BMP Performance
Event: 103079

John Kosco: Good afternoon, and welcome to today's webcast on BMP performance. This webcast is sponsored by EPA's Office of Wastewater Management. My name is John Kosco with Tetra Tech, and I will moderate today's session. Thank you for joining us today.

We'll get started in a few moments. While we wait for others to join us, I'd like to cover a few housekeeping items.

The materials in this webcast have been reviewed by EPA staff for technical accuracy, however the views of the speakers and the speakers' organizations are their own and do not necessarily reflect those of the EPA. Mention of any commercial enterprise, products or publication does not mean that EPA endorses them.

For those of you new to EPA stormwater webcasts, I want to briefly summarize some of the webcast features. First, if you have any technical difficulties, you can call ON24 at 800-833-2812 -- I'll repeat that number, 800-833-2812 -- or you can click the Help button on the bottom right side of your screen to receive technical support from ON24.

There are a couple of features we just want to highlight for you today about the webcast. You can submit questions to any of our speakers by submitting those in the Ask A Question box at the bottom of your screen. Just type in your question and hit the Submit Question button. We encourage you to submit your question at any time before the Q&A break starts, so please submit those questions early and often. I would note we can't answer all of the questions submitted today, but we will do our best to answer as many as we can.

We will have several poll questions. The poll question will appear in your slide window, and you'll need to click on the radial button of your answer and then click Submit. Don't type your answer in the Ask A Question box. And we do encourage you to answer these poll questions because we do use the information during the webcast.

If you want to see closed captioning, please turn off your pop-up blocker and click on the Closed Captioning button.

We will have a survey at the end of the webcast, so please turn off your pop-up blocker now. And if you'd like to obtain a certificate of participation, all you need to do is watch an hour and 30 minutes of the webcast, and then click on Download Certificate at the end of the webcast. If you're in a room with more than one person, we will have a slide with the URL that will have a certificate where you can fill in each person's name individually and print those off.

As a reminder, this webcast will be archived indefinitely afterwards so you can access it after today's live presentation. The webcast will be posted within a couple weeks of this time at the same website.

Now we're ready to kick off today's session. Today's speakers are Jonathan Jones, Neely Law and Nikos Singelis.

First, I'd like to introduce someone many of you already know through past EPA Stormwater Webcasts -- Stormwater Conferences -- or his NPDES News announcements, Nikos Singelis. Nikos is a senior program analyst with the EPA's NPDES Stormwater Program.

Nikos has been with EPA Stormwater Program for the last seven years and works on many projects aimed at helping Phase II communities implement this challenging program. Nikos authored the EPA Guidance on Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites, led the development of EPA's urban BMP performance tool that we'll talk about today, and is a speaker across the country on various stormwater topics, including at the most recent StormCon and International Erosion Control Association conferences. And now I'll turn it over to Nikos to talk about today's presentations.

Nikos Singelis: Thank you very much, John. This is Nikos Singelis with EPA's Office of Wastewater Management, and I'm very pleased to be here today with two very distinguished guests who have been helping us out to bring you some new information and to put together the new tool on our website, which we'll be featuring today a little bit. And, of course, I rely on these experts to correct me whenever I make mistakes, and I'm sure they will be willing to do that today.

So before we introduce them, let me just go through briefly the topics for today's discussion. First, since we have a variety of people on the line who may have varying backgrounds from people who are relatively new to the Stormwater Program to some of the real experts in the field out there.

We're going to go through some of the basics of what BMP performance is all about. We're going to introduce the two other tools out there, in addition to the EPA tool -- the International BMP Database, which Jon Jones is the co-lead for, and also the National Pollutant Removal Database Project that the Center for Watershed Protection has been working on for several years.

Then I'm just going to show you very briefly the new EPA website tool so that you can see what's in there and available to you, and then we're going to get into an interesting discussion about all the factors that we should consider when we're selecting BMPs. So we're going to start out talking about pollutants and volume reduction, but we're also going to get into a discussion of costs and maintenance and other things that are also important to making those decisions.

And then we're going to take a look at three common BMP types and do some comparisons and have some discussion here, and then finally we're going to clean up with a little bit of discussion about some other uses of BMP performance in your water quality program.

John Kosco: Great. Thanks, Nikos.

I'd like to introduce our two other speakers -- first, Jon Jones of Wright Water Engineers in Denver, Colorado. Jon has been with Wright Water Engineers for 27 years and is now the chief executive officer of the company. He is a registered professional engineer in 10 states. On behalf of the American Society of Professional Engineers, Jon chaired a committee of more than

100 engineers and prepared the manual of practice on Urban Stormwater Management for ASCE and Water Environment Federation. He also serves as co-principal developer of the International BMP Database with Eric Strecker of Geosyntec.

In his work at Wright Water Engineers, Jon conducts BMP planning and design analysis for public and private clients around the United States. And Jon will mention a couple of key points about the International BMP Database.

Jonathan Jones: Well, John, thank you. And Nikos, thank you. And John, thank you for the opportunity to be here. And for all of you who are participating, we welcome you to this event.

We do actually have on our computer screens here a list of people from around the United States who are participating, and indeed, it's a very impressive list with thousands of people participating today.

Regarding the International BMP Database, the co-project leader is Eric Strecker of Geosyntec in Portland, Oregon, and as John mentioned, this database began back in 1997 when EPA, led by Michael Cook, provided significant money to the American Society of Civil Engineers Urban Water Resources Research Council. And at that time, Ben Urbonas of the Denver Urban Drainage and Flood Control district, along with Eric Strecker, took the lead on developing the database. It is now co-sponsored by WERF, ASCE, EWRI, FHWA -- the Federal Highway Administration -- and APWA, the American Public Works Association.

As you can see from the slide, there currently are over 300 individual BPM studies in the International BMP Database. The actual number 343. Thank you.

John Kosco: Great. Thanks, Jon.

Our other expert speaker today is Neely Law, a senior research analyst at the Center for Watershed Protection. Neely has a Ph.D. in geography from the University of North Carolina - Chapel Hill. Her research and work experience over the past 15 years has focused on urban watersheds that address the human, physical, environmental factors and processes affecting water quality. Her primary responsibilities at the center include research on stormwater techniques, planning and management to include, for example, stormwater indicators, urban watersheds, urban wetlands, and street sweeping.

Now I'll turn it over to Neely to talk about her National Pollutant Removal Performance Database.

Neely Law: Thank you very much, and I'm really looking forward to the experiences we'll all share today. And I think we'll all learn a little bit more about BMP performance in urban watersheds.

So the National Pollutant Removal Database has been around for about 10 years now. It was most recently revised this past summer. You can download that version at the website listed on the bottom of your screen, and it provides a very neat summary of 166 studies so that you can get a quick and easy idea about the different performance levels for a variety of BMP practices. And it's a project that the Center is continually working on to update and improve in the upcoming years.

Nikos Singelis: Great. Thank you very much, Neely and Jon.

And now we'll launch into the beginning section here where we're going to cover some terminology. First, though, I'd like to just let our audience ponder this particular picture which Jon Jones was kind enough to provide us for, just to introduce the idea that people definitely need BMP information. The caption there reads, if you can't see it clearly, "Clearly someone needs BMP information! The design drawing for this project showed the location of the straw bales as a dashed line." Well, and you can see how that came out there. I love that picture, and I'll be using it in many presentations in the future.

But seriously, who needs BMP information? Of course, we have lots and lots of development happening around the United States. In the last couple years, there was a pretty good housing boom and we saw a lot of new construction all over the United States. Of course, other commercial and industrial enterprises are also building things that need to have permanent stormwater BMPs in place. And we need to make sure, as we continue to urbanize our watersheds, that we really do have the state-of-the-art BMPs in place, and so that's going to be the focus of a lot of our discussion today amongst the three of us.

We also have some 6,000 plus MS4s, which is municipal separate storm sewer system, for those who don't know. In our lingo, it's the communities that are regulated under Phase I and Phase II of the NPDES stormwater regulation. And those communities, particularly the ones in the Phase II regulations, are bringing their programs online right now, and they're going to be reviewing post-construction plans and BMPs and hoping to guide development to be as stormwater friendly as it can be. And so we're hoping to provide lots of information for those MS4s so that they can do that job.

And then we also have a number of other people that use BMP information very frequently, of course, permit writers -- NPDES permit writers -- also folks that are dealing with total maximum daily loads, which we'll explain at the end of the webcast in a little bit more detail, watershed planners, so we have quite a number of people that are interested in BMP information. And I think that also reflects the fact that we have such a large audience today with us, and in a little while we'll be giving you a tally of how many people are actually signed on to this webcast.

So let's launch into some of the basics here. We want to cover some of the factors that influence the performance of BMPs, get some of the terminology out of the way just so that we all have a common understanding of what we're talking about.

I sent out in my NPDES News that we would debunk this urban myth of percent removal, and so we're going to talk about why you shouldn't rely on percent removal as the only measure of BMP performance, and we'll give you some graphics to discuss that.

And perhaps the key piece of all this is to get us more aware of the importance of volume reduction. For the past 30 years, EPA, under the Clean Water Act, has focused almost exclusively on pollutants, and now as we get ourselves into the stormwater world, we're really finding out that volume reduction is a very important piece of this program if we're really going to make it successful, so we'll be talking about that some as well.

So Jon and Neely, if you want to chime in here at anytime, feel free. I'm just going to run through some of this. I think the first thing that we need to stress -- and Jon has certainly stressed this to me a number of times, too -- is that BMPs are not like some other wastewater treatment devices that have relatively predictable performance. In BMPs, you're going to have quite a lot of variability, and that variability will be affected by a number of factors, including design, the soil type, rainfall pattern, the drainage areas around that BMP, also the age of the system -- and that's another research question that we need to really look into is what happens to these BMPs as they get older and older; a lot of our studies have probably focused on a BMP that was relatively new, but what happens to it 10 years down the road and what's performance like then.

Any other sort of points you guys would like to add to that list?

Jonathan Jones: Well, Nikos, I would actually add one. Thinking about bacteria as a parameter, there are huge variations in bacteria data, both in terms of inflows to BMPs and outflows from BMPs. For example, you have a wetland, wet pond complex and many geese happen to land in the wetland and wet pond at the same time that you're collecting samples. Then, in fact, it's very likely you're going to have high bacterial levels in the discharge from the pond. That's one parameter that's notoriously variable.

Nikos Singelis: Yeah, exactly.

Neely Law: And I'd also like to add that there are certain factors that you can control -- your design and the placement of your BMP -- but there are also factors you can't control. And so focusing on those that you can control in the terms of your sampling protocols and the design factors to really maximize that performance of the BMP to reduce that variability is important.

Nikos Singelis: Absolutely. Yeah, I think that's a key point, to continuing to study these things and to really look at these studies in detail is that we might be able to, if we get a number of studies going, to discern design differences, for instance, that really make a difference in the performance. And I think we're starting to see that in a few categories and hopefully as time goes on we'll find more of that kind of information.

This next slide here we took from the International BMP Database and this is just - I'm not going to explain the whole thing here, but this is just looking at TSS removal from a number of BMP categories across the bottom there. So you can see we have detention ponds, wet ponds, wetland basins, et cetera, et cetera. And just to reiterate the point that BMP performance is not very predictable. You can see by these wide ranges that it's certainly going to be influenced, again, by design, rainfall pattern, the placement of the BMP, all the things that we've said before. But an important point to reiterate to all of you is not to rely on just one number. There's not going to be just one number that you can say, "This is going to be the performance of this BMP." So we're going to have factor in that sort of unpredictability of these systems.

Neely Law: Right. And the plot that you see here is going to - maybe it's an obvious point - it's going to be different for each parameter that you're monitoring for. So your expectation for TSS is going to be very different for nitrate or total phosphorus or your heavy metals.

Nikos Singelis: Absolutely right. Yeah, this is just one example in the whole range. And, of course, Jon just mentioned that bacteria is one of those things where the variability is very high, so it certainly does pollute - by pollutant vary.

So just moving on here, a little bit on terminology just so that we're all on the same page again, and I know most of you probably know this already. We are going to be talking about concentrations, and concentrations have their place in our discussion and are very useful. Usually we show those milligrams per liter or micrograms per liter, so those are things that you're going to see labeled on some of the charts that are coming up.

Per cent removal is another thing that's commonly seen out there in literature or brochures and things like that, and we're going to show you in a minute why that's not a very good measure. But basically what it is it's you're taking an influent and an effluent concentration and you're coming up with a simple percentage. And that percentage can often be kind of misleading, so we'll show you that in a minute.

Volume, of course, we're measuring here in liters, and we want to compare the influent to the effluent. And in the new sort of class of BMPs that everybody's talking about now, whether you use the word low-impact development or better site design or green infrastructure, whichever term you like best, those are all pointing at a common idea about infiltrating stormwater, trying to deal with it in a more nature way, and so volume reduction becomes a very important piece in this whole scheme that we're talking about.

Another thing that I'd like to talk about differentiating a little bit is total load. And total load is basically a calculation of the pounds of pollutant that are coming into and coming out of a BMP. And this makes a better measure overall than just comparing the concentrations. Then again, we'll show you this in detail, but here this actually will take into account the infiltration factor of a particular BMP.

So be aware that if you see percent removal, you should cast a critical eye on that, and if you see total load reduction, maybe you might feel a little bit more confident that expresses the performance of a BMP a little bit better.

Now I should also say - and Neely can certainly chime in on this, too - we have a lot of history of studies that looked at percent removal, and we hope as we move forward that we can influence researchers in the future not to rely on that measure but to look at a better load - and we'll need multiple measures, of course - but to move towards load particularly.

Neely Law: Absolutely. BMP is a very young science and it's a growing science, but fortunately enough, there are scientists and researchers out there who were able to adapt to the new science and technologies out there, and moving on from percent removal using concentrations to total load is an example of that.

Nikos Singelis: And another terminology bit here which you'll see as you look through a lot of the literature is this concept of event mean concentration. And maybe, Jon Jones, you could explain what this one means and how it's useful to us?

Jonathan Jones: Sure, Nikos.

Event mean concentration is a very important concept to understand and to implement whenever possible. The event mean concentration or EMC as you can see in the first bullet is defined as the total pollutant load in a runoff event divided by the total runoff volume of that event.

Now the reason that we want to express concentrations as event mean concentrations is as follows. Let's suppose that you're monitoring a wetland, and you're monitoring inflows to that wetland. And let's suppose that a runoff event occurs over the course of one hour. If you were to just take a grab sample randomly during that one hour, you might see one given concentration. By contrast, if you took 20 grab samples over that hour you'd have a much better understanding of what the actual average concentration is coming into the wetland.

Well, of course, it's very difficult to stand there and grab 20 individual samples during that one-hour time period, which is why we use automated monitoring equipment, as you see from the second bullet. And we typically express EMC values in terms of milligrams per liter or micrograms per liter.

And once we've gathered together data, moving on to the next point of terminology, and we have sufficient data, we can actually define confidence intervals and quartiles, which are statistical metrics for parameters that can be calculated from a data set that enable us to better understand how well a BMP is performing.

Nikos Singelis: Great. And we'll show you some of those, too, and it will become - for those who are not statistically up to speed like myself, I was reflecting that my last statistics course was about, oh, 20 years ago, so I've had to scratch my brain a little bit; Neely has provided some corrections to some of my things here - but we'll show you some of those things digitally in a few minutes so you can get a better sense.

Okay, so now for one of the fun parts of this thing is we have two myths that we'd like to debunk here, and the first one is this common idea out there that somehow EPA or the Clean Water Act requires 80 percent removal. And somehow this has gotten into the zeitgeist out there, if you will, that this is a requirement, and it seems to pop up commonly. I've heard this a million times, and I want to let you know that this has absolutely no basis in law or regulation. Eighty percent removal does not apply to the Stormwater Program.

One possible place I could see where there's some confusion is that in the Clean Water Act there is a requirement for 85 percent removal of TSS for wastewater treatment plants, but that applies only to wastewater treatment plants and not to stormwater.

And the other reason why I think it's important to mention this is that I certainly hope we can do better than 80 percent, and we'll be talking about that as well.

Also, I should mention that if you come to StormCon, we're going to be playing stormwater jeopardy at StormCon, and this will be one of the questions, so you can get that one right if you heard it here today.

The second one, which we'll go into a little bit more detail, is percent removal, just to show you graphically a little bit why this idea of percent removal can be misleading.

So we'll move here to the next slide. If you look at this graphic, the reason why percent removal can be very misleading, if you look on the left, let's say we have a BMP situation here where we have 100 milligrams per liter of some pollutant, whatever pollutant it is, coming into a BMP and what comes out is 20 at the end. So we can say, "Well, that's 80 percent removal." And yeah, it's great, right? And it also meets that mythical, fake Clean Water Act standard that people believe, right?

But on the right side you may have a totally different situation where you're only getting 50 percent removal, but you're actually getting a better result if you look at the 10 milligrams per liter down at the bottom. And I know this is way oversimplified, but this is just to point out how these things can be misleading.

And I think, Jon, either your or Eric had said one of the things about percent removal here is that it often tells you more about how dirty the site is than anything else.

Jonathan Jones: Very true.

Nikos Singelis: In fact, you had in the latest copy of Stormwater Magazine - the January or February issue - there's some commentary from you and your colleagues about this whole percent removal.

Jonathan Jones: Yes, there is, Nikos. I believe the article - I don't have it in front of me, but it's entitled something like "15 Reasons Why You Should Think Twice Before Using Percent Removal to Assess BMP Performance," more or less. For all of you participating today, if you have the chance to read that editorial, we'd be very anxious to receive your comments on our perspective.

But just as you've said, Nikos, it's this extreme event-to-event variability that in our view is not all that well reflected with percent removal. And one of the earliest cases that brought this to my attention was when we were monitoring BMPs in a series. We were going from swales to extended dry ponds to a wetland, and of course as you worked your way down in the system, it appeared that by the time you got down to the wetland that it wasn't performing at all well because BMP efficiency in that case was being expressed as percent removal.

We find as design engineers that when we have effluent data that are statistically presented such that, for example, we know the 75th percentile performing wetland has a TSS concentration of such and such, that enables us to make better risk-based design decisions for our client.

Nikos Singelis: Absolutely.

Okay, just in the interests of time we're going to move through some of this basic stuff so we can get into some of the meaty stuff.

Volume reduction, as I mentioned, is a very important consideration when we're talking about stormwater, and of course you've heard us, if you've attended other webcasts, talk about this, and we will certainly be talking about it in the future. But as we continue to develop watersheds through residential and commercial development, we're adding impervious surfaces to our watersheds, and that's changing the basic hydrology of many of our systems. And of course the impact of impervious surfaces on a given watershed will vary based on a number of factors which we'll briefly touch on in a minute. You can read a lot of the literature on that as well.

But this hydrology is causing a lot of impacts to the biology of our systems and also to the physical characters. I remember an interesting study that was presented at StormCon a couple of years ago where they looked at two watersheds that both had a total suspended solid problem, and they were trying to figure out what the source of all this dirt essentially was, and it turned out that it was from stream bank erosion rather than from upland sources. So having an idea of these sorts of things would be very important.

Then next we have two graphics which you've probably seen before, and Neely can help me explain these. These are generalized sort of artistic, if you will, depictions of what happens in a watershed as we increase the impervious surfaces. And Neely, do you want to explain this first graph a little bit?

Neely Law: Sure, let's quickly summarize what you're seeing on your screen, Nikos. And the solid line represents how a stream flow would respond to a storm event prior to its development, so you have trees, you have lots of pervious surfaces that are absorbing that rainwater into the ground, recharging that groundwater, and so you really don't see that surge of stormwater entering the stream quickly and in large volume.

But that all changes in the post-development scenario that's depicted here with the dashed line, with these more extreme flows or discharges in the stream that happen much sooner. And that's the result of development where you took away those pervious surfaces and that soil is now heavily compacted or, of course, covered impervious surfaces with your rooftops, roads and sidewalks.

Nikos Singelis: Yeah.

And again, this is a generalization, but the Center for Watershed Protection has done research on hundreds of watersheds on the East Coast and in the Midwest areas, and certainly there's going to be a lot of variability. I know Jon, you know, feels like there's some different conditions out west, right, Jon?

Jonathan Jones: Just a quick comment. In arid and semi-arid areas, we actually commonly see base loads increase as a consequence of urbanization in many streams. Just a quick note.

Nikos Singelis: Oh, sure. Yeah. Now whether that's natural is yet another - or a desirable feature - is yet another thing to consider.

Jonathan Jones: Absolutely. Yeah.

Nikos Singelis: And now we have another slide - this also just sort of artistically represents the same relationship that we were talking about, but in - the same relationship that we were talking about, but in a slightly different way. And Neely, do you want to talk about that?

Neely Law: Right. All right, this is from a Center publication, "Impacts of Imperviousness on Aquatic Systems," and it's a relationship that was developed from a review of hundreds of studies and has been reinforced with many since then where consistently you find these threshold points of impact from watersheds that are developed and have impervious covers at 10 percent, 15 percent to 25 percent and above. These are generalizable relationships that were put together to classify and predict your green conditions through a simple measure of imperviousness in your watershed. So it's a management tool.

Nikos Singelis: Absolutely. And again, lots of factors could cause this relationship to vary somewhat, for instance, the placement of that impervious surface within the watershed.

Neely Law: Right.

Nikos Singelis: If it's evenly distributed or concentrated in one place, it may make some differences.

Another thing to point out, too, is that, as I said before, EPA's focused mostly on chemical parameters, and if you look at some of EPA's reports on stream quality, you won't see much in the way of an assessment of physical or biological impacts, and yet we know that they're happening through studies like this. So we need to look, you know, broadly at lots of different information to sort of figure that out.

So we've talked about why volume itself is a very important consideration and really, you know, should be considered equally in many cases to pollution as a concentration.

The next thing we want to get into, though, is the relationship that volume can have in pollutant reduction in BMPs, and this, I find, is something that people don't often understand very clearly. In fact, I didn't understand this when I started looking into it very clearly either, and it led me to come up with these next two graphics that we have here to show you.

And so just very quickly, here we have a BMP that has no volume reduction capabilities at all, and we're running basically a million liters of stormwater through multiple storm events through this BMP and we're measuring and we're finding out that it's average or, as Jon said before, its event mean concentration is 100 milligrams per liter. And, again, getting at the idea of load, then that would give you a total load of that pollutant in a dry form, for instance, of 100 kilograms.

So we run it through. The same million liters comes out on the other side because there's no volume reduction, however the pollutant level has been reduced in the concentration to 50 milligrams here. So we have 100 on one side and 50, and just keep that in your heads as we move to the next slide, which in this case, because there's no volume reduction, also reduces that total load.

So what we're trying to get at here is the percent removal could be misleading if we calculated a percentage based on the beakers, but if you calculate a percentage on the wheelbarrows, you might actually have a measure that's relatively reliable.

Now let me show you what happens in this next one. So now we have the same scenario, with a BMP that reduces the volume by 50 percent. So again, the million liters and the 100 milligrams per liter on the left going into the BMP, 50 percent is reduced so the bucket has now been reduced in half, but notice just to make the point here, the concentration is the same as it was before. So if we calculated that percent removal, we wouldn't see that this BMP is actually performing better. But if you look at the wheelbarrow, you can see that we've actually got a 75 percent reduction in total load of that pollutant.

So if you're going to use a percentage, I would definitely try to use it on the load and not on the concentration is the main message behind these slides. And I want to remind everybody in the audience, too, that you can download these PowerPoint slides in a *.pdf form so that you can take a look at this in more detail. And, of course, you can send us questions via e-mail to say, "What the heck do you mean by this?"

So now we're going to move on a little bit and just wrap this section up. Actually, here we have our first poll question. So we want to find out how many people are participating in this webcast today at your location, and so you can select the little radio button to the left of the answer that best fits your situation. So the first one there is just me - you're by yourself in your cube like many of us are stuck in the land of cubes these days - you have a small group of two to five, six to 10, 10 to 20, or more than 20. If we've got any big groups out there, we definitely want to hear from you. And if for some reason you can't get to your computer and you're in a big room, please send us an e-mail telling us how many people were in your group. But this really helps us to track who's with us today and what the size of our real audience is.

So we'll give you a minute to just take a look at that and answer that.

John Kosco: As Nikos mentioned, we do use this to estimate the total audience. We have over 1,500 individual sites signed in, but with the multiple people at different locations, it could be, you know, several thousand or more.

Nikos Singelis: Right, exactly. And we'll have more of these poll questions as we go along through this thing, and we'll show you those results as we move along.

So I'll give you just a couple more seconds for those in big rooms to answer the question if you can, and then we will show you the results here.

So it looks like we have - most people are by themselves. We've got about 67 percent it shows there; small groups, about 25 percent; six to 10, we've got about 6 percent, and then smaller numbers for bigger groups. And again, particularly for those bigger groups, if you want to send us an e-mail later on and tell us how many people were in the room, that would be very helpful to us.

We have another poll question because we'd like to get a better sense of who you are out there. So if you are working for a Phase I city or country - those are the large communities that have been regulated under the Stormwater Program since the early 1990s - or if you're in a Phase II community, which could be a town, a city, a county, or possibly a university or a military base or some other installations that run their own storm sewer system, please select that. We have a category for state and federal government, for consultants, industry and others. So we'll give you just a second to take a look at that and see who we have out there. This one we'll do, I think, a little bit faster here than we did the last one since you're all sort of familiar with this now.

So we have about 11 percent from Phase I cities, and as we expect, our big audience is always from the Phase II communities, so we have about 27 percent. Interestingly enough, we have large participation today from state and federal government folk but I imagine mostly state government, so that's kind of unusual for our usual audience. Lots of consultants, of course, and we know that many consultants are actually working in Phase I and Phase II communities; some industry folk and some others who don't fit into any category at all there.

Okay. So now we're briefly going to go and talk about some elements that make up a good study of a BMP, and Jon's going to kind of lead this little discussion here. And we just want to touch on some of the things that, as you're looking through studies, you know, what really is a good study to look at. We've talked about some of those things, for instance, where a study is using event mean concentration, that is reporting loads, that is not emphasizing the percent removal - some of those things are some good characteristics, and we'll talk about a few more.

So Jon, you want to start us off on this one?

Jonathan Jones: Be happy to, Nikos. Thank you.

So here's the situation. You have a BMP and you want to go out and monitor it. You want to see how well it's performing. What kinds of things should you think about monitoring? What kinds of things are you going to have to do in the field to gather the data and then ultimately to analyze the data to assess BMP performance?

Well, as you can see on this slide, overall goals would include gathering data to establish the extent to which pollutants are being reduced, that is, the water quality performance. As Nikos has emphasized throughout the day, the role that the BMP is playing in reducing runoff volume, hydrologic source control performance. Then the hydraulic aspects of the BMP, that is, how is it performing from a treatment capacity standpoint.

One very important aspect of BMP performance to gather is the amount of flow that actually bypasses the BMP during rainfall events that are larger than the design event, for instance.

Nikos Singelis: And Jon, that would be particularly important for some of these new class of BMPs, is low-impact development techniques such as bioretention cells.

Jonathan Jones: Yes.

Nikos Singelis: We do want to have a better handle on how much they will infiltrate and what size of a cell is going to handle what storm event in that group does, and that's one of those things that's hard to nail down right now, wouldn't you say?

Jonathan Jones: Yes, good point, Nikos.

I mean, at some point, you know, we typically design water quality BMPs for smaller, frequently occurring storms based on a water quality capture volume that generally around the United States is a less than a one-year return frequency event, perhaps an 80th to 90th percentile annual event.

Well every now and then it rains harder than that, and some of the flow will bypass the BMP because the BMP just can't keep up with the flow, so that's the third bullet.

Now looking even more broadly, and when there's sufficient budget available to do it and when there are factors that would compel this, we can also evaluate downstream biological impacts associated with a BMP as well as downstream physical impacts. For instance, if you have a pond that you're monitoring and you haven't been careful with the design of the outlet structure for the pond, the receiving stream below the BMP - below that pond - can actually be adversely impacted. The channel could be widening or deepening or both.

So really ideally, Nikos, we look for physical, chemical and biological monitoring of BMPs.

Nikos Singelis: And Jon, I think it would be fair to say that we haven't done much in those biological or physical areas yet, and we certainly would like to do more in the future.

Jonathan Jones: Yes. Well stated.

Basic elements, if we're thinking about sampling, such factors as number of storm events sampled. The number of samples within the event itself that we need to collect is very important. As I mentioned earlier, if we go back to that wetland and we have one hour's worth of runoff coming into it, if you grab a single sample during that one hour, that isn't going to tell you all that much because of the variability associated with water chemistry and stormwater runoff. We need to collect paired samples, that is, both influent and effluent, and then we need to think very carefully about what parameters we're going to monitor and why.

Okay, water quality variability, that's a topic that we've discussed frequently today, but it is a fact that many sampling programs, although well intentioned, don't yield useful results yet they're reported as valid assessments of performance. All of us have seen many examples of that.

Many people don't recognize - and we'll see this in the next slide - how many samples need to actually be collected to obtain a valid result in a statistical sense.

And then the last point, more variability in a water quality parameter equals a higher number of samples you will need, and the next graph shows that.

Nikos Singelis: Okay, and Jon, I have to add a humorous note here because I told Neely and Jon that, you know, this had to be plain English kind of stuff, and I was successful for the most part until this graphic. And this one got me and many of my colleagues in our office going, "What the heck does this mean?"

So Jon, since you wanted to have this graphic in there, you've got to explain it.

Jonathan Jones: Okay. Well, shut my mic off when I've taken too much time.

Nikos Singelis: I will.

Jonathan Jones: But I'll be brief.

This excellent graphic was actually developed by Professor Robert Pitt in Alabama, and this goes to the question of how many samples do I need to collect to be confident that there is a statistically significant difference between effluent quality and influent quality? Presumably, of course, we're hoping that the effluent quality is statistically significantly better than the influent quality.

The horizontal axis of the graph shows the coefficient of variation, which is the measurement of the spread of the data that we have. Then the vertical axis shows the difference in sample set means. That would be the difference in the median concentration of the influent versus the effluent. And then the diagonal line present the required number of sample pairs that you'd need to have to in fact have 95 percent confidence that there is a difference between the inflow and the outflow.

There are two dashed lines that are given here. Just for the sake of time, let's look at the red line.

If we have a sample set mean, that is, the influent and the effluent mean, are 80 percent different, there's a very large difference. And if the data cluster tightly together and the coefficient of variation is only 0.5, then we need only five samples to determine that indeed there is a statistically significant difference.

By contrast, if you look at the blue line on this graph, you can see if the difference between the inflow and the outflow is only 40 percent and if the data have considerably more spread or variability and the coefficient of variation is 1.0. Then we're all the way out at 75 samples that need to be collected to be 95 percent confident that there is a difference.

Nikos Singelis: And I think this is a - while this graphic may be confusing to many of you out there, it is an important point for all of us to keep in mind, that rarely does a situation happen like the red scenario here where you're in those kinds of conditions. You know, more often you're going to be somewhere in between, and the number of samples is very important.

We have a couple bullets there on the left that in a very general way kind of get at some of these things that you guys in the International BMP Database have stated before.

Jonathan Jones: Right.

Nikos Singelis: And that is that in general when you boil all this down, if you're going to be doing BMP monitoring, count on collecting at least 10 valid paired samples within each storm. If you can, collect 16 individual samples within that storm to characterize the variability we've been speaking of today. If you can, use automated sampling equipment so you can calculate event mean concentration. And then, of course, sample in pairs, that is, both inflow and outflow.

Neely Law: And then also - and here we're talking about the storm event specific monitoring requirement, but [relative to] a monitoring program you should be sampling a range of storm events, so you're not just characterizing your concentration at the lower, smaller storm events or you're not just frequently monitoring the larger storm event. You want to get that spectrum of your rainfall frequencies.

Nikos Singelis: Absolutely, which is why long-term monitoring is even better. You know, if you can monitor for a year or so and really get a good range of the kinds of storms and events, you'll have a better idea of what's going on in your BMP.

Neely Law: And every sample you take is not necessarily a keeper sample.

Nikos Singelis: Yes, that's another good point, too.

So on this next slide we talk about some of the common pollutants that have been monitored, and you can see that range there. I won't go through all of those right now but those are some of the common ones that are out there, and you'll find the three tools that we're presenting today.

I would just make one comment. After looking at some of this information, we've realized that EPA needs to probably come up with a standardized list of minimum pollutants that everybody monitors for so that it will make comparing studies easier. So one of the things that we're going to be working on over the next few months, coming up with that list and sharing it with researchers out there who are doing BMP studies so that we have more comparability across some of these studies.

The next slide shows some of the protocols that are out there, resources for you if you do want to put together a monitoring program for a particular BMP. Jon, do you want to - yours is the first one there.

Jonathan Jones: Yes. For those who are interested, if you would go to the International BMP Database website, you can actually download a pretty comprehensive document on monitoring guidance that our team has prepared, and then there are many other excellent protocols around the country. We've listed only two here. There's the TARP protocol - Technology Acceptance and Reciprocity Partnership protocol that's the coalition [inaudible]. Then the TAPE protocol, developed by the Washington State Department of Ecology.

And there are other good guidance documents on monitoring that you can find quite easily.

Nikos Singelis: Great.

Okay, I think we're going to move now to our first question break. We're going to skip that next slide.

And John Kosco - we have two Johns today, so I have to keep reminding myself to say which one I'm directing this to - I'm assuming that we have questions out there.

And before you get to that, let me just say I got a report here and we have 3,200 people attending today's webcast, which is great. This is one of our biggest events, and we're happy that you're all here and we hope you're enjoying this program.

So John, do we have any questions from these 3,200 people?

John Kosco: Oh, we're getting plenty of questions. That's not a problem.

Yeah, there's a number of questions. I would like to mention we've had a couple people ask about the article that Jon talked about. That appeared in the latest Stormwater Magazine, and you can read it online at stormh2o.com. And again, that's an editorial article in the latest Stormwater Magazine. That's actually a free magazine if you want to sign up for it.

A number of people have submitted a question related to the 80 percent standard, and this is a performance standard that first came up at least in one place in the Coastal Zone requirements, non-point-source requirements, and they just asked the question, you know, how that 80 percent relates to some of these more, you know, effluent limits standards. [inaudible] Nikos or Jon.

Nikos Singelis: Well, it is true, John, that that 80 percent number did appear in the Coastal Zone Management Reauthorization Act - if I've got the acronym even close to it correct there - and that does apply in the Coastal Zone. And I think that was at the time kind of a guess basically. And I think as we're moving further and further into research into stormwater, maybe we're finding out that that's not necessarily the best performance metric to choose because it's really only talking about pollutants, and I think we've emphasized today here that we need to be concerned about volume reduction.

And of course, again, that simple percentage - which the idea seems to imply - again, is not necessarily the best way of measuring the output into a stream, a river, a lake or a coastal water. We still have to be concerned about that total load that's going out there. So again, you can get 80 percent off of a very dirty site and still be in violation of water quality standards.

So we think that there's some better metrics out there. Do you guys want to add anything to that?

Jonathan Jones: I think it's a very thorough answer.

Nikos Singelis: Okay, good. Thank you.

And by the way, I should mention we have some advertising up on our screen here. We're not going to talk about these things, but there's some reference points there for you if you - just to provide some additional information.

John, do we have any other questions?

John Kosco: Yes, another question is from Lawson Fetterman in East Buffalo Township.

He asks: After a stormwater system is constructed for development, is that system ever assessed as to whether it still meets the performance it was designed for?

And maybe we'll kick that to Jon to talk about.

Jonathan Jones: Well, Lawson, that's an excellent question that you pose. Certainly all of us are very interested in how well BMPs perform over time.

I'll share one specific example with you. We have been monitoring at a residential development in the western Denver suburbs, a development called Grant Ranch, the performance of a stormwater treatment system for eight years. We're actually moving into our ninth year. And we're pleased to report that we've seen no deterioration in performance over time.

This facility basically consists of a homeowner covenant on the non-structural BMP site followed by three extended dry ponds, all of which feed into a water quality wetland pond. The performance has been excellent. It's not deteriorated over time, and if you look at our database and the Center for Watershed Protection database, you can certainly find, Lawson, multiple studies that have multi-years of data that get at your question.

John Kosco: Great.

Another question comes from Matt in Pennsylvania. We mentioned, you know, performance of BMPs, but he points out isn't performance essentially regional-based? There's, you know, obviously freezing in arid areas, and maybe Neely or Jon could comment on how regionality plays into the performance BMPs.

Neely Law: Yeah, absolutely. And that probably reflects our list of factors we're going through, what factors can affect the variability of BMP performance. And those that we listed were very site-specific. However, regional characters in terms of development patterns, rain patterns, extended dry periods, short, rainy seasons and when those rainy seasons, you know, occur all have a factor in controlling BMP performance.

But once again, those are factors we can't control for, so how can we accommodate our BMP designs and learn from those regional factors to improve on BMP performance?

John Kosco: Great.

In the interest of time, we're going to - we do have two other QA sessions, but we're going to move on with Nikos talking about the urban BMP performance.

Nikos Singelis: Okay. I'm going to move through this section pretty quickly. I just want to introduce a new tool that we've been working on over the last six months or so that is now up on the NPDES website and is available for your use, and we hope that this will be very useful to you.

We started this project awhile ago because there are many studies on BMP performance that have been done, but they're hard to find. They might have been published in journals or websites. Some have never been published at all, never been distributed. There are many good studies from government agencies, for instance, out there that you just can't find any way. So there's no real easy way to access the information.

And so one of the things that we wanted to do is provide this information in a readily accessible place so that you can browse through it and read these studies and find out more about all the things that we're talking about today.

And of course, this is, I think, a natural complement to the National Menu of BMPs that we have on our website already, which is our most frequently visited site and has fact sheets on over 200 BMPs and stormwater practices there.

So our objective was to create a very easy to use system that would allow you to browse studies and to read abstracts, get sort of the key information from each of those studies.

So what we have done is gathered up a bunch of studies. Many of them in the first round have come from the International BMP Database that Jon represents. We also got studies from the State of California, who've done many excellent things that you really can't find anywhere else, and we're hoping to add many more to this collection over the next year.

So we developed some easy sort options for you. We wanted to provide a consistent format for reporting pollutant removal concentration and volume reduction information. As we said, that's so important and it's very hard to find the information on volume reduction in different places. And we've also given you links to statistical abstracts, design briefs and other things where possible.

So again, we have also some educational stuff. Many of the slides actually that we just went through are also on this website to further clarify all these things that we've been talking about - percent removal and volume reduction and that sort of stuff to get people a little bit more educated on this whole idea of performance.

We now have 220 studies covering 275 BMPs and we've got a search option so you can search by pollutant, by BMP type, by volume reduction, or for any key word that you might want to look for.

So here's a screenshot of the opening there of the urban BMP tool which is on the NPDES website, and here's the three basic search options that you can choose from. And I'll just show you one right now, but on the top you can search by pollutant, in the middle by kinds of BMPs, and then finally by volume reduction there.

And here's one we're just looking at by the type of BMPs. We've chosen here retention ponds. And then you can further search by any pollutant that you'd like or you can just look at all the pollutants if you want, so there are a number of options there.

And it brings you up a table like this that gives you the name of the study and a hot link on the left, a description of the BMP, the influent/effluent concentration using event mean concentration, as Jon pointed out, wherever we have them - these particular ones that are on the top here from the International BMP Database. And you can see also a percent volume reduction there that we have calculated in that information. And then finally, an indication of the quality of the study overall, which is very important to be looking at as well. And the ones with three check marks have passed the stringent criteria that's in that EPA work monitoring guide that Jon mentioned a little while ago.

And just to give you a further example, here's an abstract from this particular study that we've pulled up for you so you can see where it came from and where it was published and the basics about that as well as information about the BMP that was studied and some of the key metrics that were measured there.

We also, you'll notice, have links toward the top of that slide toward statistical abstracts. For those who really want to know more and get into the detail, we have a bunch of links there for you as well.

So we hope you explore this. I'm moving through it very quickly, but hopefully you'll go and take a look after this webcast and see what you can find there.

Over the next year we're planning to add more BMP studies to this collection from other sources of information, particularly ones that are looking at low impact or green infrastructure kinds of BMPs. There are not - obviously, we've been studying BMP performance for awhile and there's quite a lot on more traditional things like wet ponds and dry ponds and a little bit less on these, but we're going to try to add more.

We're also going to be encouraging researchers to submit their work so that we can put it there, and we're going to be making some connections, too, with the International BMP Database and the Center for Watershed Protection so that we can better coordinate our efforts across these three different tools.

And so this last slide just kind of sums up some of the key differences. You may think, "Well, there's these three sources and it's kind of confusing which one's really for me." And just to quickly summarize, our tool - the EPA BMP performance tool, which is the one I just ran through for you - gives you pretty easy access to descriptions of studies and some of the key information from those.

The International BMP Database is a really good resource for you, particularly if you're a researcher or if you really want to know more of the details, I think that's a place to go. And they have a very excellent, by the way, summary table which we'll be showing you some excerpts from as well, so even for those who are not researchers, that summary table and some of the other resources that they have there are very accessible. So I don't want to say that it's not accessible. They've got good tools, and I know they're improving it daily, right, Jon?

Jonathan Jones: We're trying, Nikos, yeah.

Nikos Singelis: And then we have the National Pollutant Removal Database, which is the product that the Center for Watershed Protection has been working on, and we'll show you some information from there as well.

And the really neat thing about theirs, it's very visual. You can look at that report - it's really more of a report - and you can look at that report and get a visual orientation to performance quite well.

Neely Law: Yeah, if you go to the link to download the report, you can also make a special request for the database, and that can be made available to people.

Nikos Singelis: Great. Okay.

So we have another poll question here. We want to find out which if any of these tools you have used so, again, same scenario as last time. Select the answer that best fits on the left there.

The first one is the International BMP Database sponsored by the Water Environment Research Foundation that Jon Jones was talking about.

The second is the National Pollutant Removal Database, which is the Center for Watershed Protection product.

The third is the urban BMP tool, which we've just launched and I would imagine not many people have actually seen yet, but that's our tool on the NPDES website.

And then you have choices here for two or three of the above, I haven't used any of these yet, or some other one that we have not listed here.

So let's take a look and see how the answers are going with that. Well, this is not going to come as much of a surprise to our speakers here. Look at this. So International BMP Database, only 3.5 percent. This webcast is really timely, isn't it, Jon.

Jonathan Jones: It sure is.

Nikos Singelis: We've got to get the word out about these tools.

Jonathan Jones: I'm glad I'm not running for office.

Nikos Singelis: Yeah.

Jonathan Jones: No doubt about it.

Nikos Singelis: The CWP product, 3 percent. Interestingly enough, EPA's new tool, which has only been available for a couple weeks, wins with 4.3 percent, but I should point out that this is not a plurality so I wouldn't be elected on any sort of popular claim here, would I?

Now we do have a bunch that have looked at two or three, so that's actually very encouraging. So I suppose those numbers are artificially low. We do have three-quarters of the audience out there that is at least somewhat familiar with some of these products. That's great. Oh no, I'm sorry. Oh, I read that wrong. I'm sorry - 7.7 percent - sorry, two or three of the above. I read that wrong. And 76 percent said "I have not used any of these yet."

So I think my earlier comment that this webcast is timely - so we encourage you to use all three of these tools, to explore them and to find out information that's going to work for you for whatever your application is there.

Okay, we're going to move into our next section here, and we're going to be talking about some of the other factors. So in the previous section, we have talked about pollutant removal and we've talked about volume, and I think we've given you a pretty good overview of those particular things.

But when you're selecting BMPs, there's a lot of other things to think about, and I think we ought to mention some of those at this particular juncture.

So Jon, do you want to maybe lead this one off and then the rest of us will just chime in as we feel?

Jonathan Jones: Okay, Nikos. But despite my polling numbers, do I still get to talk more?

Nikos Singelis: Yeah, yeah. Yeah. All right.

Jonathan Jones: Okay, well I -

Nikos Singelis: We'll grant you, you know, a little leeway there.

Jonathan Jones: I'll see if I can raise my numbers at all.

Well, yes, as Nikos says, there really are many other factors that we all need to think about when we're planning, designing, constructing and maintaining BMPs. Whether they be things like rain gardens, porous landscape detention features or green roofs all the way up to larger regional facilities like wetlands or wet ponds, those broad categories that we should all be thinking about are cost - as you see on the first bullet on the side that would be capital cost, cost per acre treated, maintenance costs. We usually think of life cycle costs when we look at costs.

Nikos Singelis: Absolutely. There's many dimensions to this whole cost thing, which is quite interesting actually. And as you bring up life cycle costs, site costs, different scales of cost, and I think Neely's got some information for us in a few minutes on that as well as one particular example. But it's a very interesting topic, very interesting topic.

Jonathan Jones: The second category that we have here is maintenance. That would be things like accessibility for maintenance, frequency of required maintenance, ease of maintenance, whether or not you can count on the maintenance actually occurring, who's going to be doing the maintenance, what do local ordinances say about maintenance, will there be assured long-term funding provided for maintenance? There's both scheduled maintenance and unscheduled maintenance, and both of those categories need to be accounted for.

Nikos Singelis: Absolutely.

Jonathan Jones: No matter how wonderfully designed and constructed these BMPs are, if they're not maintained, with time they're not going to work. So that's just a huge issue for everyone.

The next bullet is function in the regional drainage and flood plain management program, and that's extremely important. We have to remember that although perhaps in many cases our focus is on enhancing water quality, the features that we're talking about fit into a broader drainage system, and it's incumbent upon all of us to plan and design and construct and maintain urban stormwater management systems that not only protect receding water quality, but that protect the public from dangerous flooding. We have to provide assured flow paths for up to if not over the 100-year flood without them being damaged, and the role that BMPs play in that sense is very important.

Nikos Singelis: You know, Jon, another interesting little tidbit - I think we can take the time here to explore some of these ideas - but another interesting little tidbit that I've been looking into lately and EPA's looking into is the possible change in rainfall patterns that might occur due to global climate change and how that would affect us as stormwater managers and what we need to think about, particularly in terms of how we design controls or things in the future which may be more intense or our rainfall patterns in regional ways may change in different ways. And we really need to look at that.

I think it's interesting Tom Schueler, who was formerly associated with the Center for Watershed Protection, mentioned to me that the data that we're using to decide these BMPs was actually collected and compiled, I believe, in the 1960s. So that's quite old and out of date, and I believe NOAA - National Oceanic and Atmospheric Administration - is in the process of updating some of that, but still the question remains if over the next 20 years or so our climate patterns change, how should we as stormwater managers respond to that?

Neely Law: Right, and just a comment on that point. It made me think of a - you know, when you're designing and looking at your BMP using local data as much as possible to characterize the conditions that your BMP is specifically going to encounter is really key. It's not a plug-and-play from off the shelf type of materials and referenced onto it. It's really understanding your local conditions.

But on another point, if I can make a little sidebar and ask for Jon to comment on, we're talking about maintenance here and you had brought up a study in answering the question on long-term monitoring studies and about the continued function and performance of that BMP has been maintained post-construction. What would you say would be the role of maintenance in maintaining that level?

Jonathan Jones: Great question, Neely.

The study that I mentioned earlier, Grant Ranch in the Denver metro area, has in fact been characterized by excellent maintenance over time. There's a metropolitan district that's responsible for assuring that the facilities are maintained, the maintenance is contracted out, the maintenance is performed in response to our field observations as to what needs to be happening.

So all the elements are there in place - responsible entity, plenty of money, regular monitoring.

Nikos Singelis: Okay, and then another sort of set of considerations that we want to think about, too, is having a better sense of your watershed, and maybe Neely could talk to some of these points, too, and we can all jabber away as usual here.

Neely Law: Yeah. It follows up on my previous comments about understanding your local watershed and where and what you're designing your BMP for. You know, establishing and understanding this BMP is going to serve what purpose to establish this particular set of standards? What type of impacts do I need to have to ensure I account for by reducing flow volumes or is it a concentration or a combination of those two, the particular type of parameter? What are my pollutants of concern? Because certainly when you're sampling and evaluating your BMP, your costs are going to increased astronomically if you're going to sample everything under the sun. You really need to understand what your problem and issues are in your watershed.

But taking away from the science and the engineering side of BMPs, BMPs are set in a human landscape. They're surrounded and used by neighbors that - often they're in their backyard, so they want something that's visually appealing and it's not going to have any adverse health impacts on a residence population.

And the other point there, looking at the types of ordinances and regulations, are there a set type of practices that you need to meet? Are you limited, or do you need to reexamine those ordinances to understand what your options are because the current ones were set 10 years ago and you need to look up and update that?

But in addition to water quality, drainage and flooding continues to be an issue. As Nikos had mentioned, the push or - I won't say the push, but the growing interest of low-impact design or environmental acceptance to design are focusing on water quality, but revisiting also that volume reduction and maintaining flooding issues.

So anyway, so these are things that I think, pertaining to your local watershed, kind of a laundry list [inaudible] installable engineering science.

Nikos Singelis: Absolutely. Yeah.

There's many factors here to keep in mind, and in our next section, actually, we're going to try to look at some of these in a generalized way in a couple of key examples. But before we get there, we have another poll question for you.

And so here we're asking when you're picking or sizing your BMPs, what kind of criteria do you use? And so in this case, with this poll question you can select more than one answer if you're doing multiple things here.

So the first one, A, is water quality volume. And what we mean by that is something like the 90 percent storm event that was mentioned a couple of times and we'll explain in a little more detail, or perhaps addressing the one-year, 24-hour storm might be another example. These can vary from place to place, but what you're trying to do is address sort of water quality issues through these criteria.

The second one is channel protection, and here again, it might be something like the detention of the 24-hour, one-year storm but you might have some criteria in place like that.

The third one is over-bank flood protection, and again, this varies anywhere from a two-year maybe to a 10-year peak discharge rate that you're looking at. And this, by the way, is historically the way a lot of BMPs were sized and considered, with a peak discharge.

And then finally, the extreme flooding event, the 100-year flood event, might be another possibility there.

So choose, again, any which ones that you are actually using, and we'll show you the results of that in just a second.

Okay, looks like we've got a few results there. Very good. So we will show you those. So it looks like - wow, that's kind of surprising. What do you think, guys? Ninety percent are using some kind of water quality volume criteria. That's impressive. That's sort of surprising to me, but that's encouraging.

And by the way, I'll mention in a minute this new post-construction manual that we're coming up, it's going to talk a lot about sort of considerations.

About 45 percent, they are doing some kind of channel protection about storage volume; 30 percent doing over-bank flood protection, and also 30 percent doing extreme flood protection. So again, very encouraging, and I'm really sort of surprised by the answer to number one. Maybe it was easy to choose number one because it was on the top.

What do you guys think? Are you kind of surprised by that, too? Neely, do you have a comment?

Neely Law: No. It's good to have a few surprises every day.

Nikos Singelis: That's a good diplomatic answer.

Jonathan Jones: I would just say, Nikos, as you did, it shows that the state of the practice is better than some might have expected.

Nikos Singelis: Yeah. Excellent. We'll be interested in hearing more comments about that.

Perhaps if you can share with us if you think you've got some good examples out there in your local code or local design manual that you're - perhaps you can share that with us, because we'd certainly like to know. As I said, we're trying to finalize a post-construction manual pretty soon that the Center for Watershed Protection is helping us with, and we can use all the examples we can get.

So now we're going to move on, here.

Jonathan Jones: Well, Nikos, I would say one more thing while you're moving on.

Perhaps it is not all that surprising that so many entities are using water quality capture volume because recommendations along those lines have existed in states like Florida and New Jersey going all the way back to the early 1980s, and they've certainly been adopted widely. They've been endorsed by organizations like the American Society of Civil Engineers and the Water Environment Federation, as one example. So perhaps that's what we're seeing.

Nikos Singelis: Good. Good.

So now moving on to our next section here, and I just want to - the purpose behind the couple comments here is today we're talking a lot - in a minute, we'll be even talking more - about sort of site-level decisions, and a lot of the Stormwater Program is focused on kind of site-level impacts, whether we're developing a new residential development, whether we have a particular parking lot that we might want to retrofit, we have a lot of focus kind of on this site level.

And one of the things that I just want to remind everybody, too - and we'll be talking more about this post-construction manual - is that in the Stormwater Program, we really need to take our view up as well. So we need to start thinking at larger scales - at the neighborhood scale, at the watershed scale or regional scale, whatever terms you'd like, and thinking about how BMPs are performing at a bigger scale than just one site at a time.

So I put this slide in here just to talk about land use planning a little bit. And we're not going to spend much time on this, but it is coming up in the post-construction manual, which we hope to have out this spring, and we'll be discussing a lot about these different levels of planning here.

And Jon has provided us an example here from Lincoln, Nebraska, where they're actually doing a pretty good at thinking at these bigger scales. And Jon, what particularly struck you about this?

Jonathan Jones: Well, Lincoln and - the City of Lincoln and the Lower Platte South Natural Resource District have done an excellent job of major drainage way master planning and of accounting for water quality with their master planning. They have gone through a very vigorous process to develop a storm drainage criteria manual. Their major drainage ways are characterized by broad greenways, as you can see in this photograph. So an excellent community commitment to complement the stormwater management.

Nikos Singelis: Yeah, and particularly their greenway idea or the buffer strip or whatever terminology you want to use, those are really BMPs that exist on a broader scale. You know, if we're doing, you know, better planning to direct development in certain places or to redevelop underutilized parcels and we're using conservation easements or buffer requirements to maintain some of this critical area in our watershed, those are really BMPs, too, and they're not the kind that we often talk about, but in fact, they are BMPs. And as we said in the previous slide, land use is really the first BMP that we should all be thinking about.

So that's one of the things that we want to talk more about in the future, so this is just here as a teaser for right now just to make you aware of that.

And as I mentioned, the Center for Watershed Protection is - we've been doing this project for about two years now, and we're close to bringing it all together. And Neely, what's the progress there?

Neely Law: Well, I'm probably not the best person to speak to this on staff there, but it's pretty much - they have everyone behind working on this project, and it is - each chapter is being finalized, probably another one today.

But it provides - it's a comprehensive manual that provides a set of tools and guidance to develop and manage your stormwater program from the site level to collecting data information, but you scale up those results and get a look at that larger picture, as you were talking about earlier. What is that impact at the watershed? Because that's really what we want to protect, you know? And so it's putting all those pieces together.

Nikos Singelis: Yeah. Absolutely. So we'll be looking forward to that, I know.

John Kosco and I and Neely and other folks from the Center for Watershed Protection will be burning the midnight oil to get that completed and out to you soon.

Okay, so in the next section here - this is actually our fun section, and so hopefully we can show you some interesting stuff here. So what we're going to do here is actually look at the three common BMP types, and we're going to take all the things that we just talked about - whether its pollutant reduction, volume reduction, and all these other considerations that we've gone through - and we're just going to give you our sort of best professional judgment on some of these things, so hopefully this will be fun and interesting.

So a little bit of the caveats there, just so that you know that there is, again, no one number that you're going to ever find that's going to be the number - as Neely said, kind of the plug-and-play kind of solution - but we need to look at a broad range of information there. And we, despite our comments before about percent removal, as we mentioned before, we have a lot of studies out there that did pitch that removal and, you know, that's the history that we're faced with, and we still do have some of that mixed in to some of what we've got here. We hope that over the future we'll weed some of that out and have more reliable results, but we have to live with that, you know, to some extent, you know, and keeping an eye on that with what we've got.

So we're going to be showing you some percents. We're going to be showing you some concentration-based data. We're going to be showing you some things where there's not a great number of studies, so you'll see high variability. And we're going to be showing you what I call the WAG estimate down there, which you figure out what means for yourselves. But that's just kind of our best professional take on some of this stuff.

So let's first look at wet ponds, and I also put creative wetlands there because they're relatively similar although there's some different aspects to those two things that we should examine as well. And so first, just for those who are not statistically oriented, Neely's going to explain what a box and whiskers plot is.

Neely Law: It's a really nice summary way to statistically look at your data to get a visual cue on if there are significant relationships if you prepare influent and effluent box plots together.

This is an example plot of what you would see if you looked at the National Pollutant Removal Database, and the different colors present different distributions or points in your sample data set. The circle represents the average, so just taking the total - summing up your concentrations, dividing it by the number of studies, and there you have your average.

First is the median, which represents 50 percent of your values are above or below that, and then the darker, gray box, the top of that line represents the 75th percentile, where 75 percent of your values are at or less than that value, and similarly, the 25th percentile, except at 25 percent of those values.

And then the big long lines you have extending through those plots would represent the maximum value reported in the database for that particular parameter for that particular BMP and that minimum value, and on the Y axis would tell you your removal efficiency. And sometimes the removal efficiencies, there's going to be a negative removal efficiency, which means there's going to be higher concentrations leaving your BMPs compared to your influent concentration as opposed to what you want to see are values above that line.

And then in the National Pollutant Removal Database each parameter will tell you how many studies are associated with that, so you can have some level of confidence of what the numbers are made up of.

Nikos Singelis: Right. And so, as we said before, more studies is better, but again, this gives you some visual sense of variability. And as we mentioned, in these particular examples there is some mixing of percent removal and percent load reduction in these top graphics.

Neely Law: Right. And the majority are EMC based. I would say about 10 percent are load, and those are the new studies that are coming out. And as was said, you know, we're continuously trying to improve that data set and we're moving toward that measure.

Nikos Singelis: Great. Great.

So let's look at some real data here and examine it a little bit. So on the top we have these box and whisker plots from the Center for Watershed Protection's research, and then showing something very different but it's the concentration values from the International BMP Database.

Now, of course, we've got concentrations and percentages going here, but what you want to look for is are we following a sort of similar trend, and one of the things that, as I was looking at this and actually put this together, was it was interesting to me that basically these two sources of data were telling us generally the same story. It was very interesting and encouraging.

So maybe just to pick an example or two, for instance, on the top we've got TSS removal and you can see that the average of the mean, and actually that box is rather tight there for the 25th and the 75th percentile, so it's relatively close distribution in both values. And it's - I don't know what the numbers are exactly, but it's, you know, in that 70 to 75 percent range somewhere.

And if you look down below in the information from the International BMP Database, again, concentration based but you can see a pretty dramatic drop in TSS concentrations there.

And so this is my contribution to this whole mess, which is the stuff at the bottom, the stars and whatnot, and so I used a gold star to basically say, "Okay, this BMP does a pretty good job based on looking at these two data sets." And I used the little blue tilde symbol to say, "Yeah, well, you know, okay job," and then we'll see later on some places where it really doesn't do much of anything. But that's just kind of my best professional guess, and I think our guests, more or less, agree with that kind of general storytelling.

Neely Law: Right. And the data for wet ponds and wetlands - and you have the most number of studies, I think that's reflected in the International BMP Database and it's certainly reflected in the Center's database - this is where we have a lot of data, and so you don't - so the law of large numbers, you know, is reflected in this plot.

Nikos Singelis: Yeah, absolutely. And you'll see that when we compare some of these other ones.

But just verbally, now, let's - so we've just talked about the pollutant issues, but now let's talk a little bit about some of the other things that we talked about, and the first one to mention is volume reduction. And wet ponds obviously aren't designed to infiltrate water, so most of the water that comes into the wet pond is going to leave the wet pond.

So in terms of volume reduction, this BMP's not going to do a great job. It might lose a little through evapotranspiration. We might lose a little, you know, depending on how - whether it's lined or not lined and those sorts of things. But basically, we're not going to get a lot of volume reduction.

We probably will get some peak flow control here, so that's another consideration.

But as we said before, kind of the pro side here, we've got generally good pollutant removal and, of course, these things, as Jon points out, can be community assets. People like living near water and that sort of stuff. You know, we can't deny that.

A lot of the designs, like if you compare the two pictures down at the bottom, some of these designs could be enhanced or redone to provide more habitat value through planting of trees and wetland plants and things like that, which might also lower some of those costs. The picture on the right there shows a BMP that's probably pretty costly to maintain, with a lot of mowing and keeping those fountains going and all that kind of stuff. So there are things that one could do to a wet pond to maybe enhance its overall value.

And then, again, Jon mentioned earlier that this could have some impacts on the downstream side if we're not careful about the outflow.

Water temperature is another big issue. These ponds sit there and actually heat up the water quite well, so particular if it's going into a cold water stream, it can have disastrous impact on that stream and we've certainly seen that in a number of places.

And again, the cost issue - now Neely, do you want to discuss the little - some of the cost information that we have? We just have a snippet here, but -

Neely Law: Right. And this information was developed through the Center's development of the Urban Stormwater Restoration Manual series - Manual 3 on stormwater retrofits - and it reflects unit costs solely for construction. So that $8,350 is the cost to treat on a per impervious acre basis, and that number is going to be the unit of measurement you'll see in the other slide. So it doesn't take into consideration land acquisition or design and engineering costs, but it gives you a relative sense of both that initial investment that you need to make.

Nikos Singelis: Right. So again, that's just the capital cost for construction. There's many other aspects of the construction site.

Okay, let's just for the fun of it look at dry ponds a little bit, and we're strictly going to look at dry ponds that are dry. There's certainly some hybrid variations here and some design improvements that have been made over the years to the thing, but we'll just look at the dry one.

And again, maybe Neely, you can take this one and explain some of those graphics here.

Neely Law: Sure. Once again, thank you, Nikos. These are removal efficiencies and characteristics of dry ponds, not extended detention ponds, and so those that were really designed for flood control purposes.

And I think you could see through the plot of these removal efficiencies it reflects that compared to what you see for a wet pond. It has pretty - aside from total suspended solids, it has a little over 40, 45 percent pollutant removal efficiency. The other pollutants don't do that well, and there's quite a variability in the data itself.

So looking at the median influent and median effluent concentrations from the International BMP Database, similar patterns in the - you'll see by looking at the actual numbers versus the box and whisker plot.

And because these dry ponds were designed for flood control, you don't see a lot of Nikos' gold stars here. You see those red Xs you didn't see before in the wet ponds and more of those uncertain performance measures shown by those blue squiggly lines.

And once again, that unknown fact, you know, about bacteria, which we'll talk about later on. It's kind of that moving target, you know, how do we, you know, measure it, and how can we best treat bacteria.

And so because they have been designed for - not specifically for water quality, I guess the saving grace behind dry ponds is that they do have a significant infiltration capacity that's estimated maybe around 20 to 30 percent. And through evapotranspiration and other losses, that's maybe where you might be getting some of our pollutant load reduction.

So the summary point for dry ponds that this water quality benefit is probably typically underestimated because you're not really looking it as an infiltrating practice. But once again, the coming back, if we're looking at water quality, it generally does not perform well. And looking at the cost for the maintenance of ponds that are dry ponds, about $3,800, that's your base construction cost not considering the high maintenance of mowing the turf. If you don't have a sediment forebay in front of it, coming back every five years and dredging out the sediment, which is extremely high cost to incur by a municipality.

Nikos Singelis: Yeah, yeah. Absolutely.

So I think that's a pretty good summary point on that. And then in the next set, we'll just look at some of these things that have all these unfortunate names and terminology and EPA deserves blame for introducing the idea of green infrastructure. But probably the most common one out there is low-impact development, or I think Neely actually added one - environmentally sensitive design, or best - you guys used to call it better site design, was another one.

But anyway, all these sort of newfangled devices out there, such as rain gardens that you see pictured here; wetland swales, different kinds of swale designs here that can be infiltrating; porous landscape design stuff, such as porous concrete and porous asphalt and the pavers and such that really can aid in infiltration. And of course just some basic designs like curbless streets can be a BMP as well. And of course then you can see here in this particular example a very shallow swale there, taking care of the infiltration.

So now, in this area, we're going to look at bioretention specifically. But because bioretention's a relatively new technique, we don't have quite the robustness of data that we do for some of the other BMPs, so we're going to show you something a little bit different here - which is the graph of the 90 percent storm event - so you can get an idea of what we're talking about visually because we've mentioned this idea a couple times.

And we're looking at this as one possible option as a design performance standard, and so what we've done here for Worchester, Massachusetts is basically got rainfall data going back to 1948 and lined up all those rainfall events to see in rain quarter where the 90 percent value falls, and in this case it falls at 1.25 inches.

And so if you were to design BMPs where you're going to infiltrate that first inch and a quarter, you can actually take care of - the graph in this case shows - 90 percent of the volume of water that's fallen during a given year, say, on average.

So this is why we think - and if you go back to the earlier example that we had with the piles of dirt and the beakers and the wheelbarrows, if you plug 90 percent into that, into the BMP infiltration factor, you're going to have a dramatic decrease in the pollutants coming out of that thing just by virtue of that infiltration factor.

Now, of course, this is going to vary from site to site and place to place depending on the numbers, but it gives you an idea of what we're talking about here.

Jonathan Jones: Nikos, could I comment on that site -

Nikos Singelis: Sure.

Jonathan Jones: - because I feel very compelled to comment.

There are some sites where it's going to be simply impossible to infiltrate the 90th percentile annual storm of 1.25 inches. Indeed, there are many sites in the United States where, if 1.25 inches of precipitation had occurred, under predevelopment conditions there would have been runoff and not all of the rainfall would have infiltrated.

Nikos Singelis: Absolutely.

Jonathan Jones: So those kinds of considerations certainly need to be accounted for.

Nikos Singelis: Yes. Right. And actually, I guess I should refine my discussion there a little bit, that if we set out this idea, then we'd have to tailor that idea through design credits and other factors for particular site conditions, and that would be the responsibility primarily of the Phase I and the Phase II municipalities out there, to figure out how this might work. If you're doing a downtown redevelopment project, as Jon said, it may be impossible to do that, or you may only be able to do a small fraction.

In other places, where you've got good soils and good drainage, you may be able to handle that absolutely. So it will vary from place to place.

Neely Law: Right. Now I'll just make a little plug for the upcoming webcast on the retrofit manual is it provides you with, I mean, municipalities with guidance to search for that needed storage. You know, where can I find storage in these ultra-urban areas that are already developed, where you don't have the option of large open spaces.

Nikos Singelis: Yeah. And that I think will be a very interesting webcast, and the manual's very illuminating as to some of the possibilities that are often overlooked for getting better stormwater performance in existing developments.

So just looking at the pros and cons here, just to continue with our idea here, of course, we've got this high volume reduction. And again, as we've mentioned several times in this webcast, volume really may be the thing that you need to worry about. In that case, some of these low-impact development ideas can really help out, particularly with those smaller storms.

And with that, often comes high pollutant removal, and we'd like in the future to be able to tell you exactly more about that and we will by gathering up those studies.

Some interesting little things, particularly about bioretention, I know the Center did some sort of preliminary analysis - and Tom Schueler was telling me about this, that the performance of a bioretention cell without an underdrain as compared to with an underdrain is dramatically better without the underdrain. And I think based on the stuff that we've been talking about, our audience can imagine why that would be. The underdrain, of course, is going to pull off some of those smaller events. And depending, too, on the soil mix, too, I think we've seen in some of the bioretention cells that the decomposition actually adds some pollutants in some cases. So if it's possible to do it without an underdrain, you're probably going to get better performance.

Another thing that Jon mentioned to me is that if you do use that underdrain, that underdrain maybe should go to a second BMP to handle those flows. So you can use this treatment train idea to even get better performance.

So again, we may have some lower costs here for maintenance depending on how they're designed because you're not having to mow all the time. Of course, in any BMP, you're going to have to deal with trash and in many of these, annual mulching and things like that and, of course, periodic upgrades and such.

And now cost, Neely, you've got here - this might sort of stun some of our audience, so we need to put it into a little context here - $25,000 per impervious acre.

Neely Law: Yeah. And we've had discussion, you know, amongst ourselves about, you know, what's this number? And I think to put it in context compared to other more regional-scale BMPs, it's where you're putting your money. For a bioretention, there's this high cost initially on a unit cost for the BMP itself, but when you factor in with the $25,000 or the $8,400 for a wet pond doesn't consider land acquisition, long-term maintenance costs, dredging costs for a dry pond over the longer term, this bioretention cost is really going to seem quite small.

So once again, you know, $25,000 is a unit cost for treating, you know, an impervious acre, and these are designed for those smaller drainage areas as well compared to a wet pond that is designed to treat much larger areas.

Nikos Singelis: Yeah. And another dimension to this whole cost thing, which is such an interesting topic, is we look at site costs, too. If you are using more of these infiltrating-type devices - and the last board on the left there mentions it - you may have some associated cost savings through not having to put in curbs, for instance, or having less of the gray traditional infrastructure. So you may end up with some substantial cost savings there which would maybe offset the actual installation costs of the particular BMP.

We have in the resources list that's available to all our listeners out there a new document that EPA just came out with a couple weeks ago on the cost associated, kind of a site level, using a low-impact design versus a conventional design. And I think almost all those case studies show a significant decrease in your overall costs as well.

I know, Jon, you had an example, didn't you, of where you had some cost savings?

Jonathan Jones: Yes. We have been working on a design, actually, for a drainage system in a dense, multifamily area. And by integrating lid-type facilities, we were able to start our storm drain system farther down in the watershed than without the lid measures in place. So there was associated infrastructure cost savings there, Nikos.

Nikos Singelis: Great. Okay.

And we are about 15 minutes out from the 2:00 hour here, and I want to let our audience know that we can go - and it looks like we'll probably need to go - a few extra minutes. We don't have to be cut off, so bear with us because we do want to answer some more questions. We have a couple more slides here that we want to talk about.

Here we have some recommendations for designers. These are rather generalized, but just some things to think about related to this. And I think, Jon, maybe you can start this one out?

Jonathan Jones: Yes, thank you.

Certainly, there's a strong consensus on the part of professional societies, governmental agencies at the federal, state and local level, design practitioners that the multi-layer treatment train approach to BMP design should be utilized. That would include both the broad mixture of non-structural BMPs and structural BMPs.

And interestingly, with nearly two hours of discussion, we haven't talked much today about non-structural BMPs. Those would be things like pesticide controls and assuring that wide buffer zones are used next to streams.

Those measures, in combination with the kinds of structural BMPs that we've been discussing today, would be the recommended approach. And of course you would start in terms of structural BMPs at an individual lot level, and you would gradually move your way up to larger regional facilities such that the pollutants literally have to be worn out before they can leave the site and enter the receiving water.

Nikos Singelis: Yeah. Yeah.

And Neely, I know you had brought up this very interesting point going back to the work that you had done with those wonderful box and whisker plots that we don't want to continue to design for average or sort of mediocre performance.

Neely Law: Right. And the whole caveat behind pollutant efficiencies, which is how we started off this discussion - and the Center database is largely based on percent removal - that these measures really aren't an accurate reflection of the BMP performance. And so what the Center has advocated is that if you are using the median value, you're going to get mediocre performance out of your BMP. And if you're going to make this substantial cost investment, do you really want mediocre performance? I would say not. You really want to get the most bang out of your buck for that, and so what we have suggested is look at that 75th percentile pollutant removal and design around that for your BMP.

Nikos Singelis: And a practical way of perhaps approaching that, for instance, is to look through the studies and examine the ones that have gotten a little bit better than the average or median performance and see if you can discern any design details that might have led to that better performance. So I think that's one use for all this information that we're trying to compile out there.

Neely Law: Yeah, absolutely. And I think, you know, Eric Strecker and others involved in the International BMP Database as well as, you know, people at the Center are trying to distill what those design factors are. You know, unfortunately being such a young science there are a relative number of BMPs to the huge number of design factors in considerations that can affect it. It's a challenging process, but a worthy effort and hopefully we'll come up with more standards to look at.

Nikos Singelis: Well, and as we sort of advance the science we hope to share, you know, more and more information with people as time goes on.

Just to talk about, I think you've gotten some sense, you know, that we don't have the absolute answer for you, and I think we sort of said that a number of times. And we do have some challenges that are still out there. I'll just briefly touch on a couple of those, and then we'll move into our next question break.

First of all, we've got to find ways to best assess infiltrating devices, and we're going to be working with Jon Jones and the folks at the International BMP Database and the Water Research Environment Federation to come up with some ideas about how to better assess those things, so they're complex systems and a lot of things going on in them.

And so we'd like to, you know, sort of push that envelope a little bit, if you will. We've already mentioned that we need to have some consistency in the way we're assessing these things so that we can compare one study to another. The pollutant list is one way, but there are some other elements to the research designs here that could be standardized.

And we've touched on this, but moving beyond percent removal, of course, is something that we've said. We want to move into starting to assess some of the biological and stream morphology or the physical aspects of BMP performance.

And then moving up in scale, too. There's a lot of work at the site level scale, but how do multiple BMPs work at a watershed level? And we haven't done very much of that.

And then Jon has mentioned several times all these complications related to bacteria in particular as one example. And Jon, I know, this next chart here comes from a paper that you and some of your colleagues are working on.

Jonathan Jones: Yes, Nikos. Briefly, because I know we're short on time, but this is one example of how these databases can be used to analyze the questions that may be of particular interest to each of you participating today.

We have many clients who are interested in bacterial levels and bacteria fluctuation, and in the International BMP Database there are now close to 150 paired samples for e coli and about 400 to 500 paired samples for fecal coliform. So with a database of that size, we can begin to make at least some initial observations regarding BMP performance as it relates to bacteria.

And as you point out, Nikos, Geosyntec and our firm, Wright Water Engineers, in conjunction with the Denver Urban Drainage and Flood Control District and the City of Springfield, Missouri are analyzing these data and we'll be publishing our results, you know, shortly.

Nikos Singelis: Great, great.

And as you can see from this graphic that's up there right now - and this is no big surprise to anybody who's looked into this but, you know, bacteria sometimes remains kind of a confounding problem, and the red line there represents the primary contact recreation standard of 126 colony units - colony forming units - per 100 milliliters. You know, just as a generalization, you can see a lot of these BMPs are not doing so great, so we certainly have some challenges in that area. So we're looking forward to the paper. I'm sure it will be very interesting.

So let's see, let's - we have a poll question, I believe, next. In this one we want to ask you in the past, how have you been making decisions about the type of BMP that you're going to put onto a site? And so be as honest as possible here. You've been using removal efficiency information that you've gotten from perhaps a published article or a database or a design manual somewhere, so that percent removal kind of number that we have talked about before.

Option number two there is a list of accepted BMPs in your state. Perhaps your state has just a list that you have to follow.

Are you calculating load reduction based on your particular sites or are you doing some kind of calculation that's custom-made for your particular site and your particular water body, I guess I would add to that one, or some combination of the above?

So take a second to select an answer for the one option here - again, it's only one choice - that most represents what you are doing. And again, you know, be as honest as possible as to what you've used in the past.

So we'll take a look at those results here. Ah, huh. Well, that's very interesting. I guess I'm - and Jon - we should be reassured that not many people are using percent removal or we've done such a good job in educating them about percent removal now that they won't admit it, one of the two.

It looks like a list of accepted BMPs in a state storm manual is a very popular option here. And again, that might be a good place to start, but I think you've gotten the message here that we want to refine those choices from that list based on site conditions.

So not many people are doing the site conditions it looks like - the 4.1 percent there. And then another 46 percent there said some combination of the above, so perhaps that increases those numbers for percent removal being used in combination with some of the other things as well.

So, anyway, a very interesting result there. And John Kosco, do we have any questions out there?

John Kosco: Yes, we have lots of questions, Nikos.

The first one is for you. It comes from Martina in Portland who asks: In reference to your rainfall frequency chart, is EPA thinking about making control of the 90 percent rainfall event a requirement?

Nikos Singelis: Well, I would say EPA's not considering that. We are considering the idea that some kind of a performance standard such as that might be a workable solution in particular places, and I would say that because we have such variability and climates and different conditions in different cities, both environmental and economic and a whole host of other reasons out there that we shouldn't, you know, pick one sort of solution and try to force fit that in all that variability.

So we need to find an idea that might be workable and then customizable to the different situations that different folks are facing. And even within - I think it would be a challenge for these local communities to take some kind of a standard idea like that, whether it's 90 percent or whether it's some other metric, and then to tailor it for different kinds of development within the community that are going on.

You may want to set different design standards for a brand-new development on virgin land. You may want to do some different things in a dense urban environment, where you may be more constrained by the site, of the size and all that kind of stuff. You may, frankly, you know, want to encourage for a whole host of reasons downtown redevelopment for economic reasons as well as water quality reasons.

And so you'll want to vary that application of whatever that standard is from place to place and from community to community. So I would say that we are definitely looking at some of these ideas to hopefully improve these programs, but we have to find ways that will work in different communities.

Do either of you guys have comments on that?

Jonathan Jones: Well, I'd strongly endorse what you said, Nikos, about the need to customize.

Neely Law: Yeah. And I think our whole discussion today talked about variability, you know? And so having that one blanket, you know, nationalized I think wouldn't fit the ticket, so I think that approach - customizing it - is much more doable.

Nikos Singelis: Yeah, yeah.

John Kosco: Okay. The next question or comment actually comes from Eric in Florida, who notes that wet ponds can get volume reduction when you do stormwater reuse, which is what they use in Florida, and I think Jon wanted to comment on that.

Jonathan Jones: Right. For all of you participating, we actually see the questions on our computer screens, and this happens to be Comment No. 286, believe it or not. And they're all outstanding questions and observations. I mean just terrific.

This one is from Eric Livingston who's long been one of the leaders in the field of stormwater quality management and developed a superb program down there, and it's so helpful to all of us. Eric makes the excellent point that it is important to note that you can, in fact, have volume reduction with wet pond if you're reusing the water in those wet ponds. That is, for instance, if you're pumping water out of the ponds and irrigating with it, and that's indeed an extremely important point to make.

John Kosco: Great. Thanks. Luis asks: How can we submit studies to the BMP databases? And I'll just - as Nikos noted, one of the future features of the urban BMP tool for EPA will be to add data eventually, but that's not available right now.

Maybe Jon and Neely can add how you can add information to their databases.

Jonathan Jones: Go ahead, Neely.

Neely Law: Oh, well, mine is pretty straightforward, but I think Jon's is a little bit more involved.

Ours is a summary of reported studies, so currently there isn't a data entry component to our - it's not a live database. So maybe that is something we can look at to do in terms of improving it and consolidating these databases in the future.

Jonathan Jones: And from our standpoint regarding the International BMP Database, one of the earlier sites gives the logo of the International BMP Database as well as the website. You can contact us in that manner. You can also contact us via phone if you would go to our firm's website, Wright Water Engineers or Geosyntec, Inc. We welcome your inquiries and would love to work with you to input your data to the database.

Nikos Singelis: Great. And just to let everybody know online, we're going to continue with questions for a few minutes, and we're actually going to skip the last couple slides because I think we have a lot of questions that we'd like to answer here, so I think we'll devote perhaps the next 10 minutes or so to answering questions.

So those of you out there, stick with us. We're going to go a little over on this one.

John Kosco: Yeah. And those slides are available in the download, and they're pretty self-explanatory.

The next question comes from Sue in Louisville. She notes that water quality standards are concentration based, not loading or percent removal. How do you demonstrate that a BMP will achieve these water quality standards, which are concentration based?

Nikos Singelis: Well, that's a very good question and something actually in the permits program that we're at very diligently, and it actually leads a little bit into some of the slides that we're planning to skip right now.

But there are a couple ways. I think we mentioned to you before that concentration information is very important and it certainly could be looked at, just as that concentration information coming out of a BMP related to a water quality standard, and you could certainly do, you know, kind of a back of the envelope look at that to see how those compare.

As we move into impaired waters, though - impaired waters that we're writing TMDLs for - those TMDLs are based on loads, at least to start with, and then it is up to the writer of the TMDL and then the permit writer to translate those loads, which are daily loads, so pounds per day, basically, or kilograms per day, into a water quality based limit in a permit.

And that limit can actually take a bunch of different forms. It may be a narrative limit where you're describing BMPs that need to be implemented. It could be a numeric limit as well, which then is the translation back into a concentration-based number.

In stormwater, at least for the foreseeable future, we see a lot of those limits being written as narratives, so describing the kinds of BMPs that you should use. But I wouldn't say that, you know, down the road we wouldn't have some numeric limits as well.

And so there is a translation factor to kind of get at the essence of this question, between that load, particularly in the total maximum daily load aspect, back to the particular BMP.

So it can happen in a bunch of different ways.

John Kosco: Okay. The next question comes from Mark in Clark County. I think that's Clark County, Nevada. He notes that he's the driest large MS4 in the nation and because of the arid conditions, I mean, never have a statistically valid sample set in terms of the BMP information they're collecting. You know, what can they do to help improve or get a better data set for their BMP performance?

Nikos Singelis: Jon, I think that one's for you. You're the advocate of the arid and semi-arid area. That's why you put me on this committee, isn't it? And you've made a number of comments to me about how I needed to, you know, embodify my thing, so I think, yeah, you ought to take a shot at this one, Jon.

Jonathan Jones: Well, thank you. Thank you very much.

And Mark, we do empathize. I work out of Denver and am privileged to work throughout the West, and I know exactly what you're experiencing because many of our clients have experienced the same thing.

The first observation, of course, is when you have so few opportunities you're really forced into using automated monitoring equipment. The notion that grab sampling would work when you have only a few runoff events a year, of course, it's just not tenable.

And knowing Clark County and your excellent reputation, I would guess that you do have automated monitoring stations set up in many locations, and that, you know, when the events are occurring, you're monitoring them. But, of course, as we all know, just because there's a rainfall runoff event and you do actually have flow that you can sample, there can be myriad reasons why you don't have a valid sample that you actually obtained.

So stay with it. Get whatever storms you can. Keep the relevant regulators very well informed of your effort, and perhaps when you do collect a storm that may not comply strictly with all of EPA's recommendations and other recommendations for design strong metrics, run by the relevant regulators what kind of data you do have and see if that would be acceptable as a substitute.

Those would be my thoughts.

John Kosco: Okay. Before we take our last one or two questions, I just want to note that this webcast will be archived so you can download it in a couple weeks. The speakers' contact information is up on your screen. There's also a resource list that you can download in Adobe Acrobat.

You should see a webcast evaluation survey on your screen. Please fill this out. We do appreciate your feedback with that, and please turn off your pop-up blocker in order to see that.

Also, don't forget to download the certificate. Click on the certificate button to print the certificate. It will not be mailed to you. For multiple people in the same room, you can click on this link to customize your certificate, print a copy for everyone attending.

Now we'll take one or two more questions. Several people have asked a question about increased risk - they've got groundwater pollution - when promoting, you know, volume reduction or infiltration BMPs.

Nikos Singelis: I'll start that one out, but you guys can add to it.

Of course groundwater is a concern, but we want to make sure that we're not doing anything to compromise groundwater quality either.

And some of the research into this so far is that many of these BMPs actually do quite well at preventing groundwater contamination for many of these pollutants.

And, of course, we're continuing to work on that, particularly with the regulators who regulate underground injection of pollutants, so we'll have more on that for you in the future.

I would say that in certain places infiltration may not be appropriate. For instance in a place of a hot spot, for instance at a gas station or some place where there's likely to be a heavier deposit of chemical, we may not want to use infiltration. So there may be some places where it is inappropriate.

And for certain other pollutants like chlorides, for instance, I think we need to look at that very carefully because they do have a tendency to move through the system very quickly.

Neely Law: Yeah, and I'd like to add to those comments that using a treatment train approach where you focus on specific unit processes to deal with specific parameters one at a time that you can minimize that transfer of pollutants to the groundwater by focusing on sedimentation process, perhaps upfront, or particular vegetation that can uptake those toxic contaminants before it moves on to another perhaps infiltrating BMP to deal with, another set of parameters.

John Kosco: Great. Well, thank you, everyone. I'd like to conclude today's webcast. Please remember to fill out the survey and download your certificates.

Thank you, Jon, Neely and Nikos for participating today, and of course, thanks to everyone who joined us.

Our next webcast will be scheduled for April 9th addressing the Art and Science of Stormwater Retrofitting, so check EPA's NPDES training courses, workshop and webpage for the latest information. That web site is EPA.gov/NPDES/training. An announcement will also be sent out for NPDES News.

This ends today's webcast. Thank you for joining us.