

Good afternoon, again. Welcome to our roof runoff management webinar. Again, my name is Hamid Farahani. I'm a water management engineer here at East National Technology Support Center in Greensboro, North Carolina. And I will be moderating this interesting webinar. What is more interesting than capturing water from our roofs? And this area of water scarcity, I am expecting this to be an interest for folks in the East and folks in the more semi-arid environment. With that, I would like to introduce our main and only speaker, Mr. Bill Reck. Bill is an agricultural engineer with expertise in the environmental engineering field, and I think that's as much an introduction he wanted me to provide. he has a lot of water expertise, but with that I'm going to stop here and Bill, please--

Thank you, Hamid. We'll have a couple stops in here for questions as we go on, one about halfway through and one at the end. And questions will be handled through the online system. When we get to the end, we may switch and allow some voice questions. All right, her we go. So what we're going to cover this afternoon. We're going to talk about basics of planning and design for a roof runoff system, and talk a lot about sizing gutters and downspouts. Talk a little bit about some trench drains as well, better tile drains, and we're also going to talk just briefly about some storage for roof runoff for other useful purposes.

This is all based on the NRCS Conservation Practice Standard 558, roof runoff structure, and so we're going to be basing-- this presentation is based on this practice standard primarily. So roof runoff structures are structures that are used for collecting, controlling, and disposing of runoff water from roofs. That's what they're there for. So why would we want a roof runoff management system?

Well, for our purposes, the primary reason that we use roof runoff management is keep clean water clean, especially in animal waste management situations. You see here from the picture, you've got a lot of the roof area of this site is actually contributing to a potential water quality problem. The added roof runoff is mixing with animal waste, and then it becomes dirty water. If we can keep that separate, then we've reduced what we have to treat or take care of. Another way and reason to have it is, in some cases, it will improve waste handling.

For example, if you had a roof that runoff leads to a lot and you are scraping that lot for removal of manure, by taking the rain water out of the equation, you're left with a material that's easier to scrape

and handle. In this picture is a pretty sloppy mess that could've been reduced had rain water been kept out of the equation.

Reduced water storage requirements for waste storage structures. I mean, this is really a big one. In the CNMP training that we provide, we have an example that I'm going to share with you about roof runoff and how that impacts waste storage design. Here we've got a dairy, and we've got a significant amount of roof area. And in this example farm, we had about 10,000 square feet of roof, and then some other impervious areas, concrete, roof feedbunk and silage bunker, a total of about 30,400 square feet of area.

If we were to take out the roof runoff and divert that somewhere else, and we've cut our impervious area by about 1/3. And that can really impact the amount of water that we have to deal with from areas outside of the dairy cow areas themselves. For example, if you were to just put gutters on this example, today you start out with about 116,000 cubic feet per year of runoff from the whole area, if we didn't have gutters. If when we install gutters, now you're getting down to about 78,000 cubic feet. And that's a savings of 38,000 cubic feet of clean water that you've removed. You don't have to treat that.

So in this example, you'd remove 285,000 gallons from the system. So what does that mean to a producer-- and this is a selling point that we use when we're talking about installation of gutters and what the benefit is to the producer. That means 10 to 12 hours less pumping per year. It means that the storage period-- you have an existing pond, you can increase your storage period from 120 to 150 days.

Or if you're putting in a new waste storage structure, you reduce the required size. And gutters are fairly low cost. It's somewhere between \$6 and \$7 per linear foot to install gutters, so the cost and payback for gutters is really pretty good. And this is how we should be approaching producers on the benefits of putting in gutters in animal waste systems.

So why roof runoff management? Keep clean water clean, improve waste handling, reduce waste water storage requirements for waste storage structures. And now we've got another reason that's coming in here recently, collect and store roof runoff for other uses. Now, I say recently because it's fairly recently for us in the East we're doing some of this. We had a CIG in Alabama a couple years ago where they were collecting roof runoff for reuse for poultry.

I believe, they've done the same thing-- they're talking about doing the same thing in Virginia. Out West, this has been done more, in the more arid areas. Usually you don't think of the East as being a water poor area, but there are places where groundwater is not as available or there is some permitting restrictions and capturing roof runoff can actually help with those kinds of problems. Here's an example of a livestock watering facility in Georgia where roof runoff is captured and routed to a watering trough.

Here's another example from Texas of roof runoff water that was captured and then used to grow vegetables. I will say this about irrigation water, you can get a significant amount of water off of a roof, but you probably aren't going to be able to irrigate say, 100 acre corn field. There's a limit to how much water you can get off, but certainly, if you had a small vegetable crop, you could use to augment the water available during dry times and improve harvest.

So what are gutter systems and roof runoff management? What are we based on? And in NRCS, our design guidance comes from chapter 10 of the *Agricultural Waste Management Field Handbook*. It's got some information in there about why we roof gutter. There is some design guidance in there, as well. Here we see a figure that's talking about using a roof gutter and taking the water and routing it away from the production area of an animal waste management area.

Let's talk a little bit about-- let's move into design. In Chapter 10, it talks about gutter capacity in how to size gutters, the equations are here for you. I'll just tell you, it's fairly simple to calculate. And at the end of the presentation, in the handouts, I have included several spreadsheets that were provided by states that I think are pretty good. Many states have these. Definitely check with your area engineers to find out what your state is using. But most of them are based on this concept.

You have a cross-sectional area of the gutter. A wetted perimeter basically Manning's equation to calculate gutter capacity, and this is based on a gradient of the gutter of about 1/16 inch per foot. So there's typical gutter sizes that are out there. This is the K type gutter. There's galvanized. There's also aluminum standard sizes.

Rainfall, another important parameter for sizing systems. When we think about rainfall, it's two different forms that we're designing for. The 10 year frequency, 5 minute rainfall is the design that we would use for non-animal waste systems. For animal waste systems, we use 25 year storm frequency, the 5 minute rainfall.

That's just the size of the gutters to make sure that we're capturing-- the 5 minute rainfall for 25 year storm is basically the maximum that you're going to see that gutter-- if it can carry that, then it's going to be able to carry that 25 year 24 hour storm away from the production area. So that's why we use the 25 year frequency for animal waste systems.

So where does this data come from? Chapter 10, Appendix B, has got maps in it for these 25 year, 5 minute rainfall in inches. It also has a map for the 10 year, 5 minute rainfall. Now, I do need to mention that the data that was provided in chapter 10 is pre-NOAA 14 update. NOAA 14, as many of you are aware, is a recent update to our rainfall data that's being done by NOAA, and many of the states have already had this completed.

The Northeast states have got the data now. NOAA hasn't finished processing, but they can still get to the data on a website. These states will be converting over to using NOAA 14 data instead of using Chapter 10 of the *Agriculture Waste Management Handbook*. And we hope to eventually get those graphs and data in chapter 10 updated with new data based on the NOAA update.

Here's an example of Iowa and rainfall data for that state. Now, if you're in Iowa and you think, well, I've never seen that map before. It's because this is kind of a test map that we had recently graded to see what maps might look like if we update Chapter 10.

Gutter slope. 1/16" per foot is kind of the standard. It works out to a little over 6 inches of fall for 100 foot of gutter. So why is that important? Well, you need to think about does the building itself have any slope? And what's the width of the fascia board that you're attaching the gutter to. If you're going to slope and your building is level, your fascia board has got to be wide enough so that over the length of the gutter and have that slope. So it's something that you have to think about.

And why do we have slope on gutters? Well, we really don't want to have standing water in our gutters, so you want to have slope. And more slope also increases the capacity. So later on, when you're talking about sizing gutters, there's a trade off between the slope of a gutter and the capacity, and when you compare that to downspouts. And maybe you need to increase the capacity of your gutter, and without increasing the size, you may be able to do that by increasing the slope slightly. That all depends on what I said before, what kind of length of building you're talking about, what's the width of that fascia board? Just things you have to think about.

We'll talk a little bit about downspout capacity. This is a balancing act. You look at your gutter capacity and you're also going to be looking at your downspout capacity. Because one of those two is going to be the controlling factor. Downspout capacity is also a function of the cross-sectional area-- is the cross-sectional area of the downspout. The depth of the gutter has some impact on that, and here's the equation.

Here's an example of a gutter downspout, and as you look at this, you may think, wow, I've never seen a double downspout coming out of a roof gutter. Well, you wouldn't typically see this on a residential building because those gutters are not designed for that 25 year storm. But in gutter downspouts, you're limited in how big of a gutter downspout processing area you can have because of the bottom of that gutter. So sometimes, to increase the downspout capacity, you put in two downspouts, thus doubling your downspout capacity in one spot.

Another thing to notice in this particular picture is there's two downspouts come down, and there's a conversion point of the funnel and it's going into a circular pipe. So you've got to make sure that the circular pipe that's down below, also can carry the required flow rate that you're getting from the downspouts up above. Or what those gutters need to-- what those downspouts need to carry based on what the gutter is bringing to them.

Downspouts, like I said, must not exceed the bottom width of the gutter. You want to have support for your downspouts at the top and the bottom, and have intermediate supports every 10 feet. Lateral downspouts, which means if you have downspouts that comes down a little bit and then moves laterally before coming down to the ground, those lateral downspouts need to be supported more often, at least every 5 feet.

Protect downspouts where animals or equipment can damage them. Here, in this picture, these downspouts are in an area where cattle have access to-- cattle can easily dent aluminum or galvanized steel downspouts, so what you do is you put those discharging into a steel pipe or schedule 40 PVC, or some other rigid pipe, that can withstand the animal or other equipment bumping into the downspout.

In terms of the number of downspouts, first of all, you have to figure out what controlling? The gutter capacity or the downspout capacity? Once you've determined that, you can then move on and look at the area of roof served by your gutters and your downspouts. And what this does, it will tell you how often you have to have a downspout for your roof system. So I put this picture in here because as I'm

looking at this one, it looks to me like this one definitely wasn't designed as an animal waste system. You can see two downspouts on this fairly large building on either end, and this probably wouldn't work if you're designing for a 25 year, 5 minute type of rainfall event.

Let's put this into a little bit more perspective. When you're planning, what you're going to be doing is you're going to be adding up your length and your width of roof so that you know how much area you have. You're going to figure out what the area served by your gutter or your downspouts are. In this example, I may be able to serve-- each downspout may be able to serve 1/4 of the area of that entire roof, so I'll need four downspouts, and that's per side.

Sometimes, your downspouts are going-- and width is going to be controlled by the structure itself. If you have a long distance between points where you can bring down a downspout, you're going to have to have your downspouts being at some increment of those spacings of your roof posts. So that's something you consider. And this is, when you start dealing with these type systems, or when you end up having to play the game, do I increase gutter size or do I increase the number of downspouts, or downspout size? So these are when you end up having to do a little bit of a balancing act when sizing the gutters and downspouts.

Let's talk a little bit about gutter outlets. Obviously, you don't want to cause an erosion problem where your gutters are outletting. In many of our animal waste situations, we're going to outlet to an underground outlet and take that water to a safe place, but there are splash guards that are made for this purpose. In this picture, it's outletting onto a gravel surface. You could put down rock riprap, or some rock to dissipate that energy coming out of the gutters.

But you want to make sure there's something there. That you're not going to cause an erosion problem. In the example we gave before, we did use an underground outlet and then take that water to some sort of outlet, whether that's a waterway or whether we're going to take the water away from the production area and just allow it to be discharged onto a vegetated area.

Underground outlets will collect water and can collect water from multiple roofs. It can be routed around a facility. You size underground outlets much the same way that you size any underground outlet. You look at the controlling discharge coming into them, what's the size of the roof? What's the peak coming off the roof and that are coming in at different points? And make sure at each point you have a downspout coming into your outlets, that you have enough capacity to carry all of the discharge at that

point.

And the thing that's true of these lateral collection pipes. You want to make sure that the lateral collection pipe, as you're moving down the pipe, you have the capacity necessary to carry all the flow at that point. Here's another example where you've got a gutter that's coming down, and you've got one lateral pipe that's servicing the side of this particular facility so that you can come down and only have really one entrance point into an underground outlet.

I do want to mention, you don't always have to route roof runoff to an underground outlet. In this case, the water is routed to where it's needed. There is a reception pit at the end of the barn where dairy waste collects. And in this case, water being added to the system was not a concern, and that water, adding it to the manure here actually makes it easier to pump and move that slurry.

All right, I'm going to take a break here for a second and see if we have any questions at this point. Hamid, do we have any questions?

Yes, two questions. I've been trying to reply back so I'm communicating on the side, but one question from David. I thought it was interesting. He said, is captured rainwater actually considered clean? So I wrote back, and I said, well, it all depends on what the definition of clean. If the true definition of clean is safe enough to be consumed by humans.

But is it safe enough to be consumed by humans? I replied to him, it's probably not a safe assumption. And I have seen, for example, the example you offered in Alabama they use UV sanitizers to sanitize it, but my professional call would be, I would test it, see what kind of roof it's coming from, and Bill if you wish to. It's actually your question, right?

We're going to get into that a little bit later in the presentation. I'm going to talk about roof water harvesting and requirements and a little bit about that then. But you're right. There are-- Rainwater, by itself, is very clean. When the rainwater hits the roof, it can pick up contaminants and so you may even get some fecal coliforms that are in that roof's runoff water that you probably wouldn't want to drink straight.

OK. And next question now, I'm going to paraphrase all this. It's from [a participant]. He had a good question. He said, you talk about gutters and downspouts, but how do you calculate how much water you collected on top of the roof, the structure? I replied with my rule of thumb that I always use, and

that is for an inch of rain on a 1,000 square foot of surface, you get about 600 gallons. So that's my rule of thumb, 600 gallons per thousand, or 0.6 gallons per square footage per inch of water. Obviously, it depends on the slope and all, but there are various--

I had another number later in my presentation, it's probably metric, but very similar.

Would you like to entertain one more question?

Sure, one more.

Mike says, do you have any data-- oh, this is interesting. Do you have any data on how far below the edge of the roof a gutter can be before the runoff shoots past the gutter? How far can you put the gutter before there?

We have a graphic that I'm going to show later on that's really talks about lowering gutters for things like to avoid snow. And that's the only thing that I've seen in the literature on that particular question. But I think what Mike is trying to get to is you want to make sure that the gutter is wide enough to be able to capture that runoff, especially if your gutter is [inaudible] a little bit, you don't want the water to overshoot the gutter. All right, let's move on.

All right, so some other things to consider when you're looking at a site, what are you going to attach your gutter to, are the rafters there to attach to, are the fascia boards in good condition? Because you can't attach-- you wouldn't want to attach a gutter to a rotted board that's going to need to be taken care of. Is the fascia board stout enough to be able to handle the load from a gutter? And I say stout enough. If it's 2 inch-- is it a 2 inch board or is it something that's there more for aesthetics and wouldn't really be load bearing, a 1 inch board.

Some other things to think about, and we're going to get into this a little bit more. When you attach the gutters, for residential, a lot of times you'll see what they call a spike and ferrule used to attach gutters to the fascia board. And many times when you have long runs of roof, these don't work very well because the expansion and contraction of that metal. And for 100 foot run of roof, you could have almost a couple inches of movement of that metal from the expansion and contraction. And that expansion and contraction will actually work those spikes out.

In terms of weather roof gutter support spacing, typically 32 to 48 inches- you've got 32 for aluminum,

48 for galvanized steel spacing. Those will be closer in states that are dealing with snow loads, 18 to 24 inches. Another very important fact is that all the gutter components must be the same metal type to prevent electrical corrosion. You wouldn't want to mix aluminum and say, galvanized steel because you could have-- you will have a problem caused by those two metal types coming together.

So as I mentioned, try to avoid the spike and ferrule because it can be pulled out due to that expansion and contraction. Some typical gutter hangers that are out there. They call them hidden hangers that ride on the inside of these case style gutters, and you've got a bolt there that can be screwed into the fascia board. You can also use roof straps to attach to this hidden gutter hanger.

Another thing is to make sure that these gutter hangers are stout enough to be able to carry the load. And this graphic is just showing you make sure that there's a reinforcement rigging in that gutter hanger, because you wouldn't want the hanger itself to bend. Sometimes your fascia board is not perpendicular to the ground. It's in there at an angle, and so you'll need to use a wedge of some sort to make the gutter sit properly.

There's other types of connectors, wrap-around straps. In the picture on the left here, there's a strap that's going into the hidden gutter hanger as well as a wrap-around strap. This picture happens to come from Wisconsin, where they are dealing with a significant concerns about snow. Other types of support, your rigid support. You could have brackets. You could have a wooden type of brace like shown in the right. Some of these brackets are fashioned to fit your particular situation.

So the standard, you talk a little bit about the gutter material itself. Aluminum gutters and downspouts, you have a minimum thickness of 0.027 inch and galvanized steel gutters and downspouts, you have a minimum of thickness of 28 gage. That's pretty much industry standard. And again, don't mix metal types. I will mention that in some parts of the country, you can see wood still being used for gutter, and the standard does call for-- if you have a wood gutter, for it to be free of knots.

Some other gutter materials that are used, you can use the copper gutters. Obviously, that would be a very pricey gutter. And you would only see that in a special circumstance where you had maybe some agro-tourism going on and somebody wanted to really dress the place up. It's pretty much a residential type of gutter. Vinyl gutters are also out there, but I don't think you're going to see them used in an agricultural setting from the standpoint of lifespan on those gutters, as well as their carrying capacity.

Let's talk a little bit about an alternative to gutters, and that's the gravel drains. You hear them called a bunch of different types of terminology, infiltration channel, ground gutters, tile roof drains. Basically, it's the water-- the drip line comes off the roof and will hit a gravel area and at the bottom of that gravel area, you've got a drainage tile that's going to collect the water. So water runs into the gravel, infiltrates into the gravel, to the underground outlet, the subsurface drains, that's at the bottom of that.

Here's another picture, and if you notice, the roof line comes out and where the water hits the ground, you can see where that action has actually created a-- no grass is growing right where the water is primarily hitting. You normally would want to see about a 12 inch overhang before you got to that gravel drain. And here's what it looks like if you were to look at a different view here.

You've got the subsurface tile drain at the bottom of about 2 foot of gravel. And the gravel is poorly graded so that the infiltration into that gravel is very high and that should not be a limiting concern. Poorly graded gravel, you want to size the subsurface drain to carry the design rainfall at the peak rate. Same as you've designed for the gutter capacity, you're going to make sure that your gravel drain can carry that same capacity.

And another important point is if livestock had access to the area where this gravel drain might be, you want to exclude the livestock. Because one of the purposes of capturing roof runoff is to keep clean water clean. So here's a schematic putting up a fence and a curb to keep water from a production area away from this gravel drain that you've installed.

Let's move on and talk a little bit about snow and ice. Here's the picture talking about how gutters should be placed below the line. And this gets a little bit to the question that Mike had. You want to make sure that you have the gutters able to capture the runoff from the roof, but if you're in an area where you have snow and could have snow and ice sliding off the roof, you want to make sure that that's in a position where that ice and snow will miss your gutters.

So here's a diagram. I think it originally comes from the Midwest Plan Service. But you'll see this particular diagram in a lot of different places in literature if you go out and look for design of gutters.

Snow guards. The only thing I'll say about-- snow guards can mitigate the sliding of snow off of a roof. You wouldn't want to add snow guards to an existing roof. And the reason for that is, they will increase the snow load on the roof, and so you wouldn't want to-- unless the roof had been properly designed to

carry that added snow load, you wouldn't want to change the loading on that roof.

I did find this interesting. Maine has what they call a snow resistant gutter. Basically, a slot that they've created at the end of their roof that allows rain to go down and hit the gutter but snow will slide off. So I found that interesting and thought I would add that here.

Let's talk a little bit about PVC gutters. You will find some producers that choose to make their own gutters from PVC. And a couple things about that, UV resistance is key. You can either-- you buy UV resistance PVC and just have the additive put into it, or as an alternative, you can paint the PVC. If you don't do that, what's going to happen is that your PVC is going to degrade. It won't be but a very few years and your PVC will get brittle. So you definitely want UV resistance. I've included in the handouts a PVC bracket that can be fabricated for holding up PVC as a PVC gutter.

Here's some slides where the producer has taken the PVC, basically cut it in have using something like a table saw. You'll notice that there's even a T that's used to attach the gutter to the downspout. Or you can even cut in 1/2 a 90 degrees. Here's a picture of the bracket. This came from Vermont, and here we've got where a downspout trash guard was installed. And trash guards in gutters are important because you can get leaves or debris. In this case, they talk about silage blown from a nearby silo onto the roof, could end up in your gutter.

In this particular picture, points out using lag screws into your rafter, in this case. And lag screws, it would be good because they're going to be more stable than a nail, getting back to the idea of the spike and ferrule and not wanting those to work their way out. Here's another picture of a gutter on a bracket, and this one kind of illustrates a little bit of how the bracket is moving down so you can control the slope of the gutter.

And there's a picture of the PVC gutter at the dairy. And the note was, this gutter system was over 12 years old and still working. So PVC gutters do work. I will state, check with your state and see if PVC gutters are allowed or not. I wanted to mention real quick that there are-- I've talked so far about the NRCS method for designing and sizing gutters.

Many gutter manufacturers have their own websites, have their own gutter sizing tools. Here's a roof slope card that's used by one of the manufacturers, and the only thing I'll caution you about using the manufacturer's websites and their gutter sizing is several of those that I looked at didn't use the 25

year, 5 minute design storm, like what we want to use for ag waste. So if you're using one of those, just be aware of that part of the equation, what you're designing for.

Let's move on and talk a little bit about rainwater harvesting. If you're going to use gutters to capture roof runoff and then try and capture and reuse that water, there's a few things we need to think about and know. Rain water itself, is one of the cleanest sources of water in nature. However, after that rainfall water has come in contact with a roof and gutter, it's no longer clean. There has been some research to show that roof runoff can contain fecal coliforms. It can contain some contaminants, bits of trash that have been blown onto the roof and made it through whatever screen you may have put on your gutters.

So one of the ways around this is diverting the first flush of rainwater away from your storage. And really, it only takes just a few millimeters of that first flush to get rid of a majority of the contaminants off of a roof. So just something to know. I think I have a picture showing one of those here in a few minutes.

So cisterns and rain harvesters are something that's been around for a long time. You basically need something to catch the rain, to store the rain, and some way to control use of the water. Here's the example of a first flush diverter. If you look at the picture on the right, you'll notice the downspout comes down-- it comes down and then there's a plug at the end. So what happens is the first amount of rainfall that comes down, goes down the gutter, is stopped by the stopper. Once that pipe fills up, then the water is diverted and goes into storage. So the dirt and the contaminants that first wash off the roof are captured in the pipe. Clear water is then piped into the tank. Filtration is probably still going to be needed.

How much water can you get? Here's an example that John Fripp gave me. I talked about 1 millimeter of rainfall falling on 1 square meter of roof will result in about 0.8 liters of water. That's when it's hot. When it's cooler, you can get 1 liter per 1 square meter of roof. I've seen some other examples that are out there that you can have tremendous volumes of water from a very minimal sized roof.

It's a trade off in terms of you're going to use the water for-- if you're going to store, you have more storage to capture all the rainfall or-- because storage gets expensive. Or you have less storage and are more trying to bridge the gap during drought times. So there's a little bit of a trade off. You're going to have to decide what kind of time step you're looking at.

Anyway, so you can get a fairly significant amount of water off of a roof. Here's the picture from Alabama from that CIG, where they are capturing roof runoff off of a poultry house and are going to reuse that. They take that water and they did find that it was pretty clean water when it came off cleaner than they expected. And I heard Jeff Porter, who's in charge of the CIG, was just telling me that the research has found that they actually had more contamination from the algae growing in the tank than they did coming off the roof.

This is showing the same system. They've got some pretty big capture going on here to get water to that tank. And here's another one, similar case, capturing roof runoff for use in poultry drinking water. And they've used a screen to filter out the water as it comes off the roof. Another picture that John Fripp gave me. This is a small system where you've got a little bit of a roof that's going to provide a little bit of drinking water. I think John was using this as a demonstration in Afghanistan as a way to provide some drinking water for in a very arid region.

I wanted to include something in this presentation about rain gardens, but I just don't have time in this particular presentation. I did add a handout from Iowa on rain gardens, so I encourage you-- if that's something you're interested in, to take a look at that handout. I wouldn't be a good engineer if I didn't talk about O&M briefly.

Removing leaf and twig litter, inspect and repair roof components, inspect gutter drain, if you have the rock infiltration drains. Make sure that you don't have something that's blocking the flow of water into that drain or diverting flow away from it somehow. Inspect outlet pipes. And make sure that you have animal guards will be important in those outlet pipes, and ensure that they are free flowing.

So here's my levity for the presentation. Here's my gutter pre-government shutdown, and here's my gutter post-government shutdown. So somebody's going to be watching this presentation five years from now, and their going to say, what in the world is he talking about? Just talk to somebody who's been around the agency for a while about October of 2013, and then you'll get it.

All right, something else, here's a picture of a gutter that's obviously not been maintained, and you see the little plants that are actually taking root in that gutter. So gutter maintenance is important. A few more things to talk about. I've talked about gutter design and a lot about systems. So this is a way to review and some things to think about if you're making that site visit. Talk to the producer, and some of

the things that you're going to think about, inventory, while you're making that site visit.

Some things you want to make notes of. What are the lengths and widths of the roof that are involved? Look at the building eaves, can gutters be easily attached? Is the fascia board, is it good enough to attach gutters to? Is it thick enough? Is it in a good enough condition? Is there signs of rot? Is that something that's going to have to be replaced first? How wide is the fascia board? If you have really longer length building, is there any slope to the building itself? And slope to the roof?

Consider possible downspout locations. Remember, you've got to bring that downspout down and you've got to attach it to something. So if you have long open spots, or you have limited posts, like that one picture I showed earlier, you want to make sure that you're taking that into consideration when you're designing your downspouts. And then think about, could you do a tile outlet? Could you do a gutter drain or an infiltration drain? Is that a possibility? Is there room for that and can you keep livestock away from the eaves of the building.

Can a tile outlet be installed, or are you going to need to break concrete to put one in? You know, if that's the case, it may be better to run a lateral collection line down the length of the building so you only have to go down into the underground outlet in one place. What do the downspouts outlet into? Is ice standards a factor for where you're looking at? Is it going to affect gutter life span? Are long slopes present? Can I use a rock trench, and will livestock have access to the site? These are all things that you want to make notes about when you're doing your site visit.

I want to say thanks-- take a minute and say thanks to some folks that sent me information to give this webinar. I had a bunch of folks that sent me spreadsheets, a number of states had spreadsheets. I included four spreadsheets in the handouts. And primarily, don't be offended if I didn't use your spreadsheet. I tried to pick spreadsheets that were well documented and easy to use and use the methodology that's in the *Ag Waste Management Handbook*, Chapter 10. Ohio and Florida had very simple spreadsheets, just size of gutters and downspouts. Indiana's and Wisconsin's spreadsheets went into more details sizing the tile drain outlet pipe, providing added sheets for things like specs. So these has some very nice features.

Check with your area engineers to know what they are using, what they want to use, and these are for taking a look at if you don't have something or you're looking for a tool. I also included some handouts from Wisconsin. I had some great specs, a lot of the pictures came from them. Maryland has a gutter

design manual that's included. Just be aware that the rainfall and a lot of the charts that are in that manual are specific to Maryland rainfall, but there was really good information in there.

Vermont had some really good information that they gave me, especially on the gutter drains, the tile outlet drains. Iowa, the rain garden hand out. And I also included a small farms handout for talking about benefits of gutters for handing out to folks. It came from the ENTSC.

I want to say thanks for some pictures. John Fripp, Alabama, Wisconsin, Pennsylvania, Vermont, Maine, all provided me with great information. I may have received information from others, so I want to say thank you to you too. I had a bunch of people that sent me information. Thank you to everybody who did that. If you need any more information, I will point you to the Missouri Extension website. Their WQ322 page has some good information on it as well. So with that, comes to the end of my presentation. So let's see if there's any other questions that are out there.

Thanks Bill, great presentation. Yes, we have a few. David goes back, this is when you suggested that if there was any interest in what is called rain gardens, he goes back, he said he's very interested and if our center would consider that as a future webinar. I'll go back, and I will convey that to our webinar committee for consideration.

There were a couple of questions that are kind of follow up from [participant] and Laura. They're mostly interested, she wrote, she said we have very steep roofs. We have old barns with steep roofs and how to use. So the question is regarding how do you calculate the capture of the rainfall? I just briefly wrote back. I said, I would look at the footprint of that slope and then go from there, but if you'd like to add to that.

It's a trade off from the projections of the water to the gutter end and you are worried-- is guttering a consideration or not? [INAUDIBLE] graphic in there that shows. I've showed that. I do know that some of the gutter manufacturers that are out there slope of the roof itself is one of their design considerations, but it's not really in our *Ag Waste Management Handbook*.

I have seen some online calculators and you can put in your footprint and, but in any case, here's another good question. It says what are the slopes and roughness coefficient for corrugated plastic drain pipes. I guess roughness coefficient and [participant] is probably thinking about Mannings Equation. Right. I mean, that's a look-up-able item in terms of whether you have the smooth pipe inside

of the corrugation. I haven't seen anybody-- a lot of those pipes I would expect you to use the smooth on the inside version. The Mannings entry for those pipes is a look-up-able item. For a smooth pipe, it'd be 0.012. There was a slide in here that said it is typical for a smooth surface.

OK, next question is from Keith, and he says on rainwater harvest, first wash based on what frequency? Seasonal or weekly or what?

The little bit of research that I've looked at didn't get specific. The study that was done, they captured rainfall off of a roof, I believe it was done in a Midwestern state. I don't remember which state. But it basically showed that most of the contaminants that came off, came off very quickly off of the roof.

Punja has a follow-up question on rainwater capture off a roof. He says, if I want to use this to provide livestock water in a pasture? I've come up with my water requirement and now how do I size up my elevated structure to provide that volume of water to me? So you kind of have to work the problem backwards, in a sense.

So the way that you would do that would be-- there's a couple different ways you could do it. If you're familiar with the SPA Model, you could set up a SPA Model run that basically handles that question. If you're not familiar with the SPA Model, you could, a coarser way to do it would be to take a monthly time step and calculate the amount of rainfall that you're going to get on a monthly time step. And what you want to use is a 30-day curve number for that.

You could get those numbers out of the AWM computer software that we use for sizing animal waste management systems. If you just didn't include any waste, you did just the roof, you could find out how much water you were getting on a monthly basis and inside your storage so that you would capture enough water for a month for your driest time period. And likely, that's average.

So now, you're looking at an average year, sizing for an average year, you may want to add to that some safety factor to try and cover drought years. Or if you want to be really sure that you're covering drought years, then you're going to have to go to a simulation like a SPA Model or we used to have a computer software program called [inaudible] that's unfortunately, is DOS based. So I think we've lost that, but you could use that. It was a monthly time step type of the reservoir sizing software.

Well, Bill, I don't have any more questions here. If I have missed any questions, or if you have any more questions, feel free to email Bill. I think that will be fine with you. And I don't have any more questions so

Bill, if you're finished here, I guess we have reached the end of our webinar here.

Thanks, Hamid. And take a look at those handout materials. If you have questions, certainly feel free to give me an email or a phone call.

I just had one last question come through. It says, how do we get a hard copy?

Let me chime in on that. The presentations are available at Conservationwebinars.net. So if you go back to the web page you used at conservationwebinars.net to launch this live event, there will be at the very bottom, scroll down to related files, and you'll see Bill's or handouts that are presented as a zip file, and the presentation is presented as a PDF file.

Thank you, Holli.

I guess if we're wrapped up, I'm going to invite everybody back to join us on November the 12th at 3 o'clock for pastured poultry and conservation planing. We'd love to have you come back on November 12, and if not, then we'll see you the next time you come back. So thank you, everybody. And Bill, thank you for your presentation, Hamid for moderating, Emily for helping us from AT&T and to Daryl Outlaw with Southern Regional Extension Forestry. Thanks, everyone.