## Constructed Wetlands

## Part 1

## Season 1, Episode 11

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**John McMaine:** Thanks for joining us on Streamlines, your source for water knowledge. I’m your host, John McMaine with South Dakota State University Extension. This is Episode 11.

**[transition music plays]**

**John McMaine:** Well, hello again, everybody. Welcome back to another episode! Again, I’m John McMaine.

**Anthony Bly:** And I’m Anthony Bly.

**John McMaine:** And today, Anthony, we are going to be discussing constructed wetlands. Which actually is a topic that’s very near and dear to my heart because I spent about three years of my life thinking about constructed wetlands during my PhD. So, Anthony, can you tell the audience about wetlands or constructed wetlands. What’s the first thing that comes to your mind when we talk about that?

**Anthony Bly:** Well, you know, wetlands, you know, in general are really so important to our ecology and I’ve come to realize that, you know, in the latter part of my professional career. But constructed wetlands are obviously something you make.

**John McMaine:** Yeah, and so, constructed wetlands of course kind of emulate the natural process of a wetland but it’s an engineered system designed for a purpose. Usually treatment, sometimes water quantity considerations as well. But the cool thing about constructed wetlands to me, is that they are a living system. And so, whenever I did my PhD, we worked with two different constructed wetlands and every time I would go out there, I would see frogs, I would see turtles, I would see snakes, I would see birds. We had lots of gorgeous plants and flowers. I’m not an ecologist but man, I loved going out there!

**Anthony Bly:** Just a lot of diversity.

**John McMaine:** A lot of diversity and, and so, and it was a nice field site because you could, you know, have zen every time you go out there.

**Anthony Bly:** Sure yeah.

**John McMaine:** But from a treatment perspective, the nice thing is they have a kind of diversity of systems within the system. You have anaerobic zones; you have aerobic zones. And because of that, you’ll also have different microbial communities, you’ll have different treatment capabilities from a nitrogen perspective, that’s really important.

**Anthony Bly:** Absolutely, break that down. Denitrify that.

**John McMaine:** Yeah, I was actually looking at different pesticides and some of the things we saw, like atrazine breaks down in aerobic conditions.

**Anthony Bly:** Sure.

**John McMaine:** But something like pendimethalin breaks down in anaerobic conditions. And so with constructed wetlands, you can have deep zones and shallow zones and so you can actually get treatment of a variety of pollutants because its not just one continuous system throughout.

**Anthony Bly:** Yeah, like a manufacturing sense of some, some process. It’s, it’s a biological process.

**John McMaine:** It is.

**Anthony Bly:** It’s a continuum.

**John McMaine:** Absolutely. So, for our constructed wetlands episodes we interviewed Jeff Strock.

**Jeff Strock:** Yeah, my name is Jeff Strock and I am a professor at the University of Minnesota and I’m located in southwestern Minnesota at the southwest research and outreach center.

**John McMaine:** So, you might remember Jeff from Episode 6 and 7.

**Anthony Bly:** Yes.

**John McMaine:** We talked about controlled drainage.

**Anthony Bly:** Yeah.

**John McMaine:** He was, he had some great stories to tell then so we thought we’d bring him back for constructed wetlands as well! And Jeff, really had a lot of great information to share with us and I really wanted to hear his input because he has a lot of experience. Both from a research perspective and a science perspective but he’s pretty well connected to the growers in the area there. So, he get’s a good perspective from, from as well.

**Anthony Bly:** Sure, sure you have to be.

**John McMaine:** Because at the end of the day, these systems have to go in if we want them to have impact.

**Anthony Bly:** They have to work.

**John McMaine:** They have to work. So, in the first clip, Jeff gives us some of that insight and background. And to kind of covers some of the stigma surrounding wetlands and what he feels like some of the general benefits of a constructed wetland.

**Jeff Strock:** Initially, when we designed our systems, we actually designed and had our systems that we have here at Lamberton back in 2007-2008. And at the time, we called them constructed basins. And for some people and, and this is mainly at some of the state agencies, the use of the term wetlands invokes a certain picture in peoples minds about what wetlands are. And when something is called a wetland, then it becomes under the purview of other regulatory situations and to be absolutely honest, when we were looking at designing these, I based the designs on or at least one of the designs was absolutely based on a surface flow style wetland, I mean without any question of a doubt. If you looked at it, you’d say, “Oh that, that does kind of look like a surface flow wetland.” Of course, the other two were much more hybrid kinds of systems, you know. To answer your question directly, I now consider what we have as, as constructed wetlands. The ones that we’ve designed, three styles that we’ve developed, are very unique and different than one another in how they treat water, how they retain water. And so, our most tensively designed system are really kind of based on water, actually wastewater treatment plant or you know, like livestock on farm livestock water treatment type of a facility. You know, when we think about just, just wetlands, you know this is kind of cliché, but wetlands truly are kind of the kidneys of the landscape, right? As, as we have water that is either from surface runoff or groundwater flow that may flow into natural wetlands for example. You know, from a water standpoint, their purpose is really clear and, and they do a lot of purification. And they retain water, they can be sort of a storage mitigation type of a situation. And, and of course, I am not a wildlife person. I am a sportsman and so you know, I, I’ve used wetlands and wet areas for hunting purposes for example. But they’re also, you know, aesthetically pleasing and they’re habitat for various reptiles and, and amphibians of course. But you know, they also have plant diversity so there’s a lot of biodiversity in these types of systems. And depending on the vegetation, that’s how there can be really advantageous for pollinators as well. So, you know, when we were setting out to design our constructed wetlands, we were designing our constructed wetlands purposefully for treating agricultural drainage water and that was combined surface and subsurface drainage. Okay, so this was not just natural flow, it was you know, flow that was directed to the systems off of our agricultural farm in southwest Minnesota. With the sole purpose of treating that water and proving the water quality. The other ancillary benefit of the habitat or other biodiversity benefits, those were things that we expected would come but our sole purpose was really just for treating agriculture drainage.

**John McMaine:** So that term “wetland” it’s loaded, it’s a loaded term.

**Anthony Bly:** Yeah, it’s loaded. It means lots of different things to lots of different people.

**John McMaine:** Yeah, and it, it does have, you know, regulatory ramifications.

**Anthony Bly:** Absolutely.

**John McMaine:** Swamp buster.

**Anthony Bly:** Yeah.

**John McMaine:** So, do you think it’s helpful or harmful for our purposes to refer to these systems as constructed wetlands?

**Anthony Bly:** To me that, you know, coming from an ag background, kind of talks like, you know, to me that’s like a stock dam.

**John McMaine:** Sure.

**Anthony Bly:** You know because they’re constructed.

**John McMaine:** Sure.

**Anthony Bly:** Most, you know, all the time, most of all the time.

**John McMaine:** Yeah.

**Anthony Bly:** For water purposes. So, so I think that constructed related to that. But they’re also kind of wetlands in a way but their purpose is more water supply.

**John McMaine:** Sure.

**Anthony Bly:** So, it’s different.

**John McMaine:** Yeah. Do you think people would view constructed wetlands negatively because of the term ‘wetland’ being in there, or do you think they view it positively because it’s a deliberate purpose, we’re not kind of trying to mix farming and wetlands in this system, it’s a system with a purpose for water treatment and that’s it.

**Anthony Bly:** Well, I think the word constructed implies that there’s, there’s some reason there. I know the first time I heard it, it got me thinking on those lines right away.

**John McMaine:** So.

**Anthony Bly:** Why would you want to do that?

**John McMaine:** Gotcha. Yeah. So, we’re, we’re, we are able to convey the multiple benefits that we get with a wetland by tagging on constructed there. That we’re doing that for the purpose of these.

**Anthony Bly:** These activities.

**John McMaine:** These other benefits, yeah.

**Anthony Bly:** Yeah so, I think, I think that, that terminology is fine. Constructed wetland.

**John McMaine:** So, when we think about natural wetlands, they are or have been or can be pretty common across the landscape especially in the prairie pothole region.

**Anthony Bly:** Absolutely.

**John McMaine:** And so, Jeff brings up some interesting points about Minnesota, being the land of 10,000 lands and in some cases, 10,000 plus wetlands, right? I mean a lot of these are slews that, that may be lakes sometimes or may feed in the lakes.

**Anthony Bly:** Right. Yes.

**John McMaine:** So, wetlands are also very integral part of that part of Minnesota’s identity I would say.

**Anthony Bly:** Absolutely. I was thinking about the most sought after lakes, as far as water quality, I think of, I think of the Great Lakes in Iowa. They’re surrounded by a network of wetlands that filter the water that goes into the lakes.

**John McMaine:** Sure. And so, he discusses some ways that produces could be willing to adopt these practices and the idea is strategical location and maybe even the perspective of getting constructed wetlands into the landscape, maybe in lieu of natural wetlands or in addition to. To really kind of support those water quality objectives, habitat objectives, water quantity objectives.

**Anthony Bly:** Well, we intensively agriculture. We’ve overdone our soils capability by adding things to it, right? We’re increasing the efficiency of the soil so that puts it at a naturally higher load on our system and so it only makes sense that we would need more filters, right?

**John McMaine:** Sure.

**Anthony Bly:** And then originally, we had with the prairie.

**John McMaine:** Sure.

**Anthony Bly:** So, I’m not implying that we need more wetlands than that. But I mean there is a need for more filtering.

**Jeff Strock:** You know, I, I was really influenced by the researchers down at Iowa State. Wetlands at Iowa have been a very well supported treatment option for water quality in ag water sheds and Bill Crumpton down there was kind of the pioneer in a lot of that. So some of his work inspired me, I was also in Ohio and saw Bill Crumpton at the Ohio State University and kind of inspired me to think about why couldn’t we do that in Minnesota. After all, Minnesota is the land of 10,000 lands and probably way more wetlands. And we’ve lost about 50% wetlands technically speaking in Minnesota. Now, obviously when we think about wetlands we know that there are some plant criteria, soil criteria, hydrology criteria, that go into actually delineating and defining wetland. In your part of the word, John, in South Dakota, Minnesota, the northern part of Iowa, especially the Des Moines lobe, you know prairie pothole. Historically prairie, wet prairies, that’s why our soils are thick and black. It was cool. It was wet. But you know as settlers came in and started to occupy the land, you know, some of these wet spots were necessarily drained, for building roads, bridges, and infrastructure, cities, towns, and, and then eventually agriculture. And so, some of these things have been lost because of those things. And so, when we think about your question related to, are they common? They are quite common in Iowa and less common here in Minnesota although we do have some federal programs that support some of these. The tricky part, obviously producers are using large equipment, and if you’ve got a wetland that gets restored for example, in the middle of a field, that kind of creates some challenges, you know, for big equipment and having to go around those things and I understand that. But we do have some growers who have taken land that’s maybe, you know, adjacent to a river or stream, those kind of things, that really doesn’t produce well. Maybe it floods, have restored those into what their previous function was as a wetland. But when we, when we think about using constructed wetlands for example, part of our purpose in thinking about doing this was maybe we would provide growers an opportunity, if they were interested in a wetland feature, that they could probably do a much better job of self-identifying, you know areas on their farm that are either poorly drained because they didn’t have tile under them or there were seeps or whatever that they could say, you know what, this is kind of close to an edge of a field, maybe this would be a place where I would be willing to consider installing some kind of a constructed wetland. You know, so maybe it was never actually a natural wetland historically but if they could have the opportunity to develop an area and get some funding support to do such, that they would have some interest in maybe doing that. And that was also part of our motivation, is to try to give farmers an opportunity to think about this technology that if they were unwilling or unable to restore a natural area to a wet field, like a wetland that maybe they could find an area that was conducive to providing that water quality benefit, that habitat that biodiversity and kind of minimize that aggravation about trying to farm around these things by strategically locating it. And that’s about what it was for us, thinking about strategic location of being able to construct a wetland rather than have to settle for ‘well here’s where it was historically’ and ‘I’m not going do it because it’s inconvenient.

**Anthony Bly:** There you go the convenience.

**John McMaine:** Yeah

**Anthony Bly:** It’s a big deal

**John McMaine:** It is. It seems like that is an easy reason for folks to not do things.

**Anthony Bly:** Correct.

**John McMaine:** Because it makes a big difference.

**Anthony Bly:** It’s in the way.

**John McMaine:** And efficiency is important for farming?

**Anthony Bly:** Correct

**John McMaine:** I mean because time is most often the limiting factor. There’s short windows for planting and kind of optimal windows and so…

**Anthony Bly:** Correct

**John McMaine:** In order to get that efficiency, it has to be considered.

**Anthony Bly:** Yup and you know as our precipitation has increased in the last 30 years and that puts even more pressure on those time windows.

**John McMaine:** And so, placement, maybe it isn’t a restored wetland system, it’s a completely new wetland system which maybe has challenges within themselves but that can be a pretty important feature to optimize kind of the agronomic impact of a field as well as a water quality impact. Because you could potentially treat more runoff if it’s in a certain part of the field versus if it’s in another, with the tile outlet for example. So, I think placement is a pretty important question when we think about constructed wetlands from both of those perspectives.

**Anthony Bly:** Absolutely.

**John McMaine:** So, whenever you think about putting in a constructed wetland in from a farmer’s perspective, what would be some other barriers you would say, or what would be some advantages that you would see for a farmer to put in a constructed wetland?

**Anthony Bly:** Well, the barriers would impact the value of the land, you know. How you overcome the fact that investors are buying land and folks expect a return off their land and so now you make a wetland and how do you show that return? it’s more aesthetic in some ways than filtering. And so, the filtering message I think has got to come to the top at some point and it is, you know? We’re really doing that but that’s a big barrier I think, the value of the land. So, we need to put a high value on what that wetland would do. What that constructed wetland would do. That needs to be valued as well. And so, that comes from I think we’ve had conversations about that before you know? Some of the advantages … I mean, yeah happy neighbors are always good and slowing that water down, cleaning that water up…

**John McMaine:** Sure.

**Anthony Bly:** I think are at the top of the list.

**John McMaine:** Sure. Yeah. If you have a low area that floods say 3 out of 10 years, or 5 out of 10, or 7 out of 10 years. What do you think the cutoff is for somebody to say, ‘You know, maybe it’s not worth trying to farm that? Maybe it’s worth trying to put a constructed wetland in there?’

**Anthony Bly:** Well, you know we’re… this is related to the *Every Acre Counts Program* so closely because we’re identifying lands that are marginal based off of their profitability and as I mentioned, we’re concerned about value of land and can we make a profit and if we have lands that are not consistently making a profit or even coming close, we need to step back and stop putting our resources on those lands. And so, why are they unprofitable and marginally wet is one of those that we’re finding over and over.

**John McMaine:** Sure. And you could save a lot of money by not farming a lot of pieces of ground.

**Anthony Bly:** Absolutely we’re trying to bring awareness to producers and landowners about that. How much their expense is crop production inputs could be reduced.

**John McMaine:** Sure

**Anthony Bly:** Overall, on the whole farm.

**John McMaine:** Right. And so, then if we identify those marginal acres if they are a low lying area that’s maybe a perfect fit for those type of constructed wetland system.

**Anthony Bly:** Absolutely. There’s something that has a purpose, we just need to identify its highest and best use.

**John McMaine:** Yup.

**Anthony Bly:** That’s what we have to think about.

**John McMaine:** So, in the next clip Jeff is going to discuss how he went about designing their constructed wetlands and give some more background on the ways a constructed wetland performs some of those mechanisms of treatment.

**Jeff Strock:** We have six constructed wetlands, each one of them, the basin is about a half an acre in size and these wetlands receive a combination of surface and subsurface drainage from about 170 acres of our land. That’s not to say it’s surface runoff and subsurface drainage from the same areas because we have roadways and so some of the surface runoff is inhibited to be able to be delivered to our wetlands so it’s a little complicated, but two of our wetlands are designed to surface flow style constructed wetlands where there’s meant to be a slightly deeper permanent pool and then we’ve raised up the elevation to another level so that as that water level rises we can get some sheet flow into that other area. Then we’ve got another elevation rise to increase the area of the wet saturated flooded area for example. Then once it gets to that point water will begin to actually flow out of the system. Our second set is actually based on some conversations that we’ve had with stakeholders, state agencies, growers, those types of things. Years ago, when people were thinking about these potholes, and here in Minnesota we have quite a few of them that have surface intakes in them, and those can provide a lot of sediment in a direct conveyance structure for sediment for reverse ditches. So, one of the questions was well what if we treated those and we installed a high density that was shallow and narrowly space? So, our second design we developed these horizontal flow systems. So, we have some drainage pipe basically buried under the ground under our vertical flow pipes, then has to vertically flow through the soil and get treated and then water 2ill flow out those pipes. So, we want to try to keep those somewhat dry, so we don’t intend that those are completely saturated at all times. And then we have our horizontal flow system. And our horizontal flow systems were designed after a kind of water treatment center, you know? A manure treatment concept where we’re basically using rocks as biofilms for organisms, so when it flows past those systems it can become treated. So, of course we’ve got a wide range in cost too, right? Affiliated with treatment systems so we had to truck in a bunch of rock. We had to bury it and put seed over the top and plum it so that it would work right. The other system, the other extreme where we basically just have a depression where the water it would come into would basically be more or less the least expensive for us to manufacture and design.

**John McMaine:** I’d say the takeaway from that is well number one, there are different designs for constructed wetlands but number 2 there is some flexibility in, like we can make a constructed wetland to fit in any situation…

**Anthony Bly:** There’s endless possibilities is what I heard. Vertical, horizontal, rock surfaces. I mean I think if you meet up with an expert you should be able to find something that could work.

**John McMaine:** And the other thing is that constructed wetlands may not look like people typically think of a wetland. When I was doing my PhD research, I had a wetland that looked kind of like a typical wetland. I mean it had ponded water most of the time, but it has different kind of effectiveness and has a different footprint, different size to treat an area ratio. And then we had a subsurface flow constructed wetland which would be sort of like the horizontal flow or the vertical flow that jeff had mentioned. And so this system, it saturates during an event but then it desaturates between an event. So you actually not only do you get different microbial communities within the system like from different locations within the system, but you actually get different aerobic and anaerobic…

**Anthony Bly:** They change as the environment changes.

**John McMaine:** Right. You get different anaerobic and aerobic conditions as you have an event or between events or whatever else and yeah it changes.

**Anthony Bly:** And that kind of coincides with the diversity that’s required to adapt to that changing climate.

**John McMaine:** And even if we look at a natural wetland, I mean like a prairie pothole, a wet spot, that’s wet and, in the spring, and then it dries out and so these systems are, I mean this is how a lot of systems actually function. I mean they’re not necessarily wet all the time; how we normally think of a wetland right? That’s what’s in the public’s mind I think of.

**Anthony Bly:** Right

**John McMaine:** Wetlands mean wet 100% of the time.

**Anthony Bly:** No, there’s still all different types of wetlands.

**John McMaine:** Right.

**Anthony Bly:** Yeah.

**John McMaine:** And the interesting thing is, like you said, is that gives us flexibility, that gives us utility we can use these systems to target maybe different pollutants, maybe different contaminants, or be able to treat at a wide range of pollutants.

**Anthony Bly:** I’ve learned a lot…

**John McMaine:** Great!

**Anthony Bly:** …today.

**John McMaine:** Well, hey constructed wetlands are one of my favorite topics so I’m glad you’re excited Anthony.

**Anthony Bly:** Yup, I’m excited.

**John McMaine:** I’ve always been excited about constructed wetlands.

**Anthony Bly:** One of my mentors worked on wetlands.

**John McMaine:** Yeah?

**Anthony Bly:** Dr. Dianne Rickera.

**John McMaine:** Okay.

**Anthony Bly:** Yeah, and she was a pioneer really.

**John McMaine:** Cool, so an interesting story about constructed wetlands is one of the early researchers was a lady by the name of Catha Cydell, she’s German I’m probably completely getting the name wrong but she was in Germany doing research on constructed wetlands around the time that WW2 was finishing up. So, here’s this German scientist looking at water quality in constructed wetlands and at that time it was more about vegetated beds, so it’s evolved somewhat from then but just the… it’s been interesting to me is that after I learned that I had to think about that, that even in a time of… well really terrible things happening, water quality, likes there’s always a need for water quality research and kind of thinking about systems that improve water quality.

**Anthony Bly:** Well, it’s really important for all of us.

**John McMaine:** It is. So, that’s always been something that’s interesting to me about constructed wetlands and Jeff added some insight, kind of, into their research. So, we’ll play that clip and that after that we’ll get into some of the results that he talked about.

**Jeff Strock:** So, you know just a quick short story it was kind of unfortunate. It was a little odd and maybe predictable from doing drainage or irrigation work but the year after we built our constructed wetlands, it was fairly dry in 2009. 2010 we actually had what I call the mother of all years for precipitation. We had an excess amount of rainfall and actually in September of that year we had 10 inches of rain in 7 hours, which absolutely overwhelmed all of the wetlands. You know, the point is that we can try, we can think we’re smart people and try to engineer these systems but clearly, we did not engineer our systems large enough for a 7 inch, 24 hour rainstorm, okay? So, there are some limitations to some of what you’re doing out there. For the next few years after that we actually had some like ‘11, ‘12, ‘13 across our whole region, we had some drought conditions and so we really got really little flow through our systems. Back up again like in ’16, ’17, ’18, ’19 we finally got some really decent flow conditions we’ve been monitoring water flow out of our systems and paying attention to the water quality benefits. Compared to the water flowing in, we see water quality benefits all over all 3 of our systems.

**John McMaine:** So, no matter the treatment type or the constructed wetland type, it is encouraging to hear that they again, can be effective and I think it is because it is a living system. It has such a robust microbial community.

**Anthony Bly:** Sure.

**John McMaine:** It can kind of be resilient across conditions which is important.

**Anthony Bly:** And you know those floods come.

**John McMaine:** They do.

**Anthony Bly:** You can’t expect perfection.

**John McMaine:** Right.

**Anthony Bly:** But we strive for the best.

**John McMaine:** We strive for the best, that’s right and I think it’s every research project that… well another story from my PhD research that we were sampling irrigation events. It was at a plant nursery and we were going to sample back to back irrigation, storm irrigation events to see if there were any difference in treatment. And I’d have to wait for the irrigation to run out and so I’d be there at midnight switching out bottles. The cops only asked me once what I was doing there and I told them research.

[Anthony laughs]

**John McMaine:** But I was there at night, it was in the middle of Oklahoma City, switching out bottles and the one time… and I did this maybe ten times in a row and it never rained. So, I would switch them out, get the irrigation event, wait for it to rain, it never rained. So that’s kind of typical research, but then the one time it was like guaranteed, 100% chance of rain. I had to be out of town.

**Anthony Bly:** Oh my…

**John McMaine:** So, but I had great teammates and so they were going to cover for me and I get a call, it’s about 11pm. The storm was moving in and they’re switching out bottles and that storm was so big that it flooded the whole system, and we weren’t able to use any of the results so that’s kind of the typical research luck.

**Anthony Bly:** That’s how it goes.

**John McMaine:** It’s either not enough or way too much, but anyway, fortunately Jeff, they happened to get a lot of really good data and they’ve been looking at nitrogen phosphorus and anyway, I’ll just let him tell what, kind of, the effectiveness that they’ve seen from those wetlands.

**Jeff Strock:** Of course, we’re measuring nitrogen and phosphorus mainly as our nutrients. We are not presently measuring greenhouse gas fluxes but, you know, the idea is that we’re interested in nitrogen and phosphorus. And one of the things that we’ve seen is that the very best treatment system for nitrate is our surface flow style system. We have the longest residence time there because we can hold water back if we so desire, the way our systems are managed. And the least beneficial was our horizontal flow. Now, both of them treated the nitrate from the source water, so we saw reductions, and these are dramatic reductions. Like 40%, 50% reductions from the source water for all of the wetland styles. However, when we started looking at the surface flow versus the horizontal flow, there were differences between those systems. And also, not only just the load of nitrogen coming out, because we have longer residence times in the surface flow systems, but we also saw some concentration differences. So, nitrate concentrations were higher coming out of the horizontal flow system than the surface flow style system, but again, they all performed very well in terms of water quality for nitrogen. For phosphorus, we also saw reductions in load, and we saw reductions, or have seen and continue to see reductions in load and reductions in concentration. However, some of that can be seasonal right? So, on an annual basis we see these reductions. When we look at things on a monthly basis, boy I’ll tell you, things can happen. We might have higher nitrate concentrations in the spring in the water compared to summer or fall. Phosphorus we may actually have higher concentrations in, like, March or April, and then maybe again in October, November. So, some of that phosphorus is either being released from possibly the soil in the sediments that are there, but also more than likely from the vegetation that’s in these systems. So, net, we’re seeing reductions in phosphorus, we’re seeing reductions in the concentrations. However, this is where we see a flip-flop. So, the surface flow style wetland, even though it’s reducing phosphorus loads, probably not by 50%, probably more in the 25% range, does a very good job. The horizontal flow system where we have all the rock actually does much better in reducing the phosphorus. Now, part of that is really likely related to the style of rock that we have in there. So, we’ve got some type of limestone materials and things that, you know, we can expect to see some sorption, desorption on those rock surfaces. So, that’s not necessarily surprising. So, when we’re looking at those benefits, we’re definitely seeing water quality benefits which was our desire, and we see that again in water quality, but we also see that in water quantity. Especially our surface flow and our vertical flow systems because we have the ability to actually manage the outlets of those systems with control structures, like we might use with control drainage, to actually hold a little bit more water back a little bit longer, compared to the horizontal flow system. So, we’re getting a quantity and a quality benefit from some of the systems. Now, the other part is, is that we have not quantified, other than very subjective type of observations, is definitely related to some of the, you know, reptiles, amphibians, actually mammals too. So, we have seen lots of wildlife at our site and in the spring it’s absolutely amazing. Really a pleasant place to go out and listen in the evenings of early spring, early summer. During the middle of the summer, we get a lot of pollinators because we designed the vegetation systems and please don’t ask me what all that vegetation was because we’ve got lists that are a mile long and I couldn’t remember all of them if I had to. But, you know, our design was to plant forbes and grasses in these systems, right? And so, we do attract pollinators. Now, I’m going to swing on that because that’s a really nice benefit, you know, this biodiversity component.

**John McMaine:** So that’s very similar to what I saw too, but again, at the end of the day these systems perform pretty well. 50%, 60% load reduction for nutrients. 25% he said in the surface flow constructed wetland for phosphorus, but in general, it’s a reliable system for pollutant reduction.

**Anthony Bly:** Sounds like you could maybe combine different types of wetlands in sequence.

**John McMaine:** Right.

**Anthony Bly:** To gain optimal benefits.

**John McMaine:** Absolutely, yeah do these in series. Kind of a treatment train approach [train noises by John]. Everybody aboard the treatment train.

[Anthony laughs]

**John McMaine:** The other thing that I looked at in my PhD was actually pesticides. And so, looked at 15 or 16 different pesticides and again, this was with plant nurseries, so we were looking at what’s coming out of plant nurseries by phenothrin, fipronil, pendimethalin, these types of compounds, and we saw really, pretty good removal for different pesticides. And again, living systems, lots of opportunities for both sorptions, so kind of physical and chemical removal of sedimentation as well.

**Anthony Bly:** Biology.

**John McMaine:** and biology yeah. Huge on the microbial breakdown potential. The other thing that was interesting with my research was pesticides with different, I guess, affinities for soils, different KOC, the different partitioning coefficient; how likely it was to stick to soil. We saw removals of up to 80% load reduction of pesticides with a high KOC like bifenthrin, and a low KOC like pendimethalin.

**Anthony Bly:** Really?

**John McMaine:** and so…

**Anthony Bly:** Both?

**John McMaine:** Both, yeah. And I think it kind of goes back to what Jeff said about, you know, you have biofilm in addition to kind of chemical-sorption and so you had a long enough retention time, there’s ample opportunity for really any pollutant to be either captured or broken down.

**Anthony Bly:** It’s the diversity.

**John McMaine:** It’s the diversity. One thing about nutrients, and he mentioned, kind of, the seasonality of phosphorus removal, phosphorus treatment. I think if we have vegetation in these systems, if we get vegetation uptake of nutrients, the nutrients are still potentially in the system especially for phosphorus.

**Anthony Bly:** Yup. They’re just cycled.

**John McMaine:** They’re just cycled, so that is one consideration. If we actually want to remove the phosphorus, we would need to include some type of harvesting of the vegetation. Move it, either upgrading uplands or get it out of the systems if we want, you know, complete treatment or actual treatment.

**Anthony Bly:** Right, correct.

**John McMaine:** But in general, it is very encouraging to hear about the treatment and diversity treatment and what all we can get out of it. So, I’m going to play one more clip for the day, and this clip Jeff’s going to help us understand kind of the farmer’s point of view, and then we’ll get more into that in the next episode. But here’s the last clip for today.

**Jeff Strock:** Now here’s one of the challenges. And we’ve run into this, and this kind of goes back to our conversation earlier about, you know, what do we call these? You know? And I mentioned early on, we called these constructed basins. We didn’t’ want to call them wetlands, we didn’t want to use the ‘W’ word. And now, we do call them constructed wetlands and this is not a slam against wetland scientists or any environmental groups that are really purists about wetlands, okay? Because there’s absolutely a place for that, but the little world that I live in I’m trying to help farmer’s produce row crops at a very high level. So, to be productive, I want them to be profitable, but I also want them to be environmentally aware and sensitive, and adopt practices that they can in order to mitigate some of the negative impacts that we have from our agricultural drainage, right? Whether it’s surface runoff or subsurface drainage. So, one of the things… we had a meeting about this up at the Minnesota Landscape Arboretum many years ago, there were a combination of agricultural scientists and wetland scientists and some other folks there from state agencies and people were there, we were having these really great conversations. So I was asked a question and the question in a nutshell was, ‘how do we get farmers to adopt these things Jeff?’

**John McMaine:** So, that’s the question we’re going to stop at today.

**Anthony Bly:** Wow.

**John McMaine:** Because you can do all the research and science you want and demonstrate systems and practices but…

**Anthony Bly:** Make it look as pretty as you can.

**John McMaine:** Yep, but at the end of the day, it’s got to go in the ground.

**Anthony Bly:** It’s got to be adopted.

**John McMaine:** So, we’ll leave you with that question; ‘How do we get farmer’s or others to adopt these practices?’ and join us next week as we continue our discussion, hear what Jeff has to say regarding the future of constructed wetlands.

[music]

**John McMaine:** Thanks for joining us today on *Streamlines*. We sure had a lot of fun today, hope you did too. If you want to learn more about anything you heard today, head on over to the SDSU Extension website, but for now I’m John McMaine

**Anthony Bly:** I’m Anthony Bly.

**John McMaine:** And we’ll catch you next time.