. I was able to get materials relatively close but needed rigging to finish off. It's "before." You can flip right away to the "after," Candace and maybe go back and forth a couple of times to see the staircase going in there. It went right through a sandstone ledge on that. Near the top I was able to slide things around and pin it in place. We're go to the next slide here. This is a trail REALLY a blow-out area, and this is a first project in Conservation Corps that I founded and couldn't anyone to take me seriously in my late 20s. We looked at this project and said, "Yep, we'll make this happen." That was the catalyst to start the Corps. The washout of a trail -- you can go to the next photo. That's completed in one week with people of no skills training, split and moving the materials on site with that. You can go to the next slide, Candace. The next one is what it looked like from a different direction. Then if you go to the next slide, that's what it looked like after. So stone feature in a trail that is then -- that's been in place. You can go and see that regularly. What you're not seeing in the retention wall that was a couple slides back you're looking at stones purr rid. There's 2 feet of stones buried in the photo there. We'll go to the next slide, Candace. Native stone staircase on superior Hiking Trail. This project was a wooden staircase and needed to be replaced by stone. The Superior Hiking Trail did assessments where they brought in two professional trailbuilders to assess sections of their trail. The big takeaway I gave them is that couldn't believe all the stone that the Superior Hike Trail went through and did all their work out of wood. After that, taking from the assessment, they started to doing a lot of stuff out of stone and provided trainings. Their volunteer groups are doing a lot of neat stone work. In was a cops vague corps group. All the material came out of the rock or just behind those rocks above it. It was an insanely beautiful quarry 10 feet from the trail, super lucky. Here's a native stone staircase. You know, you will see this done in a lot of areas and national parks. This is led with a Youth Corps crew in Vermont when I worked there. We had no stone tools. Our stone tool was a sledgehammer, double jack, mash hammer, depending on where you're listening from right now. We completed that project and turned out really nice, and that was not being able to shape the tools. A lot of the stuff is rounded there, and there's a waterbar protecting that on the topside. We'll go to the next. The Hemlock State Natural Area Trail in Wisconsin was a neat project for me to work on and was a trail that got closed down. State natural areas in Wisconsin are really hard to work in, especially changing the location of the corridor of the trail; but after going and looking at it and proposing and getting DNR resources on board, we found a new route. Actually, we were transplanting spring ephemerals right as the work was being done in front of them with volunteers to old section of trail that was fall line. It was a neat project and really neat to see what that volunteer team did in the transplanting of the plants. Okay. We will go to the next one.

So here's a step stone crossing across Superior Hiking Trail, just an enormous amount of stones went into this, over 30 steps stones going across Encampment River. We knew this river is really flashy and could go up 12 to 16 feet right near there at different points. It definitely completely covered all the step stones. It was a week-long project done with volunteers on the Superior Hiking Trail. A stone was purchased at the stone quarry. Then in a rock sled, we took it down through the woods 300 yards to a 300-foot high line we had set up and almost dropped the stone in place going there. The training project completed, and what happened? Oh, shoot, let's go to the next slide. Bam. The weather hit. Go to the next slide there -- whoops, sorry; one more. The river rose. I mean, the river rose A LOT. Obviously this is after it already went down but can see the size of the tree in there. So after this water rose many feet above it, it settled back down, and hardly any of the step stones were moved there. One thing that you're seeing in this photo is you can see that the kind of the curved effect of the step stones in place there. Those ones that are closer to the bottom of the photo are actually lower in height than the ones that are closer, and that's to help with the water flow on this. That was by design the curve is in play there and has been working with hydrologists over the years, talking with them about that. They really brought that into the design of step stones that have been there for the past decade. So there's a lot of knowledge sharing in the trail profession field. Go to the next one. This is stonework training for SCA Skills in Alaska. On the left-hand side you're seeing the stone scare case, what it was before was a scramble. After the week, having multiple group from -- I only had a group one day at a time but did a really beautiful stone staircase through there. Let's go to the next one. This is Flying to Gotter Portage in the Boundary Waters. There's a big drop off a ledge and you can see that the wooden staircase in place, and the stone staircase we replaced afterwards. In the stone staircase, it actually starts in the water so we built the whole first base of it in the water. Strict wilderness standards, five portages in. It was a heck of a fun project to be able to take on. We can go to the next one. I'm getting down to my time here, guys, so I ... will ... looking at this. This is a training project at a state park, and it was an entrenched trail. We were able to build this over, you know, over just a couple days with some volunteers. Go through these a little quicker. This was a stairway portage in the Boundary Waters. There were 102 stones on site and replaced wooden staircases. It was completed over two months. The project was completed using only hand tools. We couldn't use any power tools of any sort. Even ripping out those wooden staircases, we had to use pocket hand chainsaws. If you had seen my hand, they move back and forth like you use a hand chain saw to make them work. In 2023, that project they nicely received that. It won a USFS National Wilderness Award. We didn't know it existed. On the next photo, you can see "before" and "after" in place. The portage had to stay open the entire time be the project was being done. This is an air environment in Parque Patagonia, Argentina, use, on-site native tool. We had power tools and hand tools on that and professionally trained a local crew to complete this project. It happened during COVID so it had to be managed from abroad. They had a little bit of training and then a lot of management from, you know, a continent apart. Another shot of that. We'll go to the next photo. You can go two more. Look at that. Superior Hiking Trail, another native stone staircase. We can skip to the next one. So blasting. It can be an effective way of getting the stone out of the corridor. I played around with different microblasters out there and use them successfully on the East Coast with harder stone out there.

In the Midwest in the driftless area, I have a lot of soft stone. The stone absorbs the charges so I've had not very good effect with the blasting and softer, less dense stone. You can go to the next photo. It works good for eliminating stuff out but doesn't work very good for directional breaking of rock because we tried it out. This is a sample, you know, with a colleague OBP Trailworks here. Just wanted to show the perfect two step again because it's a really nice example of just two steps with gargoyles, drainage above it there. I wanted to talk a little about accessibility with stonework. This is a classroom/archaeological site in Minnesota and will actually do a trench right through the middle of this stone circle, and there's accessible trail going there. Nothing was touched in the ground here; everything had A logical oversight on this. and tribal oversight on this project. It was a really neat quarry site in Minnesota. Go to -- just kind of finishing up, guys. Ending there. We'll end with this photo, and that's a trail. That's a seasonal flow of water crossing in Argentina. We went back and was able to visit that site last spring and actually seeing that landslide happened right through this area. Nothing, none of the stones that were in place, moved. Those are some huge stones. The stone behind the Great Lakes TrailBuilders logo, we moved that stone. It's huge, probably like, you know, 5 feet by 5 feet and had about five to seven rock bars moving that in place there. You know, the steps down to a water crossing, that stone paved, and a few steps out. And then the background there you have seen the Andes Mountains. I'm here to take questions and will open my screen to see questions coming in.

>> AARYN: Yeah, there's a lot of questions.

>> WILLIE: Okay.

>> AARYN: I think some terminology questions we can answer via e-mail afterwards.

>> WILLIE: For sure.

>> AARYN: So there was a few questions about your experience and special considerations or specifications when doing stone work on trails that have equestrians and horses on them.

>> WILLIE: Yeah. So great. Actually, some of the first stonework I learned was work on equestrian trails. Equestrian trail stonework -- you're looking at a bigger base. You know, 12 to 18 inches I was telling you, you're having to get a bigger -- you know, you're looking for nearly 3 feet of tread to be able to. What I also learned in the Sierra Nevadas working out there, they didn't want any of the rock to have any shine or sheen to it because they pictured that like a slick rock which they would slip on and actually also avoid the staircases if they saw the rock had a slick spot because they didn't want to fall as their mule trains came through. In the Sierras, they still use mule trains to pack in gear and stuff like that and I'm sure they use in a lot of other places in the world, too. We use some horses down in Argentina to get in our gear. Yeah, there are special things in place. Then you're looking at like, man, to make sure that is locked in place, you're jumping on it. Equestrian trail, you're really jumping on it there. Good question. Thanks.

>> AARYN: There was a bunch of similar questions about trails with mountain bikes on them and differences you do in terms of stonework and armoring.

>> WILLIE: Yeah. So on mountain bike trails, it depends if you want them on there or not, if it's a shared-use trail on the mountain bike trails. So -- because a lot of -- I just finished this trail last year, and it hits a mountain bike trail all around it. The mountain bikers are like, "Man, looks like I could almost ride that." I'm like, "Yeah, how close do you feel like it would need to be?" I started questions them and figure out how tight I needed to make my corners to keep mountain bikes off of it because it wasn't gonna be a mountain bike trail. So you have to decide, like you're having to look at it rideable. You're looking at the rise and run on mountain bike trail if you want people to ride it. You have to go pretty solid with it. As far as stone paving on mountain bike trails, which is done a lot in areas in stone armoring and whatnot and jumps -- you know, just making sure those are ready to be able to handle the use it's getting.

>> AARYN: And then there was a lot of very specific, technical questions so I will just ask a few of those. There's a couple of question about naturalizing the scars that are creating on the stones with extensive splitting and cutting and blasting and if, when time permits, or when you do that versus not doing it.

>> WILLIE: Yeah. It's a preference. I like to kind of eliminating them; some people like the history behind it. It really goes in kind of like the you're trying to eliminate those smooth spots on it. They make -- yeah, they make a meat tenderizer type attachment you can put on your rotary hammer that does a nice job of scarifying it; but if you can chip off large sections of it. If it's limestone or sandstone, dolemite, that really taking in the -- that can blend well in a year with hardly little work done.

>> AARYN: Awesome. And then there was a couple of questions I think following up from one photo you shared where it was like the rocks through the stream bed after the flooding.

>> WILLIE: Yeah.

>> AARYN: In terms of how do you secure them so they stay, when they stay with that kind of water? And also, if you're kind of related, what kind of permitting there putting stone steps through kind of a waterway?

>> WILLIE: Yeah. great questions. So there was permitting. Like I mentioned in that, we had, we work closely with the hydrologists for the State of Minnesota on that. So we came up with a design together to be able to come up with that swooping area. It kind of swooped in a "J" instead of a "U" more because the flow happened on one side -- the higher flow happened on one side of the river over another. So as far as keeping them in place, it's -- the ones that move, move like a foot. So they were able to just reposition them once they're there. That's one thing that happens. Another important thing is the spacing apart. You want them spaced far enough apart so people can, you know, make it, leapfrog over them to get to it; but not too close so they're

creating a dam. You're looking at creating, if you're at least a foot gap inbetween them, the actual stones themselves. Then the direction of the stone that you have it facing, you want the long way facing the flow of the water so you can are the short point and the wide base at the bottom. Another good question.

>> AARYN: I guess probably we have time for one more question. There's questions about the tools that you use and related to that, do you have a favorite corded power hammer? And also related to that was do you have any thoughts on battery powered rock drills?

>> WILLIE: Yeah I mean, battery powered is great and getting better and better. For one-off, if you're looking at bridge abutment and need to anchor into a rock or one thing you will break, they really work great. I find myself using it more and more. Rotary-powered hammer -- there's a lot of great manufacturers out there. I personally use a Hilti and have used the same over 20 years now and probably train hundreds of people on it so I have another version of it, too. One of them, like, it's going forever so I recommend them.

>> AARYN: Well, thanks, Willie. I think I will hand it over to Candace.

>> WILLIE: Thanks, everyone! It was great to have you all and appreciate your thought. Reach out. My information is out there, we're doing -- I think there's one spot left in our training that we have coming up so one of you on here could get the last spot in Boise for the stone training I will be doing. Definitely a shout-out to other PTBA office. I work off the beaten path, Peter S. Jensen, and others, and learned a lot from those individuals to also talk about trails in New York.

>> CANDACE: Awesome. Thank you so much, Willie; thank you, Aaryn, to help field the question. There are many more questions that we were not ability to get to so I will be sharing those with Aaryn and Willie to help answer as well. You can retch out to Willie or reach out to me. I can forward your e-mail to Willie or reach directly to Willie or Aaryn yourself. Again, this resources slide will be available on the webinar's web page as well. I want to thank our webinar partners along with the professional trail builders association. I want to thank iZone Imaging, GrizBurger Fund, Terrabilt Wayfinding Systems, the Bureau of Land Management, the National Parks Service; as well as U.S. Fish and Wildlife Service. Please consider donating to American Trails to help keep these live webinars produced weekly and free to everyone. Again, a special thank you to our Trail Champion Members noted on the screen. And we hope you will be able to join us for our next webinar in the "Advancing Trails" webinar series. That's noted on the screen and will be our, another webinar hosted in partnership with the Professional TrailBuilders Association. So thank you, again, everyone, for your interest in this webinar topic. I hope you all enjoy the rest of your day, and happy trails!