

Tools and Guidance for Developing Your Post-Construction Stormwater Management Program
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Sonia Brubaker: Good afternoon, and welcome to today's webcast, titled "Tools and Guidance for Developing Your Post-Construction Stormwater Management Program." This webcast is sponsored by EPA's Office of Wastewater Management. I am Sonia Brubaker, with Tetra Tech, and will moderate today's session. Thank you all for joining us today.

We'll begin today's session by going over a few housekeeping items. First, if you have any technical difficulties you can call 1-800-833-2812 or click the Help button to receive technical support from ON24. Again, that number is 1-800-833-2812. You may also use the Ask a Question area to post any technical issues you are experiencing. Please include a telephone number where you can be reached, and we will help you troubleshoot your problem.

We will have several question-and-answer sessions during the webcast. To ask a question, simply type your question in the text box located in the lower section of your screen, then click on the Submit Question button. You don't need to wait until the question-and-answer periods to submit your questions. In fact, there are a large number of participants today, so we highly encourage you to submit your questions early.

There will also be several occasions when our presenters will ask you questions. These poll questions will appear in the slide window. Please submit your answers in that same slide window, not in the Ask a Question box.

And if you would like to see closed captioning, just click on the Closed Captioning button on the lower left corner of your screen.

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This webcast will be archived indefinitely so you can access it after today's live presentation. The archived webcast will be posted within a few weeks on EPA's NPDES training website.

Now I'd like to introduce you to today's speakers. The speakers for today's session are Nikos Singelis, of EPA headquarters; David Hirschman, of the Center for Watershed Protection; John Kosco, of Tetra Tech; and Steven Hubble, from Stafford County, Virginia.

Nikos is a Senior Program Analyst with EPA's NPDES stormwater program. Nikos has been with EPA's stormwater program for the last seven years and works on many projects aimed at helping Phase II communities implement this challenging program. He coauthored 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 and is a speaker across the country on various stormwater topics, including StormCon and the International Erosion Control Association conferences.

David Hirschman serves as the Director of Practices for the Center for Watershed Protection. In this capacity he coordinates the Center's stormwater local restoration projects, focusing on technical and program tools for use by local and state governments. Dave coauthored the new post-construction guidance document published by the Center in July, which is the main topic of this webcast. Prior to joining the Center, Dave worked for about 20 years in the public, private and nonprofit sectors on a variety of water resources issues, including running a local stormwater program for Albemarle County, Virginia.

John Kosco has over 15 years of experience working in stormwater and nonpoint source control programs, including stormwater program development, implementation and compliance in both the public and private sectors. Along with Dave, John coauthored the new post-construction guidance document published by the Center. John has also authored several other guidance documents, including Minnesota's Stormwater Construction Inspection Guide, EPA's Municipal Stormwater Program Evaluation Guide, as well as EPA's Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites.

And, finally, our fourth speaker, Steven Hubble, is the Environmental Programs Manager for Stafford County, Virginia. Steve manages the county NPDES Phase II stormwater permit program as well as the county's inspection programs for erosion control and stormwater management. Prior to this position, Steve served as an environmental planner with Stafford County and also worked with Dewberry & Davis, providing support for flood plain mapping for the National Flood Insurance Program.

Now, as a reminder, 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 EPA.

And just another note -- we will try to answer as many questions as possible throughout this webcast, but due to the high number of participants, all questions will not be answered. However, today's speakers' contact information is provided on your screen should you have any questions following the webcast.

Now we are ready to kick off today's session. Nikos will now introduce the Center for Watershed Protection's new manual, *Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program*.

Nikos Singelis: Thank you, Sonia, and welcome to everybody on today's webcast, and welcome to our esteemed group of speakers. We have a lot of material to cover for you, and so we're going to jump right into it. As Sonia mentioned, we do have a couple question-and-answer breaks today, so we'll be taking your questions, but encourage you to submit those early so that we can pick out the best ones for those sessions.

So we're going to be talking about this new guide that came out about a month ago that the Center for Watershed Protection took the lead on developing, and we've been working on this for I think about two years now, so it's been a long process, and we're all very happy that this thing has been issued and it's out there now on the street for everybody to look at it. So there's the cover of it there, and you can get it at the Center for Watershed Protection website, which is listed right there.

And we're going to show you now just an overview of the chapters. Now, many of you will remember that last September we did a webcast on kind of a preview of this manual. So we've covered some of this material already in a previous webcast. So today we've picked out some new and different things that we're going to be focusing on. But for those of you who maybe didn't tune in the last time, the manual itself is a rather hefty document, like any good Center for Watershed Protection document. It's got that weight and stackage factor to it. Right, Dave?

David Hirschman: It wouldn't be a Center document without a lot of stackage, Nikos.

Nikos Singelis: Yes, exactly. Okay, well, and so we tried to develop kind of a soup-to-nuts guide, particularly for the Phase II communities, the smaller communities that are out there sort of struggling with this whole post-construction minimum measure. And so we started, the first chapter there is kind of an introduction and background, but we really get into it with the program development. How do you put the program together and what are all the elements that you need there.

Then, of course, land use planning, which is a local government function, is a key to all the things that are going on in stormwater, and so we devote the next chapter, really, to talking about that linkage between stormwater management, future growth, land development kinds of decisions and those sorts of things. So we try to bring those things together in that chapter.

And then we go and talk about the stormwater approach and the criteria that will be used, developing an ordinance, which of course is one of the key requirements in the Phase II program, and then putting together a local manual, whether you decide to write your own manual or whether you beg, borrow and steal from other places and cobble together your own. We have a number of suggestions and approaches for you there.

And then we also get into the plan review process, the inspection of BMPs while they're being installed, which is a very key thing, particularly for low-impact development kinds of BMPs, wouldn't you say, Dave? But getting that installation is really critical to making sure that they'll work.

David Hirschman: I would say that is true for all BMPs, especially the low-impact development ones, but all of them, they've got to start out their life on good footing, so that is --

Nikos Singelis: Yes, absolutely. Yes, so getting that actually, all the elevations and the flow path and everything else really put in place can make a big difference as to whether these things are successes or failures.

And then the all-important maintenance thing there, Chapter 9. We talked in several previous webcasts about the importance of BMP maintenance, and so we'll be touching on that again just to remind folks of what a critical element that is.

And then the whole tracking and monitoring and continuing to reevaluate the program and refine it as we go on. As you know, the basic principle behind the Phase II program is an iterative approach for municipalities. And so from permit cycle to permit cycle, we are looking for improvement in the programs as they move forward. So having a sense of tracking and evaluating that program is very important. And we've covered, by the way, that topic in great detail in a previous webcast, as well, with the California Stormwater Quality Association a couple of months ago.

So in addition to the manual itself, another really important part of this whole manual development process was also putting together a number of tools. And we have seven tools completed. There's still one straggling out there that's almost done but not quite ready for prime time there. And the tools are also available at the same website that I mentioned before. And these tools complement the various chapters in the manual that I just went through, and we've picked out a couple today that we're going to focus on. We're not going to go through all of them, but we have picked a couple that we will focus on today.

So let's get into what we're going to cover today. First, Dave is going to start us off with a BMP quiz, a little tongue-in-cheek kind of exercise, I think, here, but just to warm us all up for that. And then we're going to talk in some detail about trying to get better BMPs on the landscape. We've kind of, I think -- I think this varies a little bit from place to place in the country, but we're in a trend where we sometimes see the same BMPs being repeated over and over again. And so we're going to talk about ways to get better BMPs and to really figure out which ones are going to get us where we want with our water quality goals. And Steve is going to talk -- from Stafford County is going to talk about specifically what they've done to do that.

And then, as I mentioned, we're going to talk about some of the tools. So the first one we're going to talk about is the self-assessment tool. We've put this tool together to help you assess your own program and to identify the gaps that you'll need to fill over the next couple of years. And we're also going to be talking about the ordinance, and one of the tools here is a model ordinance. And we'll also be exploring what Stafford County has done in the way of their ordinance.

And then finally the stormwater manual and the manual builder tool that goes with that is another thing we'll be looking at. And then, finally, as I mentioned, we're going to again hammer that point home about maintenance, and Steve's going to talk to us about their maintenance program, particularly for LID practices.

So before we move in further with that -- oh, there's the -- we have a poll question for you, and I'm sure that most of you have attended these before and know how to do this, but for those who need a little reminder, just select the radio button on the left. This will help us get a better idea of who is attending today. So if you're a Phase II community, a Phase I community, a state/federal government employee, consultant or some other category, select the radio button to the left there and then use the black Submit Answer button at the bottom of the screen to submit your answer.

And while we're waiting for you to do that -- by the way, if you're in a big group, just select the answer that best fits the people that are there -- the help number again was 1-800-833-2812, so if you are -- experience any kind of technical difficulties, we have people standing by to help you with that.

And so let's see how we're doing with the poll question here. By the way, I should mention that EPA is sponsoring two workshops in the next couple months. The first one is going to be in Arkansas on September 17 and 18, and the second one will be in Albuquerque, New Mexico on November 6, and you are welcome to sign up for either of those. There's information on our training website at the NPDES website. And let's see, it looks like we've got some very good responses here, so we'll push those out to you so you can see.

As usual, most people with a Phase II community, almost 40 percent, about 11 percent with Phase I community, 17 with state government, 5 percent with the federal government, a number of consultants, as usual. Lots of smaller communities rely on consultants, so we have quite a few there.

And then we have another poll question for you, as well. And this really helps us get a better idea of how many people are attending, because we know there are a number of people out there in groups. So, again, just select the radio button to the left. And if you have a big group, it would really help us to get a sense of how many people are attending if you could answer this poll question.

And, Dave, you guys have -- the Center for Watershed Protection is doing a Stormwater Institute in Savannah, Georgia. Is that correct?

David Hirschman: That is correct, Nikos. And unfortunately, I think, for people who want to get in on that, I believe the registration is full at this point.

Nikos Singelis: Oh, is it?

David Hirschman: But there is a waiting list, but, yes, but we have people coming from Hawaii and Oregon and quite a few from Georgia, South Carolina and North Carolina, so it promises to be a very exciting event, if you're a stormwater geek, at least.

Nikos Singelis: Well, if folks don't know, the Center for Watershed Protection does these institutes, which are kind of intensive training events, from time to time, so even if this one is full already, there'll be other ones in the future.

So let's see how people are doing with this poll question here. Looks like we've got lots of results here. And, again, many people, 72 percent, sitting in their cubes. I just got my own private office, so I'm really thrilled to have an actual office instead of sitting in a cube. But we do have a number of people in groups, about 22 percent there, as you can see in smaller groups. And if you missed this poll question and you're in a big group and want to send us a message and tell us how many people are with you, that would help.

Okay, so now we're going to get into the meat of this, and the first thing is Dave's quiz here on a couple BMP factors. So, Dave, you want to take us through this?

David Hirschman: Yes. Thanks, Nikos. With tongue in cheek, we'll go into this quiz, and for those of you out there sitting in your cubes, you can think about what the right answer is to these questions. There's basically three questions. And it's a visual tour of various BMPs that may be employed at the site level.

And the first question is for you, Nikos, for you to answer.

Nikos Singelis: Oh, by the way, the folks in the audience, you can answer these as we go along, but we're not going to ask you to fill out a poll question or anything like that.

David Hirschman: Right. Just see if you get it right. Check yourself. So, Nikos, which BMP that we're going to present here does the best job of reducing the overall volume of runoff? And, as you know, Nikos, as you've gone to some of these national meetings, this idea of BMPs reducing -- not just treating water quality but reducing runoff volume is really gaining some traction and becoming an important stormwater question. So the candidates are (a) bioretention, (b) the green roof, (c) riparian restoration, and the assumption with the riparian restoration is it will receive runoff from an up-gradient developed site. It's almost like a filter strip type of restoration project. And of course (d), the wet pond.

Nikos Singelis: Okay, so he's putting me on the spot here. And I would have to say, Dave, that I think it would probably be (a) or (c) might be the two highest ones, either the bioretention or the riparian zone. And it might vary a little bit depending on how those would be designed. So that would be my answer.

David Hirschman: Well, that's a pretty good answer, Nikos, and I think maybe you attended this session at StormCon, so a little bit of unfair advantage. But you were right, that (a) and (c), and this is -- these are numbers based on research that's been conducted across the country on specifically this question of what flows in and what flows out of a particular BMP and their ability to reduce the overall volume of runoff. And you can see each of the answers there has a range, because there is design factors, of course, which influence runoff reduction capabilities.

For instance, with bioretention there are some designs which infiltrate the water through the subsoil, so they'll obviously do a better job of runoff reduction than a bioretention area with an underdrain, which acts more like a filter. But you can see the take-home point there is that we have these practices with a media and with filtering and with plants, almost that sponge effect that helps with taking up some of the stormwater and reducing the volume.

Nikos Singelis: Absolutely, and as Dave said, and if you've heard any of our previous webcasts, you know how important volume reduction is. So what's your next question, Dave?

David Hirschman: Well, the next question I think we're going to ask Steve Hubble here from Stafford County.

Nikos Singelis: Now, Steve doesn't know the answer.

David Hirschman: He has no unfair advantage. But the thing about Steve is he is in charge of a local program, so this is an important question, Steve, obviously, about maintenance. Which of the following BMPs would you rather maintain? And a maintenance obligation is how difficult, how burdensome the maintenance is, and perhaps even the cost. So (a) would be pervious parking, (b) is some type of undisclosed underground system, (c) is preserving sensitive site features, like this wetland here, as a BMP, and of course (d) is the 1963 VW bus.

Steven Hubble: Well, Dave, I have been on the side of the road in a broken-down VW bus before, so I think I'm not going to choose that one, nor will I choose the underground system. As we all know, those have a lot of safety concerns associated with inspecting and maintaining them. So I think I'll choose (c) and preserve sensitive site features.

David Hirschman: Okay. That sounds pretty good. But I thought I saw you drive up in that bus today, Steve, so you must have got it running.

Steven Hubble: No, I don't think -- didn't think it would make the trip today.

David Hirschman: Okay. Well, let's see here. Instead of having numerical results here we have low, medium and high, and I think, Steve, you hit the nail on the head here, that if we use a site design approach and not so much a built structural BMP, we can actually pick a BMP that's fairly low maintenance. So you hit that one good.

And, okay, let's go to the next one. I guess we'll get John Kosco to weigh in on this one. So, John, I know you also worked for a local government in your career, so which BMP of these candidates must be considered early in the design process -- in other words, not as an afterthought in the final planning stage of site planning? So our candidates here are (a) a dry pond, (b) small-scale distributed practices -- it shows here a downspout disconnection and small infiltration practices, (c) the wetland swale, or (d) preserving -- again, another site design approach -- preserving the riparian corridor.

John Kosco: I think, Dave, ideally, you'd look at any of the BMPs early in the planning process, but I think I'll go with the small site scale practices. Those are probably the most important.

David Hirschman: Yes, I think John also had an unfair advantage. But obviously that's not a difficult question to answer. I think if you are going to distribute practices around a site, those are categorically not going to be an afterthought. They have to be built in and incorporated into the site design from a very early stage, as well as protecting site features. And that approach as stormwater BMPs has a lot of promise, and there's also a lot of reasons why it doesn't happen in a lot of places around the country, and we'll talk more about that.

So I appreciate you all participating, and I don't know how many of you sitting in your computers, on your computer, with your computers have got the right answer, but maybe we'll find out in the evaluations. But there are some take-home points. It's not all fun and games. And the take-home points that we want to convey with these series of pictures and questions that we'll talk about in the rest of the webcast is that in a lot of cases we artificially limit the BMP that we might choose to use at a site. We are very familiar with the structural practices such as the ponds

and basins, but the site design approaches or the source control approaches are perhaps less used, and there are some reasons for that. But they introduce a very promising palette of practices to reduce runoff, to treat stormwater and to really have a better overall effect.

However, there's a caveat. Obviously, as we talked about, if those practices are going to be used, then the local government and the site designer and the developer have to be engaged in the process of exploring those practices early in the site planning process. And this is what happens. The BMPs that end up on the site plan or the subdivision plan are the ones that will be built and that will have to be maintained in perpetuity. And so that initial decision of BMP selection is going to have a profound effect on the cost and the long-term maintenance burden.

So if a local program does desire to fold in a broader menu of practices, including the conventional and including the innovative practices, then they have to be very deliberate about doing this. It's just not going to appear because people think it's a good idea. And so we are promoting here a systematic approach, and we want to show you in the next few slides how the Post-Construction Manual can give you some guidance on putting together this systematic approach through your ordinance, design criteria, inspection program and so on.

So, as Nikos indicated -- do you have a comment, Nikos?

Nikos Singelis: Well, I was just going to say, Dave, why don't we explore this in a little bit more detail? Because it just does seem to me that, as I mentioned before, that we have a lot of the same BMPs popping up all over the place. And there does seem to be some hesitancy into using some of these newer ideas. So I think there is kind of an incentive angle to it, and there's an unfamiliarity angle to it. And Steve is certainly going to chime in on some of this, too, but let's talk about that some more.

David Hirschman: Well, frankly, Nikos, I think as we go around the country and we talk to both site designers and local government people, in a lot of places there's a strong desire to fold in some different types of practices, but there are some pretty big mountains to climb in terms of zoning code requirements that require a curb and gutter or require a certain setback, or basically make it difficult for the site designer or developer.

And really a lot of the incentives or disincentives for the different practices are at play in the plan review process, because nobody submitting a plan wants to enter a black box where they don't know if the local government's going to accept it, not accept it, if it's going to take an extra two months of review. And so a lot of the issues in why more practices don't get used are systematic and institutionalized within the local review process and design manuals and so forth. And we'll certainly explore that in more detail.

Nikos Singelis: Now, we're -- we've got some pictures up here of some of the more common things, like wet ponds and dry ponds. And I just wanted to remind folks that we did a webcast about a year ago or so on BMP performance, and we examined some of these performance aspects of these different types of BMPs, so we're not going to cover that again today. But if you did attend that webcast, you'll remember that some of these things might do fairly well for certain pollutants, but oftentimes, as Dave mentioned before, they don't do a great job in

reducing the volumes of stormwater, which we're finding is so important, particularly to our small stream systems.

David Hirschman: Yes. And basically I think one of the things here, Nikos, is that the reason that we get a lot -- that we have a lot of ponds and basins is because the local stormwater ordinance or criteria or design standards basically ask for that type of design to meet the storage requirements, and we'll get into that here with our discussion of stormwater criteria.

So, Nikos, we talk about having a systematic approach, that the local program really needs to be deliberate if they want to fold in either the LID or the site design type of approaches that are very legitimate ways to handle stormwater. And what we've shown here is that you have to have this type of intention to incorporate a wider range of measures and fuse the whole program, from what's in the ordinance on through what's the specs and details in the design manual.

We're looking forward to hearing about Stafford's recent attempts to update their design manual to incorporate LID as we talked about plan review and all through the program there the local government has. So one of the things that the guide does is to -- in different chapters we give some tips and we give some guidance about how you might retool your program or modify things so that you can get a broader suite of BMPs.

So now, Nikos, I think we're going to open up our first major topic area here, which is stormwater criteria. And this post-construction guide goes into quite a bit of detail on stormwater criteria, and it's in Chapter 4, if you downloaded it or will download it. It's a very detailed discussion with some tables with some suggested language and examples from around the country of all these different criteria. The Guide has these seven different criteria, but for the sake of our time today we are going to really concentrate on Number 2 through 5, which are really the common criteria which dictate stormwater design and sizing.

So people are, I believe, Nikos and John, they are familiar with these criteria, and they've seen them in local ordinances and they see them in design manuals, and the site designers out there have designed stormwater systems based on these. But I think it's important to convey that these criteria do have a relationship to the receiving stream, and this is just a little graphic conceptual that shows that the criteria are going to have an impact on the stream channel, how we put them into the local code.

On the far left there, we see the Re_v , which is the recharge, or this is the runoff reduction or the groundwater recharge criteria, so to the extent we can get that water into the ground, it doesn't even reach the receiving stream, at least during the duration of the storm event.

As we get down into the stream channel, we see the WQ_v , which is our water quality volume, and that's the volume associated with our smaller storm events, our more frequent storm events. And so this is going to affect how clean the stream is during those more frequent storm events.

As we move up we see the CP_v , which is the channel protection volume. And of course that's associated with our bankfull storm event. And this is increasingly an incredibly important stormwater criteria, because this relates to how the runoff from the development site either contributes to a stable channel or contributes to destabilizing the downstream system with the

bank and bed erosion and the consequences for our habitat and biological conditions. So channel protections is very important.

And of course moving on up we see that 10-year or that conventional detention criteria, which is our overbank or nuisance flooding type of criteria.

So each of those criteria relates to the stream channel, but also each of the criteria relates to a certain volume of water that's coming off of the site that has to be managed. And the biggest volume of water -- so we're going to refer to this as the nested approach to stormwater criteria as we talk about the different ones -- each of the criteria relates to a certain volume of water that the site designer has to figure out how to manage that's coming off that site. So flood control is a big -- it's a large amount of water, so that rules a lot of stormwater designs. The typical flood control criteria, the 10-year, 25-year storm, bringing the post-development back to the pre-development peak rate.

Nested within that flood control there, some local ordinances have a channel protection criteria, and this again is to try to release water so we are not causing trouble and degradation to the downstream receiving channel. And so, but that generally is a smaller amount of water than the flood control that has to be nested in there but still managed.

And going on up to the smaller type of storm events, we have the water quality volume, and that, again, some people might refer to it as a first flush, but we like to think of it as treating most of the average annual rainfall that might come off of that site, but that's typically going to be a smaller amount of water.

And then topping out this nest, this layered nest, is this topic of runoff reduction which we talk about, or groundwater recharge, and that also may have to be managed.

So the site designer is really confronted with a pretty big challenge to try to address this whole spectrum of volumes, peak rates and runoff reduction from a site, and for different sites it can be a very challenging task. And a particularly challenging situation may be if we have a redevelopment condition. And I think what we are recommending in the guide is that redevelopment is a chance to get some incremental improvements, and so it's an important factor, especially in some localities. It may be the main form of development, so it may also be the main form to get some incremental improvements in water quality and the conditioning of receiving streams. But it also is a situation which requires a bit more flexibility on the part of the local program, so there may have to be different options for complying with a redevelopment condition, including, perhaps, even some offsite mitigation or contribution to a watershed type of project.

Nikos Singelis: And, Dave, talking about the differences between the kind of criteria that you would apply in new development versus redevelopment, it seems to me that a lot of that would have to do with kind of that thing that we skimmed over a little bit about land use planning, that we want to encourage people to redevelop existing land.

David Hirschman: Yes, that's a very lively discussion that's happening at state level and local level all over the country, because there is a sense that if we discourage or throw up undue

obstacles to redevelopment by very stringent stormwater criteria that that development, which may be trying to infill or redevelop some sites within a town center area or a designated growth zone, would be pushed out to the fringes and to the suburbs or into rural areas. And so we want to really try to have our stormwater programs send a consistent signal with our land use programs, if we're really trying to do -- to target growth to certain areas.

Nikos Singelis: Yes, absolutely, and most of the MS4s, of course, have control over the area, their jurisdiction, but they're not going to have any control outside their boundaries, which is where a lot of development, at least in the current practices, seems to be happening, sort of that more sprawly kinds of development. So I think there's kind of a -- Steve, wouldn't you say there's kind of a balancing act that needs to be done there?

Steven Hubble: Absolutely. I know a lot of our friends in northern Virginia are concerned about some of the redevelopment requirements, because that's obviously something they are very interested in and they don't want too stringent of a requirement to discourage that ability to redevelop.

David Hirschman: And, Nikos, that can be a particularly challenging situation, say, if the redevelopment project is within a watershed that has a TMDL, because then you have to overlay the -- the signal we want to send is yes, we like the redevelopment, but, yes, we also have to meet this TMDL. So there's a lot of complicated questions on the table.

Nikos Singelis: Oh, yes. Well, it's not going to be easy. That's for sure.

David Hirschman: So let's just talk about how a local program -- we talked about the criteria, the flood control, channel protection, water quality and recharge -- how a local program may try to line up a particular rainfall event with each of those criteria. And this slide shows what's called a rainfall frequency distribution. And basically what we have on the Y axis is a rainfall depth for a given storm event and along the X axis is the percent of rainfall events on an average annual basis which are at or below that rainfall depth.

So on the left side of the curve we have our very frequent, very small rainfall events. For instance, if we look at the 50 percent level what we're seeing with this particular curve is that 50 percent of all rainfall events on an average annual basis are about a quarter inch or less. And as we move on to the right side of the chart, we see our rainfall events which are much less frequent but have a higher level of rainfall. So in this particular community, almost all of the rainfall events that occur on an average annual basis are three to four inches or less, with the exception of one or two bigger events which define the extreme end.

And one of the interesting things is that this curve will obviously change depending on what part of the country you're in, but the general shape of it is there's a lot of similarity, and what you see there is there is an inflexion point upwards right around the 90 percent mark. So this inflexion point also represents an optimization point. Because if we can treat 90 percent of all storm events with water quality treatment, then we are going to be doing a pretty good job of water quality treatment at the site.

And obviously the channel protection is going to be a bigger storm. A lot of places use the one-year 24-hour storm, which in this particular locality is 2.4 inches. And this topic of runoff reduction is obviously we love to see it, we want to see it wherever we can, but we have soils, we have contaminated soils, we have soils that aren't conducive to infiltration, we have shallow water table, bedrock and all kinds of conditions. So the idea with runoff reduction is to try to maximize it and to get the most out of it that we can at a given site.

Nikos Singelis: So it would seem, then, that if you were maximizing your runoff reduction, right, then you can subtract that amount that you are able to reduce from some of these other areas.

David Hirschman: Yes, exactly, Nikos, and we'll be running through a quick example showing that.

John Kosco: Dave, I'd just add there's instructions in the post-construction guide on how to create your own rainfall frequency spectrum in your local area.

David Hirschman: Yes, that's right, John. That's in Figure 4.2, for those of you who have it.

Now, going back to this pond thing, one of the reasons, frankly, is that ponds meet all these criteria, Nikos. I mean, they have the volume, you can design them with adequate volume to address your flood control and to stack on top your water quality and channel protection, perhaps. So the designers that put -- that are designing these ponds are responding to that signal, that we have to meet these criteria.

And, frankly, there's -- they have done a good job. There's nothing inherently wrong with ponds for the purposes for which they were originally designed, particularly that flood control and drainage control. But the evidence is that they're not getting the whole job done. And the evidence is also downstream from sites that have ponds and you can see the condition of channels and the erosion and the destabilization and the impact on the biological resources downstream. And so that's why we really like to have -- why we're promoting this broader suite of practices, some of which are shown here.

However, here is this message again. If you want these practices in your community, you have to be deliberate, and you have to have some type of system which authorizes or gives credit or incentives for site designers or developers to use these practices. And I think that message is a really good link to talking about Stafford County, and the reason we have Steve here. Because, Steve, I know you're going to tell us a little bit about Stafford and a brief background, but you guys have really done some interesting things in terms of your stormwater criteria, and particularly with LID. So you do you want to tell us a little bit about that?

Steven Hubble: Sure. Thanks, Dave.

For those of you not familiar with our area I'll run through some brief information about Stafford. But we're located in northern Virginia, and we're a suburb of Washington, D.C., approximately 40 to 50 miles south. And because of our proximity to Washington, we have experienced tremendous growth in the last 20 years. In fact, our population has doubled since

about 1990. We are a small- to medium-size county of about 270 square miles. About one-fifth of that is eaten up in federal land with a Marine Corps base.

We are also subject to the NPDES Phase II requirements, as many of the other folks listening to the webcast today are. However, we're a little different in that we've implemented a post-construction stormwater management program in our community since the early '90s. And the reason for that is because in Virginia there are certain localities subject to what's known as the Chesapeake Bay Act, and that is a special set of regulations that applies to certain local governments and to put some controls on land use and has water quality requirements. We also in our county feel some significance in the fact that we drain to the Chesapeake Bay, and obviously that's an estuary of national importance, and I think there's some desire to do what we can to help protect that.

We have requirements for water quantity in the county, those of which are very similar to what Dave discussed a minute ago. But we have requirements for stream channel erosion, and we require a 24-hour extended detention of the one-year storm. And if you were paying attention to your slides a few minutes ago, that was what Dave mentioned as what seems to be a standard for that. And also we have requirements for flooding, ours are the 10-year storm, and we require the post-development to not exceed the pre-development rate.

Additionally, we have requirements for water quality. We use a technology-based approach for water quality. And basically what that is, is you look at the total imperviousness of your site and then you determine BMPs that are appropriate to treat that level of impervious. So, for example, if you have a low -- a site with low impervious, you might be looking at using level spreaders or bioretention or water quality swales, and whereas if you have a site that's 70 or 80 percent impervious, you're probably going to be looking at a pond or an underground device there. Additionally, as Dave mentioned, we also have requirements for our redevelopment projects.

Additionally, Stafford County is heavily involved with implementing low-impact development requirements. We became interested in low-impact development earlier in this decade as we saw what was coming out of Prince George's County, Maryland, and some of the work that we were doing up there, and we decided to start encouraging and in some cases mandating the use of low-impact development for new development sites.

And basically the way that our process works is we use a stormwater concept plan, which is the first step in stormwater planning, in our plan review process. And essentially our requirement is that a development site submitting its stormwater concept plan shall utilize LID techniques to the maximum extent practicable. Additionally, we require that runoff from parking lots be treated by filtering or infiltration device. And this helps people co-locate BMPs and get -- meet both of those requirements.

If you design an LID plan in accordance with the Prince George's County EPA criteria, you meet our requirements for water quantity and quality. These requirements, since they've been effected -- enacted, excuse me -- we've seen a lot of increase in the use of LID technologies. Mainly bioretention is the one that most folks seem to use, but we have seen some of the other more innovative techniques be used on a small basis. And it's important to note that LID in our community is not mandatory. However, you must evaluate its use before you opt for a

conventional design or what's known as a hybrid design, which is basically a combination of LID and conventional stormwater.

Nikos Singelis: So, Steve, how is this -- what's your impression on how this is working out for the developers? Are they going along with it? Are they finding it reasonable to implement, that sort of thing?

Steven Hubble: It depends. There were a lot of challenges at first in implementing the program, but it seems to have gotten easier over the past couple of years. The big concern from the development community is increased cost, and the increased cost just comes strictly, from my experience, in the sheer number of LID facilities that are being constructed on a site. Your development site before may have had four to five ponds and now it has 50 to 75 individual isolated BMPs. So there's an increased cost in installation and construction there.

We have seen some developers get some offsets and save some money by recouping land that originally would have been dedicated to stormwater ponds. They were able to find additional building lots or additional building space in commercial areas. So there have been some who have been able to see some offsets and allow the financial part to balance a little more for them.

Nikos Singelis: Well, one thing I like about the system that you described is that it has some flexibility for adjusting for the different kinds of sites, what's there, what's planned and that sort of stuff. So it seems to have some goals that you need to try to meet, but it also has the flexibility built into it, and that seems pretty useful.

Steven Hubble: I'm not sure all of our developers would find it as reasonable as you do, but, of course, we try to -- we really do try to be reasonable. We like LID and we want to encourage its use, but we also don't want to slam it in to someplace where it's not really going to work.

Nikos Singelis: So, Dave, let's talk about credits a little bit.

David Hirschman: Yes, I think that that example from Stafford, where they put it in their ordinance is a sort of an interesting case, because you put it in the ordinance before you really knew how the implementation was going to work, so you really were going out there ahead of the curve, it seemed like.

Steven Hubble: That's right, Dave, and I think most of our fellow local governments in Virginia are still watching us as an example and seeing if we succeed or fail in this.

David Hirschman: Yes, you guys are certainly in the fishbowl, from what I've seen.

Okay, Nikos, let's talk about this idea. And I've put this in parentheses, this idea of credits, because that can be a confusing term. But we want to go to this point, and if you want to see a good set of practices in your community, you've got to have a system to authorize the innovative practices. And this is just a list of some of the state manuals -- there are several local ones, too -- that have a pretty good system of offering credits or incentives for LID or innovative practices. And if you want to get into the nitty gritty details, we have one of the tools that you can download, which is called Tool 5, the manual builder, and it has a section in there where you can

download these manual sections that talk about different types of credits, such as the Minnesota Manual Chapter 11, which is a pretty good illustration of that.

The objective, obviously, is to get a better mix of conventional and innovative BMPs, as Steve referred to as the hybrid approach. But, Nikos, I know some people think of credits in a different way.

Nikos Singelis: Yes, I think one of the most common things that I find in talking to people is that they immediately think that this has something to do with money, and what we're talking here about is design credits, so this relates back to the criteria that we were just describing, the various criteria that they need to meet, and then giving incentives within that criteria or design system, right, for encouraging some of these newer, innovative, low-impact development kinds of features. And so we'll talk about that in more detail.

It is probably worth mentioning that it is possible to do this financially, as well. For instance, if your stormwater community has a stormwater -- if your community has a stormwater utility, it would be possible to reduce the fee that a homeowner or commercial operation is paying based on the number of innovative practices that they have. So it would be possible to do that, but that's not the focus of our discussion today. We're talking about the design process.

David Hirschman: Yes, that's a good clarification. And basically the issue of the design credits is -- I think a lot of site designers and a smattering of developers and some local government people like the idea of incorporating some of these practices, but particularly the site designers and the developers, when we go on the road and we do these workshops, what we hear is, "Yes, it makes sense. We like it. We understand that it might be a better approach. But if we're going to make the effort to design these types of sites, we want to get something in return. We want to get a reduction somewhere else in our obligations and requirements." And I think that's how you make credit work. So it has to come out somewhere else, because it is a significant effort to fold those into a site plan.

And so the way that you give that type of credit is you can reduce the volume of runoff, you can make part of your water quality volume go away, or that's a certain percentage that you don't have to treat in a structural BMP. You can do it through simple compliance systems. And there are some communities that even give credit for those larger storms, such as the channel protection and the flood control storms, by having a system of adjusting curve numbers and even perhaps times of concentration within their TR-55 or their hydrologic method, so they even give the credit on up in the storm chain. And, obviously, if you do this the hopeful result is that fewer and smaller structural BMPs would be needed at the site.

So I want to -- I know we've been throwing around the term "LID," and here we are that the Center for Watershed Protection just has to introduce another term. I apologize, Nikos, but LID is, it's used in different applications with different meanings by different people, and it gets awfully confusing. So what we want to talk about is this term "runoff reduction," because it actually describes the function of the practices that we're talking about. And this is pretty self-explanatory, is runoff from the post-development site is reduced through a variety of mechanisms, such as infiltration, canopy interception, even bioretention with underdrains delays

the outflow from a storm event so that it's effectively reduced, evapotranspiration using vegetation.

So it becomes a very interesting barometer to calibrate the conventional practices such as ponds and things that we've had trouble in the past measuring, such as riparian restoration or open space protection. So runoff reduction becomes a very interesting construct when we throw it into the stormwater mix. And, not surprisingly, the different practices and use out there vary pretty sharply in their ability to reduce that post-development runoff volume with our conventional practices, our ponds, doing a fairly modest job of the overall runoff reduction. Obviously it varies from arid climates to humid climates. But the research has indicated that our bioretention and infiltration practices and some of the swales are very promising in their ability to reduce that runoff volume. So that's been something that's just been collected together.

And, again, that runoff reduction memo that's on the Center's website on the same page as the Post-Construction Manual has a lot of documentation of different practices and their ability to reduce runoff. And that memo is in the lower left there. That's the pathway, if you want to download and read all about in nitty gritty detail about the different ability of BMPs to reduce runoff. The chart here just gives just a summary, and I'm not going to go into detail there, but to reinforce the point that runoff reduction varies from BMP to BMP, and it's an interesting construct. And that technical memo has some appendices which go into detail.

And a lot of people on our staff, and Tom Schueler was very much involved. He worked with Kelly Collins and some of our other staff to tease out the runoff reduction message from these actual research studies, so it's a very interesting piece of work. So the runoff reduction practices that this is not an exhaustive list, but these are the ones that we evaluated within that technical memo, and so you can go to that to see the different results.

So what I want to do now is make this a little more real for people by giving an actual site example of a site that either does or doesn't use these runoff reduction practices. And so this is a residential site, very typical. It's 37 acres with 100 home sites with hydrologic soil group A and B. The impervious cover on this site is 30 percent, so it's a pretty typical residential site. And what we've done, our staff, particularly Kelly Collins and Greg Hoffman were instrumental in putting this site design example together, what we did is we did some modeling of two different cases. And the first case was using this site with just the conventional end of pipe. We did make it a constructed wetland, so -- but all the runoff just is treated by one BMP at the bottom of the site, the constructed wetland.

Whereas you can see that with case two, we tried to fold in a reasonable level -- we didn't go whole hog with this, Nikos, in terms of we're not going for lead gold here, but something that maybe is a little bit more achievable for a broader range of sites with runoff reduction distributed practices. About three-quarters of our rooftops have simple disconnection, which just means that the downspout goes off to a pervious area, not directly into the curb or into the storm sewer. And the other quarter of rooftops are going to a rain garden. And all of the rooftops and driveways are going to overflow into a system of grass channels to convey the water down to the constructed wetland. So it's a pretty modest approach.

And the technique that we used to model the two different cases, one with just the end of pipe and the other with the runoff reduction practices folded in, is this curve number adjustment, which is, there's a lot of different ways to do it, but we used a method that we are currently using, developing for a state-level program.

And you can see in this chart with case one, our curve numbers were 71.2, that was obviously the curve number for the site. And with the runoff reduction practices, what you see is we get a fairly modest adjustment to the curve number, because we're trying to get the curve number to match the reduced runoff from the site. And that's the techniques we used. And what you see there for channel protection, where it says CP_v , we have a curve number adjustment. But for flood control, which is a bigger storm, that's the 10-year storm, we have less of an adjustment. And we'll talk about that when we get into the hydrographs here.

Now, this is somewhat of a conservative crediting method, because we didn't want -- again, we wanted to show sort of a reasonable example. You could make an argument for also adjusting times of concentration, but engineers will argue about that for a long time, so we'll see how that plays out in the real world.

But here are the two hydrographs for the water quality volume. So, again, this is our frequent, relatively small storm. The top line there is the water quality volume without the runoff reduction practices, and the bottom one is the benefit we get. And, as you can see, with using just those modest runoff reduction practices just for water quality purposes, the amount we have to treat we have almost a 50 percent reduction in both the overall volume as well as the peak rate of flow from that water quality storm event.

Nikos Singelis: That's pretty substantial, Dave, for a pretty simple system there.

David Hirschman: Yes, and again, Nikos, that's because this is the small storm.

Nikos Singelis: Right.

David Hirschman: I mean this is the one-inch or the two-inch storm. So if you do have runoff reduction practices, these can really substantially reduce the outflow from that type of storm event.

The situation changes a little bit when we get to that channel protection storm, which in this case is the one-year, 24-hour storm. We do get a reduction based on the modeling that we did of including the runoff reduction practices, but, as you can see, just about 20 percent on the volume and about 25 percent on the peak. So we're getting some benefit, just not as much, because this obviously is a bigger storm event.

And going into the flood control situation, we see that the benefit of the runoff reduction practices in terms of the peak and volume are quite a bit less. And that's simply because our curve number was adjusted less for that flood control storm, because it's a bigger storm event, and so the response of runoff because of the runoff reduction practices is less.

But, so you might say, well, okay, I've tried these runoff reduction practices, but I've still got this flood control storm I've got to deal with. We didn't really have a substantial change in that. But let's see what happens with our actual site design based on these results.

Because of the benefit we got to the water quality and channel protection storm, we were able to reduce the size and the footprint of our end-of-pipe solution quite a bit. We went from the case one, which is just the end of pipe, a 1.14-acre pond, and we reduced that to .59-acre pond, and, of course, using much less of the contributing drainage area, and that kind of goes back to something that Steve talked about, was that if you use these practices perhaps you get more -- the incentive for the developer is you get more developable land, notwithstanding setbacks and other restrictions. But that's what this case study also shows.

Steven Hubble: That's right, Dave, and we have seen that occur, like I said earlier, in a few circumstances.

Nikos Singelis: Dave, I've got a question for you. Did you, in this case, did you look at the total volume for over a year, say, and calculate what the volume reduction would be over a year of multiple storms?

David Hirschman: No, we didn't do that, Nikos. That pretty much is documented also in that runoff reduction memo that's on our website. But these are storm event-based modeling.

Nikos Singelis: Right. But it'd be interesting, too, to look at it over time, too, to see what kind of numbers you might get. Because I think you'd get quite a lot, because most of the storms are small.

David Hirschman: Exactly. Most of the storms are going to be in that water quality volume storm or smaller. So you're going to get a significant impact over the course of average annual rainfall.

So these types of systems, I think we demonstrated that they can be used. You can have a quantitative way to fold in runoff reduction into your local compliance system. However, these things just don't magically appear. The local program really needs to have some what you might call infrastructure in place, and I'm not talking about pipes and curbs, but infrastructure in the terms of plan review and design guidelines and public outreach, because it does take -- it does take quite a bit of communication, working together with the design consultants and the developers to get this stuff incorporated.

So let's look a little bit about in general what's needed for a local program to try to use some of these types of credits, credit system. And I think what we talk about is early consideration in the design process. We just keep hitting on that. A lot of these practices just aren't going to get on the ground if they're not considered early.

And the other thing that's there at the bottom bullet there talks about policies, procedures and guidance. And there are so many communities across the country, including Stafford, which are - they say, well, if we want people to use LID, we've got to have the design specs. They want to know how big does it have to be, what materials do we have to use, how is it going to -- the

installation checklist. So all that type of stuff really helps that type of system get going at the local level.

Nikos Singelis: We're up to our first poll question. Thank you, Dave. And I want to remind people to submit questions, because we are going to have a question break in a few minutes, and we'll have another one later on in the webcast. But before we get there, we do have a poll question now based on the things that we've just been talking about. So this question says, does your program, local or state, authorize, allow or require LID or runoff reduction, as Dave introduced yet another new term of art to the now-large, growing collection of terms here, practices through some type of credit system? So, again, your options there with the radio buttons to the left, LID is required, LID is allowed through some kind of a credit system, it's more of a case-by-case kind of thing, we're silent on this, we haven't gotten there yet, and the last one, LID scares us.

So, now, you can only choose one. So there's not a whole lot of -- if you want to say LID scares us, you can't answer one of the other ones as well. So it's just a one at a time here. And so while we're giving you a second to look at that --

David Hirschman: Nikos, I think the term is sort of tongue in cheek -- LID scares us.

Nikos Singelis: Oh, absolutely.

David Hirschman: But there are quite a few local programs that are a little gun shy of it, because of all the things we talked about, the maintenance and verification and design procedures. So I think that's kind of what we mean there is we're just not really ready to take that on.

Nikos Singelis: Yes. There's a certain amount of humor to all this. By the way, I wanted to mention that we have about 1,800 people attending today's webcast, so we have a good crowd for basically the second workday after the Labor Day weekend. So let's see what the answers to this are here. So, not surprisingly, we've got about, Dave, about 6 percent here say LID is required, and then we've got -- oh, that's encouraging, 11 percent there, LID is allowed through a credit system, so that's great. We have 33 percent who say case-by-case thing, which is -- that's also encouraging, as well. Now we do have the largest share here are silent on this. So we've got about 45 percent there that at least our advice would be here's something that you can consider and work on, something for the future. And an honest 5 percent down there who find LID scary. So we hope maybe that will reduce as time goes on, as well.

Let's see. So we have a question break now, Sonia. Do we have any questions?

Sonia Brubaker: Nikos, we have a lot of questions.

Nikos Singelis: Oh, that's good.

Sonia Brubaker: And the first question is for Steve. Joseph in Maine wants to know what percent of your overall projects use LID design.

Steven Hubble: At this point probably 80 to 90 percent of them use it at least in some form or another, at least for limited water quality treatment.

Sonia Brubaker: That's great. Thanks, Steve. Now, the next question is for Dave. Richard from Pennsylvania has asked, does the manual detail regional implementation of the program or provides help on how to coordinate it?

David Hirschman: Well, I think so, if I understand the question. Chapter 4 of the guide is the one that talks about criteria. And I think the important thing to understand about criteria is it's not a one size fits all. For instance, Richard's calling from Pennsylvania, and they have karst there, and it's a big issue with karst, and implementation of their new manual in Pennsylvania has some requirements for infiltration. There are other areas that are arid climates or where the existing system relies on basically ditches and channels that have already been modified, and other places are very humid.

And so I think one of the things, the take-home points, and we offer some tips within the guide on how to adapt the criteria to different -- I wouldn't say different parts of the country, but I'd say different hydrologic regimes, whether that's karst or the coastal or shallow groundwater, things of that nature. So these things just can't be taken out of a book and plugged into a local ordinance without a lot of good thought and adaptation.

John Kosco: Yes, this is John; one thing to add to that, it's not the focus of this webcast, but it's a focus of one of our past webcasts is looking at things on a regional scale. Land use planning is kind of the first BMP. Chapter 3 of this Guide talks about that, and actually one of the past webcasts went into much more depth on that topic.

Sonia Brubaker: All right. Thanks, Steve and John. Those are both really good points. Now we have our third question is for Nikos, and Henry from Ontario is wondering what approach should be used to get small practices on private property implemented and maintained? Is a mandatory approach better or a voluntary approach?

Nikos Singelis: Well, I think that that can happen in a variety of ways. Particularly in new development, a mandatory approach might be possible when you have a new housing development. Clearly, if you're redeveloping smaller parcels, perhaps a voluntary approach is going to be more appropriate. But one of the sorts of key things in sort of determining the approach that you do take is the whole maintenance issue, which I know Steve is going to talk about in a little bit. But particularly you've got to recognize and be prepared for the fact that these small practices on private land are going to require maintenance, and it's going to be -- it's not an easy thing, shall we say, to get these things maintained properly.

So the community would need to have a very good education and outreach program to continually reach out to homeowners to get them to maintain these things. As homeowners' boards change, people will forget what they're supposed to do. Individual homeowners may not be aware if they sell the house to a different person why this thing is even there, or may want to change the landscaping. So there's kind of a continual need for education out there to make sure that they know why these things are there and what they need to do with them.

And then the other key point of that is a good, very clear maintenance agreement that spells out exactly what needs to be done at what points in time, and then frequent inspections to make sure that you get that. So it's not a free lunch. Sometimes people might think, well, it's on private land. I don't have to worry about it. But whether you decide to maintain it yourself or whether you get somebody else to maintain it, there is going to be a burden there.

Dave, did you want to add something to that?

David Hirschman: Yes, I believe that in this regard that the answer depends on how far along the program is. And they're putting together their post-construction program. And a lot of times they may want to start out if it's new, it's a brave new world, may want to start out with more of an incentive type of approach. And we've found, both the local government I worked for and a lot that I've worked with over the years, a great way to get this out into the community is to use these practices at your own government facilities, either schools or parks or public works yards. It's the leading by example which I think really takes hold in some communities. And I think that's another option for local governments to consider.

Nikos Singelis: Very good point.

Sonia Brubaker: Great, Nikos and Dave. Those were great approaches. And now our next question is for John. Catherine is located in the Southwest and is wondering if BMPs should vary by geographic region or climate, and does the guide contain any BMPs for arid areas?

John Kosco: Yes, the guide isn't written specifically for arid areas. We do, however -- I mean, obviously your BMPs are going to vary based on your climate and the amount of rainfall you get. One thing I would suggest is she can also look at our menu of BMPs as a general resource for all different types of practices, both for arid and more wet climates.

Nikos Singelis: Yes, the manual really isn't kind of a list of different kinds of BMPs. It's more about how to get the program put together. But as John mentioned there are sources out there for looking specifically at arid climates. Another one would be the manual for eastern Washington has a pretty good range of dry climate kinds of BMPs. And, again, the focus is going to change. When you have larger, flashier storms, your focus and the whole way you set up your program is going to be different than you do in a wetter climate with smaller storms.

John Kosco: Yes, that manual Nikos mentioned is on the Department of Ecology, Washington State's website.

Sonia Brubaker: All right, thanks. And our next one is for Steve, and maybe Nikos would want to chime in. Daniel wants to know if there are any BMPs that can be used to reduce contamination to groundwater.

Steven Hubble: I may pass to Nikos and let him chime in on this one, if he doesn't mind, not to put him on the spot.

Nikos Singelis: Always putting me on the spot. Well, yes, there's been actually some research. Actually, the Center for Watershed Protection wrote a paper quite a while ago about the impacts

of stormwater on groundwater. And it really is kind of a pollutant-by-pollutant kind of thing as to whether the -- whether there's a potential for the pollutant to end up in groundwater. So you'd have to really examine it. These infiltrating practices are good at many kinds of pollutants, but there are some that will end up in the groundwater. For instance, nitrogen is one that moves through the soils relatively quickly. Chloride, also, from salt, from salting roads, will tend to move through the soils very quickly. Certain other things like metals, phosphorus, things like that, will get captured in the soils. So certain things will work better than others.

Dave, do --

David Hirschman: I just want to point out that in Chapter 4 of the guide there is -- one of the tables addresses stormwater criteria for groundwater protection if you have a source water protection area or a sensitive groundwater zone. And a lot of that has to do with, you know, some practices just might not be allowed in those areas, or allowed with a hefty amount of pretreatment to make sure -- I mean, that's the worst thing in the world, to do a good job of treating stormwater but contaminating your drinking water supply or groundwater.

Nikos Singelis: Yes, absolutely.

John Kosco: And, this is John, the only thing I would add is that for treating groundwater contamination the best practices are source control practices, so things like your spill control, employee training, making sure that those type of pollutant sources are not -- are under cover, are not even exposed to stormwater in the first place is really your first type of practice for addressing this.

Nikos Singelis: All right, John and Dave. We're going to move on. Thank you, Sonia, for getting us those questions, and, again, we encourage folks to ask more questions. We'll have a longer break at the end. But in the interest of time I'm going to turn it over to John now to talk about program planning.

John Kosco: Great. Thanks, Nikos.

So as we talk about program planning, this is Chapter 2 of the guide. And it's really discussing setting up the overall program, setting up your plan for what you'll do when. And what we're finding through our MS4 audits or talking to other cities is that many programs right now are just kind of in this getting by mode. They're implementing what they have. They're not really creating things new or assessing what they currently have. And they may be constrained because of budgets or other things. But there's really a need for them to look at this overall approach and what their current capabilities are and what their gaps are and define what is needed there.

And so what we've developed is a tool. It's the post-construction program self-assessment tool, where the stormwater program manager primarily goes through and fills out this checklist and helps identify these gaps and other program activities that are needed in this part of the program. So it helps them identify some short- and long-term actions and some measurable goals they can use. It's a pretty detailed checklist that basically follows with the guide itself, so each of the checklist components relate to an individual chapter. So if you find you're missing program components in a certain area, you can go right to that chapter and get more information.

If you're interested in a more general program assessment -- this is focused on post-construction - - EPA's MS4 Program Evaluation Guide is also very useful, and that covers all the different program topics beyond just post-construction.

But the checklist self-assessment is broken up into three different groups or categories of questions -- initiating the program, enhancing the program and advancing the program. And basically these Group A questions are basically the bare minimum that we would expect a post-construction program to have. So these are things that really you should have done already as part of your first five-year permit term.

The Group B questions, enhancing the programs, are the type of questions that are probably most programs in many cases would be implementing. So you'll want to look at those types of questions and really decide if it is appropriate for you. And, like we said, in most cases those are probably needed for most programs.

However, the Group C, advancing the program, are more of the cutting edge or more unique program components, and those are things that you may want to look at and decide if you have the funding, if it really applies in your area, or if you're interested in those type of activities. But this really goes through a checklist and helps you identify those potential activities.

So what we'll show you in the next slide is a screen shot of just one example set of questions here. And this is for Chapter 4, the Stormwater Management Approach and Criteria. And, as you can see, we have a couple of questions here on initiating the program and a couple of questions on enhancing the program, looking at things like your maps to identify sensitive areas, or whether you have a local rainfall analysis conducted. And as you go through you can check these things off. If you don't know whether you have that type of component check that box and go through and identify that later. This is really a tool to use yourself. So modify the questions if you need to. Add questions if you need to. And go through the tool in detail.

Under each of these chapters, we also have an action item list. So we have both short-term and long-term action items. So as you go through these, identify things either you don't know or that you don't have an answer to. You can identify that as an action item. We need to find out whether we have these maps, or we need to find out whether -- or we need to fill out an ordinance or revise an ordinance. So identify those as short- and long-term action items, and then use these to help you develop any measurable goals for your program.

The next thing we want to talk about after doing the program planning is a stormwater ordinance. And as we developed the guide, one thing we did was do a quick survey of a number of different municipalities to see where they currently are. And when we did this survey about half of the Phase II MS4s that responded said they had actually adopted some type of a post-construction ordinance. So over half had not had this ordinance developed as of that time.

But when you develop this ordinance you're really looking at developing the ordinance across other program areas, addressing things like your zoning or subdivision or even including erosion and sediment control elements and that, and looking at those conflicts between those other

ordinances. But adopting this ordinance is one of your key early steps, if you haven't done that already.

And in Chapter 5 of the manual we go through some of the key elements in a standard ordinance. So you can see them on your screen there, things like the regulatory structure. This is what's typically in your local ordinance, like your legal authority, your definitions, waivers, applicability, what size sites is your ordinance going to apply to, are you going to waive single-family homes, and other things like that.

Next element is the design elements. What type of criteria, as Dave talked about in detail earlier, are you going to require? Is there going to be regional or watershed specific requirements or approaches in the ordinance? And then obviously we're not going to talk in detail about this during the webcast, but what kind of plan review requirements you want to include, something in the ordinance to address who needs to submit a plan, what components or what requirements should be addressed in that plan?

Also, the maintenance elements that we'll talk about a little bit, whether it's a maintenance agreement, inspections or reporting requirements in terms of maintenance. And then what type of enforcement penalties are there? Are there civil violations? Is there stop work orders or other types of remedies and inspection requirements?

And then also with the ordinance there are a number of major decisions you need to make in terms of developing the ordinance. Obviously, whether you do a comprehensive stormwater ordinance that looks at not just your post-construction requirements but things like erosion and sediment control, illicit discharge requirements, the Phase II program requires an ordinance for those three major elements, but also whether you're going to look at redevelopment. Are you going to give some incentives or flexibility for projects that are in a redevelopment situation?

Are you going to look at watershed-based approaches, maybe a fee-in-lieu-of program where these practices can't be implemented onsite, maybe they pay into a fee in lieu that can be used on more of a watershed scale? How are you going to address the concept plan stage requirements? What type of things are you going to require early in the plan review process? And then how are you going to work with your other local codes, things like your zoning and subdivision codes? When you revise your ordinance, make sure there's no conflicts and that all these ordinances are working together. And one of the other tools that we're not going to mention in detail today is the code and ordinance worksheet tool that goes into depth on looking and assessing your local codes and ordinances.

Nikos Singelis: One thing I would add, putting my EPA hat on for a second, is that Phase II communities out there that haven't done an ordinance yet, we certainly hope that those numbers have improved from what John mentioned from two years ago, but now we're getting towards the end of the first permit cycle, so folks really had better have that in place. But even if you do, as well, we hope that you take a look at this model, because we've really never had a great model before. So even if you do have an ordinance in place, we hope that you'll take a look at it and take those ideas and try to put them into your existing ordinance or refine your existing ordinance to make that a better product, as well.

Steve, why don't you --

Steven Hubble: Great. Thanks, Nikos. We did a lot of work with our stormwater ordinance earlier in the decade. As I mentioned earlier, we adopted a stormwater management ordinance for the first time in 1994, and in the late '90s we started looking at options to improve and increase the effectiveness and performance of that. And actually the main reason that we got involved with using low-impact development technologies was through a better site design roundtable, which was basically a meeting of stakeholders in our area of Virginia. There were some other local governments. There were some local advocacy groups. And there were some other experts from state government.

And out of that basically came this idea for LID, which had kind of taken off in Prince George's County, Maryland, which is just up the road from us here. And subsequently in 2003 we revised our stormwater ordinance to include low-impact development practices as an option for complying with our water quality and quantity requirements. And, as I mentioned earlier, a year later we decided that we really wanted to focus on the use of low-impact development practices, so we changed our requirements to have new developments evaluate the use of LID to the maximum extent practicable.

Additionally, in order to remove hurdles and provide some incentives in our ordinances, we had to look at what was in our zoning and subdivision codes, because, as Dave mentioned earlier, there can be a lot of roadblocks to using these innovative practices in those other non-stormwater ordinances. So we had to make some changes to accommodate the use of these types of facilities.

The first change that we had to make was to allow low-impact development practices to be located on private residential lots. Previously we required that all stormwater management facilities be located on an out-lot or an open-space area within subdivisions. Additionally, we relaxed our curb and gutter requirements for projects that use low-impact development. This is a two-fold purpose. A, obviously curb and gutters don't always mesh well with low-impact development facilities. And also there can be some financial incentives here to developers if they're able to save costs from not having to build curb and gutters.

Also, we allow landscaping in our LID facilities to count towards overall site landscaping requirements. And we allow alternative pathways in lieu of sidewalks where necessary. Although I should note that even though we made all these changes and removed these hurdles, their use has been limited to this point, and mainly in the last couple of years that's been because of economic conditions due to a slowdown in residential construction in our part of the country.

John Kosco: Great. Thanks, Steve.

Now, we just want to talk about the tool for the model post-construction ordinance. It's Tool 3, and, again, as we mentioned earlier, all these tools can be downloaded individually. And the model ordinance tool is actually a Word document, so you can go in, you can edit it, you can change it and delete stuff. The people involved in this will be the stormwater program managers, your legal staff and probably a much broader group of people than some of the other tools like the program self-assessment.

But you want to go through and look at what language you want to modify. And this is just, again, an example model ordinance. There are also many other model ordinances out there. But the interesting thing with this example ordinance, or model ordinance, is that it does go through and identify, similar to the self-assessment, different levels of activity that you can consider in terms of your ordinance.

So the basic program, again, is something that would be basically required in almost any ordinance. So you're going to go through and look at that type of language. The enhanced program language is something that we would expect most programs to include in the near future if they haven't already included this in their ordinance. These are things that would really provide more flexibility and more detail to the program requirements and are probably going to be implemented within the two permit terms. And then the advanced or alternative program elements are things that are more unique or, again, cutting edge, that will help advance the program.

But the Center is looking for feedback on any of these tools, and so if you do have that feedback you can email Dave or the email address that's listed in the post-construction guide. But you really need to consult with your legal staff and look at working this ordinance in with your other ordinances like the zoning and subdivision type ordinances.

So I'll turn it over to Dave to talk about the guidance manuals.

David Hirschman: Yes, just to follow along there, John, there is another tool in the manual associated with the guide which does help you evaluate, systematically evaluate, other ordinances such as zoning and subdivision, and that's called the code and ordinance worksheet, and I think that's Tool No. 4, I believe. But that's also one of the downloadable tools. So we have the model language in the post-construction ordinance and then a tool to help evaluate the other codes that you may have active at the local level.

All right, Steve, your favorite topic, stormwater guidance manuals. And I know you've just been through quite a drill there getting yours updated in Stafford. But it's a very important component of the local program, and Chapter 6 of the post-construction guide has a lot of information on putting together or adapting a manual. And, frankly, most localities will probably choose to adapt, not go out on their own and build a manual from scratch -- and there's really no need to do that -- but to adapt manuals that may already exist at the regional or state level. So the guide gives some guidance on doing that.

Now, here's the skinny on manuals, that a lot of states have them. There are manuals all over the place, not only states but territories and other countries. And many of them are very, very good, and many of them are somewhat out of date, especially on the inclusion of some of these innovative practices we've talked about today. And many do not have a credit system or a way to have design guidelines for LID. And I must say from recent observations that while there is this perceived efficiency that manuals are out of date, there's also a great flurry of activity taking place now since it -- such as in Stafford and at the state level across the country of updating manuals, providing LID credits and incentives. And we're going to be seeing a revolution in stormwater manuals, I think, in the next five years as some of those come online.

So the stormwater manuals across the U.S., as we said, when we were putting this chapter together, our staff reviewed almost all of them, I think that are out there, plus a smattering of local ones, that -- about three quarters of states have a manual, but only just over 20 percent maybe would be considered a modern manual. So we put together as part of this, this manual builder tool, which is Tool No. 5, again, that can be downloaded from the CWP website, CWP.org. And what we tried to do in this manual builder tool is put together a spreadsheet with links to manuals across the country, and also including the territories, of very good stormwater examples, both technical aspects, such as what's the best -- what are the best bioretention design guidelines out there, plus some policy issues, like I need a template for a maintenance agreement or an easement document, and so that's all in there.

And this was quite a task, because these manuals, to review them, if you stack them up, I think, on top of each other, it went out the roof. And our engineer there in our office, Mike Novotney, did a great job of culling through all this and picking out the best examples.

So, as I said, this manual builder is Tool No. 5. It can be downloaded. It's a spreadsheet. And you can get links on both the technical and the program issues.

So I know, Steve, you guys have a manual that was out there when you first adopted the ordinance, but what happened after you did all this LID stuff?

Steven Hubble: Well, we recognized right away, Dave, that there was a big void, particularly in policy information and development, that needed to be made. So actually way back in 2005 now we started the process of updating our design manual. And I'm very happy to say that actually yesterday it was officially adopted. So not to scare everybody with that three-year time frame, we had some things that happened that caused it to lengthen out. But also to acknowledge that there is a lot of work to go into these things, and you want it to be done right once you put all that effort into it, also.

Some of the key issues that we were dealing with in our manual were determining a definition for the term "maximum extent practicable." As I mentioned earlier, we had trouble with that. And I know that's something that Nikos and his friends at EPA struggle with a lot, also.

Nikos Singelis: You're not the only one that's had a problem with that.

Steven Hubble: Essentially, what we did, instead of coming up with a definition, we developed a system of levels of low-impact development implementation, and we call those full, partial and limited, and our design manual gets into those in detail. In the essence of time we'll skip that discussion today, but anybody who's more interested in that can certainly contact me.

Another issue that we had to deal with was whether to require underdrains or not in our bioretention and biofiltering facilities. And we felt for a good margin of safety that we did want to require those at this time.

Another issue particularly associated with bioretention is the composition of the bioretention soil medium mix. That seems to be changing on a yearly basis with the research that's going on at the different universities around the country.

And additionally also some policy issues. Maintenance is obviously a big deal for these types of facilities, and since they're located on private property that can be particularly sensitive. So we make sure and require drainage easements around all our facilities, and also access for maintenance.

And then finally you can also have -- with any type of infiltration facility you can have issues with setbacks from buildings, wells and septic drainfields. So we had to make sure that all those issues were addressed in our manual.

Nikos Singelis: Great. Thanks, Steve. Yes, maintenance is such a huge thing, as we've been talking over and over again. And, John, let's talk a little bit about some of those important maintenance aspects.

John Kosco: Sure. We just want to touch on some of the key challenges with maintenance. And probably the biggest challenge, especially for programs like Steve's that's been up and running for a while, is just locating all these BMPs. If you haven't adequately tracked them in the past, going back through your records or going out in the field or trying to find -- everyone knows pretty much where the large ponds and retention basins are, but some of these smaller practices or the underground systems or things like that, trying to find those is difficult. Identifying responsible parties, looking at BMP designs that may not allow for adequate maintenance, or even just not having adequate authority through your ordinance to go and do maintenance are all different challenges and problems associated with the maintenance program.

What we have with this next slide, and we go into much more detail in the guide, is a level of a service matrix, or program service matrix. And basically this goes through and describes a decisionmaking process. Who will do the maintenance? Are you looking at having your own government personnel do the maintenance, or private, or some combination? How often do you want to do the maintenance? What kind of schedule are you going to do this? Is it going to be -- is there maintenance based on complaints, or some set frequency? What kind of evaluation are you going to do for the maintenance? So the service matrix helps you go through and answer a lot of those questions.

But typically what we've seen is there are three general approaches to setting up a maintenance program. And one approach is to basically put all the maintenance responsibility on the private homeowners, private developers or landowners. And this can essentially minimize the budget to the local governments, because a lot of the maintenance is paid for by the individual landowners.

The second approach, which isn't that popular but has been used in some cases like Montgomery County, Maryland, is where most of the local program maintenance is conducted by the local program. But you're looking at a much larger maintenance budget. But there are definitely benefits behind this, because you can essentially ensure that the maintenance occurs, and you have trained staff and whatnot to do that.

But another approach is a more hybrid approach, where you're looking at a blended public and private maintenance program where more of the responsibility is put on the local government, but also there are specific aspects that the private government, or the private landowners, still

need to maintain. But there is a lot more detail on that in the chapter on maintenance in the guide.

Nikos Singelis: And we should probably mention, too, that looking at option number one there, if you're only spending \$5K on maintenance, you're probably not -- probably don't have a very good maintenance program. So this shouldn't be viewed as kind of the minimum. This is what we found in the reporting was actually being spent, but that doesn't mean that that's necessarily a good maintenance program.

But going back to that previous maintenance matrix that we showed, one of the things that I think that would be very useful, too, is if your community is considering a stormwater utility, you can -- it helps you kind of plan out the kinds of maintenance activities that you're going to need to do, and that'll help you set the stormwater fee for the stormwater utility.

David Hirschman: Yes, Nikos, I think you made a good point there with the option one, the private maintenance. As you noted, those are reported budgets. But there really is no such thing as a maintenance program that doesn't take any oversight by the local government. If you have private property owners conducting maintenance, it is incumbent on the local program to provide the structure, the oversight and inspection and compliance mechanisms.

And I think everybody out there knows if that doesn't happen, then the maintenance is also not going to happen, and our BMPs are slowly going to sink into disrepair and failure. So this, it's pretty important. I think most of the people out there listening probably use this model where private property owners are responsible, but it's not an obligation-free deal for the local government to choose that.

Nikos Singelis: Yes, as I mentioned before, you're going to have to plan for education and outreach training and all that sort of stuff to go with it, and we often see that being neglected. Steve, want to tell us a little bit about your -- how you maintain particularly the LID pieces?

Steven Hubble: Absolutely, yes, and I think Dave just made a really good point in talking about private maintenance, because in our county that's how we're set up at this point. And I would say it wouldn't be unfair to say up until this point that we've done a good job with the plan review and design, and we've done a good job with our inspections during construction, but an area where we've been a little weaker is in our maintenance program, so that's something that we need to bring along, because obviously it's critical to the overall long-term performance of these facilities.

But, like Dave mentioned, in our county, except for government facilities, all maintenance is done privately by commercial property owners or HOAs or private property owners. We do require detailed maintenance plans for all of our development projects, and these are recorded within the county's land record so that they can be tracked in perpetuity. There's also an operation and maintenance plan that's part of the maintenance agreement that details for the owner how to take care of the facility. And we're starting to see some really nice maintenance plans being put together by some of our engineers who are preparing low-impact development plans. And Nikos mentioned that I should offer you all a copy of those, if any of you out there would like to view those, and I'd be happy to share that if you want to email me on that.

Additionally, we also encourage our developers to record covenants and restrictions in their deeds when properties transfer to help make property owners aware of the types of facilities that they may have on their property and the arrangements for maintenance that are associated with that. And, as I mentioned earlier, we are a little -- have been a little slower to come along in our maintenance program, but we have started this year a full-force maintenance inspections program, and our staff will be going out and doing those inspections and then notifying the owners of the work that needs to be done.

Nikos Singelis: Thank you, Steve. And we've got a poll question now for you. So based on this previous discussion, does your program currently allow practices on individual residential lots? Are easements and maintenance agreements required? So pick the answer that best suits your situation currently. Yes, you allow them, and you have easements and maintenance agreements. Yes, but no easements or maintenance agreements, or weak ones. Not sure. Maybe. Case by case. Not consistent. And then, Dave, we've got another scary answer here. Maybe we should have done this webcast on Halloween, instead.

David Hirschman: I think so. Well, post-construction in general is a pretty scary topic, Nikos, as you know.

Nikos Singelis: Yes, it is true. I think it's among the most challenging of the six minimum measures for communities out there to really get a handle on, because it is very complicated and also requires dealing with a lot of other people within the local government. So, again, same routine as last time. Pick the answer that best represents your current situation there. And we'll show you those results in a second.

I wanted to mention to you that this is the last webcast in our 2008 series, and we'll be taking a little bit of a break. And we hope to resume again in January, and we'll be publishing a schedule for next year later in the fall, beginning of the winter.

So let's see what we've got here in terms of results on this. So let's see, got about 29 percent -- wow, that's impressive -- 29 percent say yes, they do allow these things and they have good maintenance agreements and easements in place. And then we've got about 14 that allow but probably could use some work there on the maintenance piece of it. We've got a whole bunch in the case-by-case basis, so, again, some probably work on consistency of the approach in those communities there. And then, again, same as last time, about 15 percent are scared. Actually, I think a little more are scared this time than before, if I remember correctly.

David Hirschman: I think we may have had somewhat of a flaw in the way we phrased this question, because we said practices on individual residential lots, so those in fact may be basins, and I think our intention in phrasing the question was the rain gardens and dry wells. And so it would be interesting to know. Obviously, if you are doing practices on lots, it certainly is a good idea to have those maintenance agreements and easements in place.

Nikos Singelis: All right. Let's move on. Again, we're going to have another question break coming up again very soon. So just kind of summarizing, we do have seven tools up on the Center for Watershed Protection website right now for you. An eighth will be coming shortly,

hopefully in the next, what would you say, two weeks or so we'll have that finalized. And, as I think John mentioned before, we are asking, too, for your feedback. If you're looking at these things and you've got some other great idea that you want to share with us, please let us know. This is a work in progress, particularly with the tools, so we anticipate updating them from time to time. And we'll put dates on there to show you which one's kind of the latest version there.

And so, guys chime in on the summary here. But I think the folks listening have been getting an idea that we really have to make our systems, or we have to adjust our systems, really, so that we get a better mix of BMPs that are appropriate for our watersheds, for the particular conditions that are going on in our watersheds, the problems that we want to confront and control.

Dave mentioned that some places we've got TMDLs in place that we want to address. In other places we have known water quality issues that we want to deal with. The issue of channel protection and the all-important volume, again, is something that you won't often see in a TMDL but is something that is a very common issue in smaller streams, that we're just getting a lot of channel degradation. And so we've got to adjust our system to ask for the right kinds of BMPs to deal with those situations, same as Steve was mentioning, kind of the special considerations that they give to the Chesapeake Bay [inaudible] and the issues that are going on there.

And, of course, we do want to see a good plan. One of the things that we've seen in some of the MS4 evaluations that we've been doing is not a very good plan in place, not a very clear statement of the logic about why we're doing what we're doing in the program and how all these pieces relate to each other. Again, adopt or update the ordinance. A lot of ordinances out there are like nonexistent or weak, so there's a lot of areas for improvement there, and John talked about some of those, some of those improvements there that we could make.

And then, the issue of a manual, and I think not every community has the ability like Steve did to go through that long process of doing it from scratch, but if you look at the manual builder we have given you a way to look at the best sections from different manuals from across the country and so that you can beg, borrow and steal, which is really important in a stormwater program, to come up with a good manual in a relatively easy fashion. And if you're in a state that has a really good one you could also rely on that, as well, if you're lucky enough to be there. And, of course, the all-important maintenance thing.

Anything you guys want to add to the summary there before we get to our last question break?

David Hirschman: I think you covered it pretty well, Nikos.

Nikos Singelis: Oh, thank you. Oh, a compliment, sort of. Okay, Sonia do we have any questions?

Sonia Brubaker: We have a lot of questions.

Nikos Singelis: That's good.

Sonia Brubaker: Yes, it is. The first one's for Steve. Robert in California comments, in one of your examples you've shown that typically 90 percent of the runoff occurs in storms of less than

one inch. He's wondering about the pollutant loads. Would you expect 90 percent of fine sediment to reach the receiving waters in storms with less than one inch?

David Hirschman: I think I'll take that one off of Steve. The question is whether the pollutant loads may be associated with the storm events. And obviously it's going to have some regional differences, but in general if you are capturing and treating 90 percent of storms, you can't say unequivocally you're also capturing and treating 90 percent of any particular pollutant, because some of them are particulate, in the case of fine sediments, some of them are soluble, as nitrate and nitrite. So there's a lot of dynamics at work, but you can say with certainty that if you go after the 90 percent of storms, you are going to be optimizing, or doing as good a job as you can, of capturing and treating the average annual runoff volume, which is going to get a pretty good level of pollutant removal, and obviously depending on the pollutant.

Nikos Singelis: Yes, and I would add to that, if we can infiltrate 90 percent or some percentage around there, if we're infiltrating that amount of water, we are dealing with those pollutants in terms of what's being discharged to the nearby surface water. And, as Dave mentioned, if we're treating 90 percent in some combination using infiltration and treatment techniques, then it's going to vary as well.

Sonia Brubaker: All right, great. Thanks, Nikos and Dave. And now the next question is for Nikos. Bob has asked, is runoff reduction usually an appropriate management strategy, and are there any conditions or situations where it is not?

Nikos Singelis: I think we've mentioned that there are cases where runoff reduction wouldn't necessarily be the right thing to do, or it may be only one -- or you might want to use it only in limited fashion. Dave mentioned some of those cases. For instance, in an industrial site, where you might have high concentrations of pollutants, you may not want to use runoff reduction or an infiltration technique. Say at a gas station, where you have the potential for a spill with a large amount of hydrocarbons, you may not want to use infiltration, or if you did you might want to have some kind of pretreatment or sort of capture technique in place in case you did have a spill.

In areas with karst topography, or places with high water tables, your abilities may be limited. Different soil types, as well, are going to change the amount that's possible. So there's a whole wide variety of choices. So we're not trying to say that this is a panacea for everybody. But we think that in general it's usable in different places in different amounts, depending on your conditions.

Dave, did you want to --

David Hirschman: Yes, I think we're going to anger a whole constituency out there in the rainwater harvesting realm if we don't at least give a nod to that, because that is definitely one of the techniques also. It doesn't have to be infiltration into the ground. There's a growing movement, and it's growing pretty strong in some parts of the country, to harvest and reuse the stormwater runoff for both outdoor and indoor uses. And so that's another technique, which, unless if your state courts consider that a water right violation, but that's a huge frontier and a huge area of opportunity, I think, in the world of runoff reduction.

Nikos Singelis: Oh, absolutely, yes. When I sort of talk about infiltration I tend to mentally include all those things together, but, yes, rain barrels or cisterns and things like that can also be very useful.

Sonia Brubaker: All right. And, John, can you please address the value of rainwater harvesting as a BMP method?

John Kosco: Yes, like Dave just mentioned, I mean, it's basically like or similar to infiltration where you're removing that water from the system that's going to eventually reach the receiving water. And it is being used in at least a number of areas right now, like up in the San Juan Islands, where it is being used as a drinking water source, and other areas are using it for irrigation and things like that. And, as Dave mentioned, if you're not limited due to water rights, it's definitely an option and a growing option for many areas. It's just it's not going to be the panacea where it's going to be the only BMP you need. It is limited on how much water you can treat and hold.

Sonia Brubaker: All right. Thanks, John. And we do have a few more minutes to answer additional questions. But first I want to remind you that this seminar will be archived, so you can access it after today's live presentation. An archived webcast will be posted within a few weeks, or you can visit EPA's NPDES training website to view the archived presentation.

And, as a reminder, we have posted the speakers' contact information, in case you would like to contact them after today. And you can also find a comprehensive resource list by pressing the Resources button on your screen. And you will need Adobe Acrobat Reader to view this document.

Now, finally, a webcast evaluation survey should soon appear on your screen, and please complete the survey and let us know your thoughts. We do appreciate your feedback as we work to improve our webcasts. If you do not see the evaluation survey on your screen, please turn off your popup blocker.

Also, don't forget to download the certificate. Click on the Certificate button to print the certificate after this webcast. It will not be mailed to you. If there are multiple people in the room with you, you can click on the link to customize your certificate and print a copy for everyone attending. And that link will actually be the very last slide of this presentation.

So now we have additional time for questions. And we're just going to throw this one out there. In situations where poorly drained clay soils are present, are LID BMPs as effective in terms of runoff control and pollutant removal?

David Hirschman: "As effective" is a relative term, because that area will not be infiltrating as much water in the natural condition as an area with soils that percolate better. So the question is, can you get closer to a pre-development hydrologic regime by using LID? And I think that the question to that -- LID or runoff reduction -- and the question to that is obviously yes. You're not going to be achieving the same objectives and goals and flow rates as another area with better soils, but even the use of, say, bioretention with underdrains, based on the research, does accomplish a good dose of runoff reduction and pretty darn good treatment, too. So I don't think

there's any area of the country where some practices can't be adapted with some ingenuity and creativity to the local conditions.

Steven Hubble: Yes, Dave, I wanted to add that we do have a lot of clay soils and a lot of C&D soils in our county, and that hasn't really discouraged the use of these types of facilities. We just would use the bioretention as filters instead, with underdrains, like you mentioned, and they've still managed to be fairly successful, from what we've seen so far.

Sonia Brubaker: All right. Thanks. And, Steve, you mentioned you relaxed your curb and gutter requirements to help encourage LID practices. Did you have any internal issues to address with your road maintenance section regarding possible degradation of paved roadways -- roadway edges due to vegetation growth or just normal traffic?

Steven Hubble: We didn't have any concerns from those folks about those particular issues, but we have had some concerns from the development community and from our own internal staff. Their major concern was that many end users, i.e., the homeowners, enjoy a curb, gutter and sidewalk type of subdivision, and they did have concerns about us deviating from that typical type of neighborhood design.

Sonia Brubaker: All right. Thanks. And, Nikos, Bart has commented that the Center for Watershed Protection says that watersheds become impaired when impervious levels reach 8 to 10 percent. If the appropriate BMPs are in place in a watershed, what level of imperviousness can be tolerated? What is a good way to show the effect of BMP performance on the impacts of impervious?

Nikos Singelis: I'm going to let Dave take that one, since that's their work.

David Hirschman: That is such a good question, and I wish we had Schueler here to wax philosophical on that, but we'll have to wing it. That actually is addressed in the guide, and I believe it's in Chapter 2. We have modified what we call our impervious cover model, so it's not a fixed line right now at that 8 and 10 percent, but it's more of a cone. And what we are seeing in that at low levels of impervious cover there is a bigger range of stream conditions, but as you get up into 50 percent and more high impervious cover sites the relationship with impairments and stream health is a pretty strong one.

So the question of this is can BMPs mitigate or in some way unravel that relationship between impervious cover and stream health? And, my gosh, there's been quite a bit of research, and I would say the answer to that is more positive as you get to the lower levels of impervious cover and maybe a little less of an interrupting effect at the highly urban watersheds, where it's very hard for BMPs to have -- to undo that negative influence both on the channel stability and biological condition of the receiving stream. So I think at those higher levels of impervious cover it's a matter of clearly defining restoration objectives that are realistic and that can be achieved.

Nikos Singelis: And one thing I would add to that, from your retrofit manual -- the Center for Watershed Protection did a really nice retrofit manual, and one thing that I remember from that is a discussion and graphic that shows the number of retrofits depending on the relative level of imperviousness in a particular watershed that would be needed in order to start addressing that problem. And the number of projects is rather daunting. So we're talking about a very long-term

effort. It's certainly not something that can be handled with just a few BMPs around the community.

Sonia Brubaker: All right. Thanks, everyone.

At this time I'd like to conclude today's webcast. Thank you, Nikos, Dave, John and Steve, for presenting today, and, of course, thanks to everyone who joined us.

Our next stormwater webcast will be held in early 2009. An announcement on the date and topic will be sent out through the NPDES news listserv and will also be posted on EPA's NPDES training page, at www.epa.gov/npdes/training.

That ends our webcast for today. Thank you again for joining us.