

## Hydrology, Geology, and Biology of Springs

Good afternoon. Welcome to today's webinar, Hydrology, Geology, and Biology of Springs. My name is Jennifer Ryan and I am a natural resources specialist for the Natural Resources Conservation Service's East national technology support Center and I will be your host.

I would like to take a moment to remind participants that any of our webinars is for information purposes only. Mention of a trade name does not constitute endorsement by the department or the Natural Resources Conservation Service of comparable products that are not named. With that we will begin. I am pleased to now turn the webinar over to Karen Fullen, the Ecologist and Environmental Compliance Specialist at the West National Technology Support Center. Karen started her career in her hometown, Fresno, California, as a student employee in 1992. After obtaining degrees in forest and park technology and biology with an ecology emphasis, Karen worked as a soil conservationist and wetland biologist for NRCS in California. In 2004, Karen was selected as the state biologist in Utah and in 2010 became the Idaho state biologist. She has served in her current position since 2014. Karen, you may now begin.

Thank you very much for that introduction and now it is my pleasure to introduce our panel of expert speakers today. Jon Fripp is a Stream Mechanics civil engineer with the National Design, Construction, and Soil Mechanics Center. He has 20 years with NRCS and tenures with the U.S. Army Corps of Engineers. Prior to government service, Jon worked in the private sector on development projects. Jon has also worked on a variety of restoration projects across the United States, as well as in other countries. Jo Johnson is a National Geologist and Geological Services Unit coordinator. She started her career in 2008 as the state geologist in Tennessee. There she worked with the NRCS staff and producers regarding geologic related resource concern, with an emphasis on farm production, quality and quantity of groundwater and rock riprap integrity. She worked in the environmental consulting industry primarily on groundwater issues. Zach Freed is a Hydrologist with The Nature Conservancy in Oregon where he leads the policy and planning program. He also serves as the chair of the global groundwater working group, which seeks to advance groundwater science and conservation in North America, South America, Europe, and Africa. Zach has worked on water management in the American West for 10 years and previously held positions with the U.S. geological survey and the Environmental Protection Agency. We have a lot of information to cover today. Jon will begin speaking on the hydrology topic and then will turn it over to Jo and she will turn it over to Zach. Finally, I will finish up with a bit of information on compliance issues that can be related to spring development. I do suspect we will have a Q&A at the end. And we want to get to as many questions as possible, but I do suspect we may go a bit over the hour, so hopefully people can stick with us if that happens. Before I turn it over to Jon, I just wanted to review, I have been asked why we are doing this webinar. About once per year, there is a call in NRCS for states to submit webinar topics that they would like covered. And so this webinar originated with one of those requests from a state biologist who was concerned that perhaps some spring development she was seeing were having adverse environmental impacts that were not being addressed. So we want to be sure to cover NRCS's conservation practice standard criteria and mention that one of the criteria is that an evaluation of the site be conducted to determine the water quantity and quality needed for the purpose of the spring development, the suitability of the spring location, the suitability of the soil and the geology. Impacts to existing ecological functions that benefit from the spring and potential losses caused by the spring development, including impacts on wildlife and habitat. The effects of consumptive use of the water on health and function. Spring flow, water temperature, and local aquifer recharge and impacts to wetlands. We will follow-up at the end and see how well we did addressing this criteria.

With that I would like to turn it over to Jon Fripp to talk about the hydrology aspects of springs. Jon.

Well, thank you. Hopefully I unmuted myself. I will start talking. Since the 1930s, which is more than 90 years ago, NRCS and its predecessor agencies have worked in close partnerships with farmers, ranchers, local and state governments, and other agencies to maintain healthy and productive working landscapes. It is the policy to provide ecosystem-based assistance to our customers to help them improve ecosystem health, restore damaged ecosystems and sustain natural resources. We implement a variety of techniques and practices to do this. Things ranging from ditches to dams to spring development. We categorize a lot of what we do through Conservation Practice Standards, so the next two slides are largely focused for our non-tran24 friends to illustrate how we see the world, how we classify and account for our work and how we define what we do. These conservation practice standards, often shortened to CPS or sometimes just PS are how these things are defined. They define why the practice is applied and where it is that there is the

minimum quality criteria that has to be met by a practitioner and these things are essentially policies. They are kind of important to us.

One particular note is code 574, which is conveniently labeled spring development and again it gives us the what, where, how. It's not that long, only a few pages, but it provides specific information, really good information, to define the boundaries of things we have to look at. As Karen mentioned, it specifically calls out that we need to look at the potential impacts to the ecology. We are in the natural resources business, it is in our name, we have to look at these sort of things. We have to realize we might be moving water for a very important economic purpose, for livestock or other sorts of wildlife, but we have to account for, we have to mitigate for, we have to think about things holistically.

Again, often we are talking about spring development. Something that collects that water from a source that might be a spring. Something that transports it, moves it from where it is to where we needed and then something that allows it to be utilized. So often we will link 574 with other practice standards which apply to them. Nine times out of 10 it is going to be a pipe. A lifestyle livestock pipeline, 516. And some sort of watering facility, indexed to how it will be used. As we see in the photograph on the lower right, little cows are the ones using that water.

Lots of designs are available and put together since almost the beginning of the agency and I believe it is probably 70 years that separates these two designs, the one on the right versus the one on the left. The one on the right uses the old pen and ink, while the one on the left is CAD, so it is easier to read, but you look at them and they are basically the same thing. We think we have some improvements with CAD, but essentially they are the same thing. They provide that additional information for the construction, to collect that water. To transport it from where it is to where we need it. That outlet to distribute the water and something to manage the water. Here are some examples from the United States, as well as around the world. Guatemala. The lower left, Nicaragua and the lower right, Afghanistan.

Let's look particularly at the water source, because that is the crux of the matter and the main focus of the presentation overall that we are doing. Fundamentally we are dealing with water we are accounting for. We have to look at where it is coming from and where we are using it. Wetlands are specifically mentioned in the conservation practice standards, CPS 574. I wanted to start off with a little bit of discussion on that.

One of the ways we can look at springs, the wetland associated ones, is there something called the Hydrogeomorphic Wetland Classification System and we often use this in functional assessments and planning, design, and monitoring of wetlands. They are classified by landscape position. Where they are. The dominant water source. Not the only water source, the main water source. In the hydrodynamics, which direction it is going and how we see it manifest on the surface.

A particular note when dealing with springs is slope wetlands. We see these in a concave position. Often we are looking at the dominant source of the groundwater, forced upward by the topography. It may be by a restrictive layer. Some sort of cohesive layer on the bottom that is forcing it up and we often see it manifest itself with some sort of vegetation or the like.

I used to work with a colleague of mine who was a wetland engineer and he referred to SLOPE wetlands is kind of the Rodney Dangerfield of wetland classification. They don't get enough respect and they are pretty important for the systems and the ecology. We see them all over the country, all over the world. They provide a critical upland water resource. We will hear about that later in this hour in more detail. They also provide flow. A large potential source of some of the base flows that we have in higher-order streams, lower order streams, further down the watershed. They also will get some buildup of organic soils. We get sequestration of organic carbon and as we know, the organic carbon plays into some of the focus that we have no on the impact and mitigation for thinking about greenhouse gases and the like. Again, here are various types from Kansas to North Carolina, Idaho to New York.

Again, the headwater SLOPE wetlands. We have two examples here from a land resource unit in Wyoming. Both are reaches, though we do not see a channel within it. On the picture, depending on how big your screen is, you might see some of the hummocking.

Often these are targeted for spring development. This is in Afghanistan. We did find a few of these. We would look at areas in terms of topography. We would see the slope of the topography. With it, you can see extra green vegetation. You walk a little closer to it and you can notice the wetland associated vegetation. Low points in the area that are using that water and that water is consumptive use by the vegetation and by evaporation. We can install and put in those devices to capture the water and convey it from upstream to downstream. This largely is the same thing that we do in the United States, as well. We can see this area in Oregon. There is that green area up there and downstream, something is done to capture it. A pipe is brought downstream and we can see on the side where it is brought down for agronomic use of the lower portion. If we have time, we are going to talk uses. We will see this picture again and talk about the change in that use of the water from that location. We are not creating any new water when we are transporting it. We are

moving it from one point to another. What sorts of impacts that can have positive, in terms of down where it is needed, as well as negative, because we are taking it away from the upper portion.

So, without further ado, it gives me great pleasure to introduce and pass the presentation over to Jo Johnson. She is our national geologist as well as our GSU coordinator. So, Jo, take it away.

Sorry, I forgot to unmute myself. Thank you, Jon. I would like to say, I will mention Jon slide that he pointed out earlier, he has a better picture of something I wanted to show, but he already used it. Anyway, we have a definition of key terms in geology. I'm not going to read them, but you have them in the presentation. Groundwater. An aquifer, that is critical. It is a zone of saturation in the Earth's crust. And then the definitions of springs and seeps. A place where water from an aquifer discharges naturally into a surface water body or onto the land surface.

Okay, I have a handout and a lot of these pictures are from that handout. That handout is in the engineering field handbook 650, chapter 12. It is either springs and wells or wells and springs, I always get them backwards. Anyway, this is the hydrologic cycle with a focus on groundwater in that document. One of the things we are dealing with our springs and I am going to point out a couple. This is probably what you're going to find on the upland. Springs that Jon was talking about. Like I said, he used a better picture. You've got your artesian wells. As you can see, the whole cycle, underground, it can be complex, but it is fairly simple. I recommend you go back and look at this. Okay.

We have springs and we have seeps. Springs basically have a defined outlet. Seeps might be at the edge of a hill and there is just a line of water trickling out of the hillside. The best thing to note about that is seeps are treated like springs when developing, capturing, and funneling water to a point of use. So you can use seeps.

Okay, factors that control aquifer discharge. An aquifer spring is an aquifer discharge. We have porosity, and expression avoid spaces in earth material. Permeability, the interconnectivity of spaces in the earth material. Aquifer components. Unconsolidated material, sand and gravel. Jointed and permeable sandstone. Jointed and soluble limestone. Jointed or fractured volcanic material. Jointed or fractured hard rock and fine grained material, primarily silt and clay. That last one is not really an aquifer. It can include the impermeable layer that Jon was talking about.

Okay, here is a rough table of yields based on aquifer components. You all can read that, but basically if you are at the beach or on the coastal plain, you are probably going to get a lot of water. Everything else in between fine grained material, which is low, is variable. They can depend on the interconnectivity of the porosity of the material or the fracture system.

Okay, now we will go types of springs and another controlling factor for flow. That would be pressure. A lot of springs that we work with our gravity springs. I will go over the types of gravity springs. We have artesian springs, where the driving force is hydraulic pressure.

This is actually -- sorry. What I was showing in the previous slide is actually what they call a tubular spring. Okay, depression gravity springs, seepage, or filtration. Where the land surface intersects the water table. Typically the yield is low, but probably enough for livestock. Sorry. Wrong screen.

Okay, then you've got contact gravity springs. As mentioned earlier, you might have an impervious layer. An outcrop of a perched water table. It comes out laterally on the hillside or down low. It is typically low, but again, probably enough for livestock needs.

Now you have gravity springs in jointed limestone, is what I am showing in this picture. Water emerges from fractures or joints in rock and channels in limestone or gypsum. Or it can be from volcanic rock. However, when I talk about permeability, you are generally talking about soil. You can see that springs here, the one on the left, probably has more yield than the one on the right.

Okay, artesian springs at aquifer outcrop. Relatively caused by impervious strata that have exposed near the surface or at higher elevations. Again, the yield varies depending on their reach, difference in the elevation of the recharge area, and the openings for water being transmitted. You can get not enough for your practice or way too much for your practice and for the intended purpose.

Okay, I know that is a lot of information and there is a lot of information out there to help you decide whether the spring you are planning on using as a water source will yield the right quantity and quality. Here is a list. Basically existing well locations. Precipitation and departure from normal precipitation. There is loads of data out there. Contact your geologist, they will be able to help you.

Okay, so you found a spring and it doesn't quite meet your practice design criteria. There are ways of increasing flow from springs and from a gravity spring, sometimes just the removal of obstructions, which can be sediment brought in by the groundwater at the outlet. Slope wash material. Vegetation. Collection of flow. These are methods. Artesian springs, all of the above, but the big one is lowering the outlet elevation if you can.

Okay, now springs are generally located in areas that are prone to flooding. So you want to be able to protect your practice along with the spring itself. So you will need to design for that if your spring is located

in an area that is susceptible to flooding, so it does not cause damage to structures or reduce the quantity or quality of wildlife around the spring outlet.

And with that I am going to turn it over to Zach.

Great, thanks, Jo. Good morning from Oregon, everybody, and welcome to the second half of the presentation. We are just about on time. I want to acknowledge, it is a pretty beautiful day where I am, which means my neighbors are doing some overzealous landscaping. Hopefully that is not coming through and you all can't hear it. Like Jo said, I have been asked to talk about the biology and ecology of springs today. Why should you care about them? What characteristics make springs unique and interesting and worth learning more about? After I talk I will handed over to Karen to discuss the relevant policy. I just want to quickly say, don't worry, I am aware of the time here. I will be sure to get you out on time, while still hitting all of the highlights. First I will talk about the diversity of spring habitats. Then the characteristics that make springs Keystone ecosystems, a term I will define in a little bit. And finally, their ecological utility as a refuge.

So, spring habitats. If you are anything like me, while Jon and Jo have been talking through the geology and hydrology of the springs, you have been picturing a spring in your own mind. Some mental visual that you think about when you hear the word spring. To me it is something like this photo on the right side of the screen. It is crisp, clear water, emerging out of a single spot on the landscape, flowing well enough to form what we call a Springbrook or headwater stream. I want to make the point, springs are much more than this. There are a huge amounts of different habitat types. Jo referred to several of these, but these directly affect what kinds of plants and animals inhabit the spring. The different habitat types are dependent on what we call the hydrogeologic setting, which is a sort of jargon term that oversimplifies and sums up many of the characteristics that Jon and Jo have discussed. You can think of the setting is a way of asking a series of questions, like where does the water come from? How long in time and space does it take the water to reach the spring? Why is it emerging at this point? What is the underlying geologic characteristics and many others. I will provide a few examples. Anyway, those types of factors, hydrogeologic setting, really ends up determining the type of habitat available for plants and animals. In this particular habitat we see on the right, this particular spring, you might expect a similar set of plants and animals that you might find in any other perennial stream. You can see in the photo there is a little bit of riparian vegetation. A little bit of emerging aquatic vegetation. You can imagine and I know from first-hand experience that invertebrates like stonefly's that like flowing water, cool, clean water, will probably be there and maybe even some small fish.

There are other types of spring habitats. Jo mentioned seeps. They are like the wetland you can see on the left side of the screen. They are diffusely discharging streams that tend to support similar plants and animals you might find in other wetland habitats. Obligate wetland plants, amphibians, and semi aquatic invertebrates. A lot of beetles and stuff like that. These diffuse habitats are often great forage resources for larger wildlife, like mammals. Think of elk or pronghorn or birds. A lot of different birds. And then yet other springs are systems like we see on the right side. These are more like ponds or lakes and you might expect, as you can see in the photo, a good amount of riparian vegetation. Some submerged aquatic vegetation and amphibians and fish that might like that still water. You would also see, if your monitor screen is much larger than mine, you might spot a couple of dragonflies flying around. Macro invertebrates might really prefer springs like this one. In those three habitat types I would venture to say that in my personal experience, the discreet discharge spring on the previous slide, the wetland habitat on the left and the pond habitat on the right, these tend to be the most commonly seen springs, at least in my perspective and experience. But there is a huge, wide world of other habitat types that have become yet more exotic and kind of, in some ways, more interesting. Like you can see on the left side of the screen, a hanging garden spring habitat in Zion National Park. This is a spring discharging directly from a cliff face and even though it is in a relatively vertical context, in this case even an overhang, it still supports a really neat little microhabitat. You can kind of see on the screen on the left side that there are Mosses, ferns, and others. Macro invertebrates, you can't see those, but they are there, trust me. These types of springs are useful forage for birds and other animals. Lizards. Getting even a little more exotic on the right side of the screen, if you look closely you can see a hot spring. A thermal spring. This, again, supports its own set of unique plants and animals. Think about extremophiles populations, like bacteria that thrive under these extreme conditions. You can also see, highlighted in the red circle, directly adjacent, the other spring on the right side of that photo. That is really just to show this is a Coldwater spring, a pond lake spring. This is to show diverse habitats, even when located spatially, very close to each other.

There are more habitat types but I think you get the point. You can get creative about this and think about deep-sea thermal vents, things like that. Where there is a discrete stream source in a riverbed. We will go right over that, because I want to make some bigger picture points and I think you get it that spring types are diverse and the diversity leads to different habitats for different plants and animals. So I want to talk about

spring distribution in space and time. If you were to look at a map of springs in your state, I bet you would find they would be clustered densely in some areas and are sparsely distributed in other areas. That is what we call a patchy distribution and that goes back to the hydrogeologic setting. It controls how many springs and what the characteristics are. Springs also have a patchy distribution in time and this is a key point I want to make, so perk your ears up. While most springs have a much more consistent flow than most surface water dominated habitats, there are still plenty of springs that are not quite as consistent. Springs that might be seasonal, seasonally flowing, or intermittent. There are even huge sets of springs that may occur under cycles. In my neck of the woods, the Pacific oscillation. During wet decades we may see many more springs across the landscape than in drier decades. So I wanted to make the point that they are also, in some cases, unevenly distributed in time. I won't dive really deeply into this right now, but I also want to say that spring habitats can be affected by their position in the watershed itself. You kind of got a visual of this from the cross-sectional images, that both Jo and Jon showed earlier, but the short version is that if you have a spring that is higher up, near the highest local point, like a watershed divide or high on a mountainside, the potential contributing area or recharge area for that spring is quite small. Water is not going to come up from the valley bottom and discharge through that spring. It will probably be dependent on a very local upslope area. That limits the spring discharge and also limits sideboards for the possible water chemistry characteristics within that spring. Springs lower in the watershed, for example emerging near a valley bottom, they may have a much higher possible diversity of discharge, what are diversity and habitat. Anyway, all of that is to say that the plants and animals that inhabit these springs depend on the spatial and temporal distribution, for things like source populations versus sink populations. The immigration of individuals and populations from one habitat to another and finally they also dictate refuge, which is something we will talk about in a little bit.

First, I wanted to move on to the fact that these different habitat types, the diversity of species, qualify springs for a pretty cool term. Springer and Stevens describe springs as Keystone ecosystems and this term means that they contribute a disproportionate amount of biodiversity to the landscape, compared to their habitat area. Again, imagine looking at a map, from the top down at a map. Most springs are fairly small, however they have certain characteristics that contribute biodiversity on a local or regional level to that landscape. Let's talk about those characteristics. You can see some of them listed on the screen. We will start with probably the most obvious, the ones that make our trout on the left happiest. Flow and temperature. Springs and other groundwater ecosystems tend to have very consistent and very unique discharging water characteristics. Some even have their own sort of fingerprint or signature set of characteristics. This is due to the fact that there is a unique underground flow system that leads to the spring and that underground flow system, especially for deeper flow systems or longer flow paths, they provide a muting effect. Whether that might otherwise cause nearby streams to dry up in dry weather or conditions, they may not affect spring flow at all and similarly, really hot air temperatures that warm-up other surface water systems, they might be minimized or totally ignored in a spring. So, species like this red band trout can rely on spring flow during the dry season and they can rely on Coldwater micro-habitats during the dry season. One last thing about the temperature, the reverse is also true for temperature. Some species, particularly birds, will utilize springs during cold, cold winter, because spring temperatures are so consistent that they are relatively warm, compared to the surrounding surface water habitats.

Let's move along and talk about seeps again. Let's revisit this idea. If you are sharp eyed, you can see the dark green habitat in this photo. I will circle them, also. The soil and depth are also important characteristics to local plants and animals. As you can see in this photo, wetland plants and animals can enjoy continual soil moisture during the dry season that is being supported by groundwater. I say during the dry season and I also mean during dry decades in some cases, due to that seep to the groundwater. The depth to the water table is really important. Many plants need continual water to their root zones and if the groundwater flow is altered or if the hydrology has changed and the depth of the water table increases, so the groundwater is below the plant root zones, than those plant communities experience stress and mortality.

Finally, I want to mention this -- sorry, my computer briefly froze. Let me get back on track. I want to mention the other characteristics. I mentioned pH, turbidity, dissolved oxygen and other quality parameters. That includes things like specific conductance. These characteristics are often extremely consistent and hopefully you are seeing a trend when I talk about consistency. For some species, like these tiny snails on the left side of the screen that have very low tolerance or a high sensitivity to changing conditions. Springs that have nice, consistent parameters and characteristics can support populations of the species that would otherwise fall victim to fluctuations or disturbances in surface water habitats. And one last note about groundwater dependencies, we broadly define them into obligate spring dependent species or facultative. For obligate species, springs our life. If the spring goes out or is changed, without the spring there is no population of the obligate species. They will be locally extinct. For facultative species, like the happy frog on

the side, they prefer springs. Many times they would utilize springs of available, but when push comes to shove, some of these facultative can survive elsewhere. They could reluctantly utilize surface water habitats. This is important language to understand, so that you know how different species react and require different springs.

So, we have talked a lot about consistency, which I have said that word over and over again today, but much of our discussion has been on sort of a short-term context. I talked about dry weather or warm weather. Droughts. Low-flow seasonality. But this consistency is crucial in a much longer timescale, as well. Some springs can act as climate refuge dating back thousands of years. For the sake of time, let's ignore the figure on the right. You can revisit that later. The very short version of that figure is that there are different types of timescales and different types of refuge. But let me define my terms quickly. A refuge is a habitat or condition that is most resilient and resistant. Resilience is the ability to bounce back from disturbance. Resistance is the ability to not be affected by disturbance. When we are talking about really long, thousands of years timescales, it often means changing climate. Think about the climate of your area and how it has changed. In most cases in North America, has changed quite a bit and has mostly become warmer and in many cases, dryer. Some springs can provide a long-term refuge that protects the plants and animals that inhabit them for thousands of years and to be clear, it does not mean that no change at all occurs, but it does mean these refuges provide areas where the changes happen slower and are buffered and any short-term trends are muted.

This capacity has led to, in my opinion, a beautiful term. One of my colleagues described springs as museums of biodiversity. That means they continue to support species that may otherwise be extinct across the landscape and those types of species are considered relative species. They were once widespread and found throughout habitats, but they have only survived in specific locations. Springs are very common to find relative species and because of the same reason, there is a high level of endemic species. Endemic species are only found in one certain area. One example in my neck of the woods is a fish only found in one spring in southwestern Oregon and nowhere else in the world. There are plenty of other great examples, but for the sake of time, we will pass over that. I also wanted to acknowledge that we have been talking a lot about fission plants and bugs, but springs are important to another animal that is very important to me, humans. Our own evolutionary history, especially during dry decades and in regions like in the Middle East, our human history has long depended on springs as a source of refuge for drinking water. This cliff dwelling, for example, in Mesa Verde national Park in Colorado, utilizes a spring's drinking water to build up the whole dwelling around and near springs for that reason. So, similar to Jon I will propose a discussion question, but we will not discuss it yet. The question to think about is if you wanted to know whether a spring was potentially a refuge, what types of data might you collect? What data would contribute to understanding a springs refuge potential? And with that I turn it back over to Karen to talk about laws, regulations, and policy. Karen, over to you.

Great, thank you, Zach. I will try not to bore everyone with this part of the presentation after looking at cool plants and animals. NEPA is the umbrella law under which NRCS considers impacts of all of its practices, implementation on the ground. Normally, we do this programmatically. We publish our conservation practice standards in the Federal Register. We take public comments on those. Each of those practice standards is accompanied by something we call a network effects diagram, which discloses to the public the direct, indirect, and cumulative impacts of the practice, spring development in this case. When we plan a spring development, we follow a nine step process that mirrors the requirements of NEPA and we complete a concurrent environmental evaluation with that. We document it on a form called the CPA 52 and that, in most cases, well, it helps us determine the level of NEPA compliance required to implement the practice and in most cases we can categorically exclude a lot of our work. It is important to note that NRCS's NEPA regulations require NRCS to minimize the adverse effects of all of our planned actions on all resources and that is the reason, that requirement there, is the reason that we don't have to write for everything we do.

So, let's go through some of the special environmental concerns. What NRCS terms special environmental concerns. These are resources protected by law or executive order or agency policy that NRCS has to consider and has specific policy on that is usually more restrictive than what the minimum requirements of the law are. So, first of all, cultural resources, and that covers a broad suite of things, in NRCS terminology. Compliance with the national historic restoration act and about a dozen laws and other orders covered by its own part of the general manual and also has its own handbook. NRCS policy is to protect, in place, cultural resources to the fullest extent possible, so avoid impacts if possible. If we cannot, then minimize or mitigate. Medication can be quite an involved process, negotiated with the State historic preservation officer. Potentially tribal historic preservation officers and the advisory Council on historic preservation. In the arid West, so I would say west of the 100th Meridian, there is about an 80 to 100% chance of having cultural resources associated with a spring, if that spring has flowing water. It could be prehistoric, indigenous use of

the spring. It could be what we call a traditional cultural property. Important to a tribes culture. Or it could be historic artifacts associated with the westward expansion and pioneer settlement of an area.

In the national cultural resources procedures handbook is a section on geologic resources of local or regional significance, including caves. These may be associated with some types of springs. There is specific guidance in the geology part of the national engineering manual.

NRCS's policy on endangered and threatened species and species of concern is included in NRCS's NEPA implementing regulations, which means they are required by law to be followed. So, NRCS goes beyond the minimum requirements of the Endangered Species Act, to not jeopardize the continued existence of a federally listed species. We also consider species proposed for federal listing or are candidates for listing. Of course we have to consider under the Endangered Species Act, designated critical habitat. We also consider proposed habitat, which is not yet protected by law under the Endangered Species Act. We also consider impacts on state and tribal species of concern and their habitats.

Invasive species, there is a presidential executive order on those that says federal agency must prevent introduction, provide for control, and minimize adverse impacts. If there are invasive species in the area surrounding the spring, the disturbance created by a spring development will often give them a chance to expand and sometimes even come to dominate the site. So you have to plan for how you will try to prevent that from happening or at least provide control measures, usually by establishing competing vegetation.

As Zach noted, some spring support riparian areas and NRCS has specific policies on these. Assistance has to maintain or improve riparian benefits. We can't make the situation any worse than what we encountered when we first went out to assist the person who wants to do a spring development.

NRCS also has policy on the protection of wetlands and this policy is based upon an executive order, but it goes beyond the requirements of it. Once again, we have to follow what we call mitigation sequencing. So, if we can avoid adverse impacts to wetlands. If avoidance is not possible, then we have to figure out ways to minimize those adverse impact's. And as a last resort, if we can't do either of those, then we have to compensate for lost wetland functions and acres. There is other relevant policy. The national biology manual has specific policy on avoiding adverse impacts to fish and wildlife habitat from the installation of practices that are installed for other resource concerns. The national planning procedures handbook talks about alternatives and developing those alternatives and if there is going to be an adverse impact, we need to keep planning until we find a way to meet our client's objectives, meet the planning criteria for the resource concerns that are identified, and mitigate all negative effects. Then the national environmental compliance handbook talks about how the client selects the alternative from the planning process that they want to install and not once -- that becomes the basis for the analysis, but NRCS does not have to fund that alternative if it is inconsistent with their objectives and other environmental requirements.

So, circling back to the spring development site evaluation criteria, I think we have touched on each of these subjects briefly in the hour that we have had today, which is almost up. Jennifer, I saw some people were having trouble downloading the presentation, which is intended for you to have our contact information, which is on the last slide. Also the policy regulatory references that I talked about. But let's get to a few questions before we have to wrap up for today, and I am going to skip these, I think, and just go to some of the questions that came into the chat. The first one here is for Jon Fripp, does NRCS have any standards regarding the minimum percentage of flow to leave in order to retain natural hydrogeologic function and wildlife habitat?

Okay, I have got myself off of mute. Jo Johnson put a nice value in there, as an answer to that. The only thing I would add is essentially what Karen talked about, that we do have part of our policy to avoid those adverse impacts to wetlands and avoid is not possible, so minimize it. Part of that involves going ahead and doing this type of overall site by site type of evaluation. These are not something to be put in casually. In terms of a specific amount, I am not aware. It would be more of a generalized assessment with that. Karen, do you --

Jon, I lost you there.

Okay, I was going to turn it back over to you. I finished babbling there. In terms of an environmental or biologic standpoint, again, this kind of reiterates why a lot of these are natural resource type projects involving these interdisciplinary approaches, because we all bring different elements or different focus to what we are seeing here.

Yes, thank you, Jon. That is a good point. You can't substitute for interdisciplinary expertise with these things. With so many potential issues involved. And, no, there is no cookbook for spring development as far as just leave this amount of water and you will be okay. It depends on how many other Springs -- is this the only source of water in a large area? Is the spring already impacted by past spring development? Is the existing spring trampled by livestock or wild horses and Burroughs or elk, other large mammals? Is it supporting a spring brook or a pond or wetland? There are a lot of different things to consider. Next question

I am going to turn to Jo, working with Amish farmers that have high nitrates in springs that are used, where can we find info on bioreactors and how well they might work to lower the nitrates and details of designing? Do you have any information on that?

I did respond to that one, but one of the things I wanted to say, I'm not quite sure where the individual that asked questions is from. A lot of states in, I want to say the southeast, produce a document called -- I can't remember what it is called, I had it up a minute ago. Something for serious grazers and in their they talk about the quality of water with regard to nitrates. They have, maximum contaminant limit. But they have that in there. The first thing I would do before I would spend money is to find out if the nitrate concentration is going to impact whatever livestock you have. If you think you need a bioreactor, I would definitely talk to your state environmental engineer and if you do not have one, your state conservation engineer. They can contact the national environmental engineer. If they don't have one.

Thanks, Jo. I've got one more for you. How would a soil restrictive layer impact to the spring? Would the spring water still come from below the restrictive layer or be water running between the surface soil and the pan?

That is situational. You would need to really consult with your geologist. They would do the research. Hardpan, depending on where you are from is pretty much a thin layer. I don't want to say it is impermeable, but it seems like it is, that you encounter. Definitely harder than the soil above it and the soil below it, typically. Typically. But it would really depend on the layer itself and whether it is in an aquifer system, because a lot of times those are intermittent and the best answer I can give is to consult with your geologist, that they can research and find out the answer for you.

I can add something to that, Jo. Fundamentally it depends on what direction the water is coming from. We talk about something slowing the water down and forcing it one direction. You know, where it is coming from in that watershed and when dealing with the upper portion of it were coming in from an adjoining watershed. It depends on location. It is a very good specific question, but the best answer we can give is, it depends.

We call them hardpan where I am from. They are generally very thin layers. More consolidated material that surrounds it. Like Jon said, it is really situational.

Okay, thank you, both. I am going to take a couple now, one related to the need for a Clean Water Act 404 permit for spring development. The best advice there is, it is going to vary. Some spring developments may need one and some may not. I am not going to try to tell you under the current waters of the U.S. rule, which do and which do not, because how we define waters in the U.S. has changed a couple of times, a few times, over the last several years, and may change again. The best piece of advice is to go to your local corps of engineers office and talk to them about whether your particular spring development is going to need a 404 permit or not. Only the core and EPA can make a jurisdictional determination. 1024 cannot. Then a related question is about NRCS's certified wetland determination for spring developments. Certified wetland determination are made for compliance with the wetland conservation provisions of the food security act, which were designed to discourage conversion of wetlands for annual crop production. That is not usually a concern with spring developments. Those are usually done on rangeland and forest land for grazing purposes and not for crop production. So unless your particular spring development could make production of an annual crop possible, you do not need a certified wetland determination. One more for me that I will answer and then I will throw one out for Zach. How would NRCS determine no adverse effects on wetlands when many projects deliberately redirect flow from springs and seeps into water containment projects? Again, it is a very site-specific thing. If we show up to a spring and it has been developed, but in the past, so it is already disturbed, but maybe it is silted in. Livestock have uncontrolled access or other large mammals. Gosh, even off-road vehicle use. A lot of disturbance, existing disturbance around the spring that has already altered ecologic functions, many times there is an opportunity to improve those by redeveloping the spring. Perhaps fencing out or somehow controlling access to the point of discharge. Allowing areas to revegetate. It just really is a very site-specific thing and of course, as a last resort, you can mitigate. That would be the last resort. So kind of a series of questions to ask yourself. If you have decided there is a need for livestock water, for example, is there any other way to get it? Is there any other practical way to get it without disturbing the spring? That would be avoidance. If you can't do that, if there is no other way, may be a well, but it would be so expensive it would not be practical. Then how can we minimize the impact? Perhaps through the use of valves. So you don't have to redirect the flow from the spring. You can use that water only when livestock are in that area and need it. Maybe if you have a spring complex, with a lot of springs, you don't develop all of them. You just develop enough for the livestock needs and then as a last resort, you go somewhere else and create a wetland to replace what is being lost. Zach, are there resources you recommend for learning more about how to manage her while also supporting and protect spring animals and spring plants?

Yeah, thanks, Karen. Good question. So, I see that one of the other presenters from NRCS has mentioned with some design information. 210-650-12, which I'm not sure what that is, but sounded useful. I think a lot of the potential scenarios you just listed, Karen, are good ways to mitigate or reduce damage to spring animals and spring plants, while still benefiting herds. I think, you know, there is continued need to keep developing the science or low-tech solutions to get enough water for livestock, but still maintain sufficient flow to protect ecologic priorities, especially when those are spring obligates that require spring habitat. I think several federal agencies, NRCS included and also the U.S. Forest Service are looking for developing and continually redeveloping good guidance for methods and mechanisms to achieve that goal. I think at the end of the day we want to make sure that we do meet the needs of people, while also protecting the ecosystem. There is an immense amount of cases where that is possible. Often as a zero sum game. I think in a lot of cases there ways to follow that mitigation pathway that you described to a benefit. One other thing I would add in is that at least in my area of work, there are a lot of springs that have already been developed. Those developments have become defunct, obsolete, or broken. One piece of that mitigation pathway, I would also remind folks that it is always nicer to redevelop an existing development that has been damaged, rather than just going to develop a currently pristine spring. Always try to develop it first.

Great, Zach. And could you answer the discussion question that we drafted there, in case nobody asked questions, what data would contribute to understanding a springs potential and we will end on that note, because I think Adobe Connect will kick us off.

Great, thanks, Karen. And thanks, Britney, for asking that question. I think there is an easier answer and more complex answer. I will lead with the easy and pivot into the complex. The easiest answer for trying to find out which springs might be a refuge zone, this is an oversimplification, but find out which springs have acted as refuge in the past. So, you can look at the biology. Do you see existing or relevant -- if so, they have acted as refuge in the past, almost certainly. That means barring any current intervention, those springs are likely to act as refuge. In the future. Then I would add sort of the more complicated part of that answer. There are data sets related to hydrology, geology, water quality and chemistry, that you can use to try to provide clues to the potential. So thinking with hydrology, look at your local springs and how they are discharged or how the soil moisture area changes in response to local droughts. If those springs are resilient to short-term weather, that means they are more likely to be resilient to longer-term climate changes. Geologically speaking, regions of high permeability that support large aquifers might be better candidates for refuge than lower permeability systems. From a water quality and chemistry perspective, consider stable isotope analysis. They're great for telling you the residence time of the water. Longer residence time tends to mean longer flow systems. There are a couple of other things you can use, climate modeling, microclimate assessments. Remote sensing. But I will end by saying one kind of underappreciated and underutilized technique is to utilize traditional ecological knowledge. A lot of people, indigenous people in the communities, have either an oral history or have artifacts or some associated cultural significance with long-standing, long flowing springs. If they remained stable during past droughts, which you might know from interviews with communities or you might know the cultural significance of these springs, again, they are more likely to be resilient and resistant to future forces. So I will end with that. Karen, and or Jen, I will turn it back to you to wrap up.

S, Jen, please go ahead and take us home.

Thank you, Karen. On behalf of the USDA and the Natural Resources Conservation Service I wanted to say thank you to Karen, Jon, Jo, and Zach for providing an excellent presentation today and thank you again to everyone for attending today's webinar. Please provide your feedback about the webinar and if you selected to earn continuing education credits, please return to your browser window to continue the process offered by step two. For the folks that had issues downloading the handouts, I will also upload them to conservation webinars and they will be available along with the recording of the webinar early next week. This concludes our webinar presentation.

[Event Concluded]