EPA-State Approach to Instream Monitoring
for NWQI – Webinar 1
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Slide: Webinar 2 – Monitoring in NWQI Watersheds

Lynda Hall
Okay, well, hello, everyone. I'm Lynda Hall, chief of the Nonpoint Source Control Branch in EPA's Office of Water, and this is the second in a series of webinars that we're doing for -- primarily for the state water quality agencies, monitoring folks, and nonpoint source coordinators to discuss the project and expectations associated with NWQI monitoring and also to provide what we hope is helpful technical information and eventually assistance to that effort. So this webinar has two pretty distinct parts. In the first part, which will be relatively brief, I'll be going through a few program updates with you. We'll be picking up where we left off in the last webinar, which is talking about where we are in our discussions with USDA on the conservation cooperator agreements. We'll also be reviewing next steps and some deadlines that we want to call to your attention in terms of identifying watersheds where you'll be focusing monitoring efforts and just kind of forecast ahead for you some things that will be going on in the next few months. And then we'll pause there for any questions or discussion. And then we will segue to the second part of the webinar, which is the bulk of this webinar, which is a technical assistance presentation by EPA contractor Tetra Tech.

Steve Dressing and Don Meals, who are longtime experts in nonpoint source monitoring, will be going through a presentation that's specifically tailored to NWQI and the opportunities and challenges that it presents for monitoring and just present some design information that might be particularly helpful, given the nature of the NWQI initiative. So we hope that will be both interesting and useful information to you. And I just want to emphasize up front that this is technical information for you and for your use. We, as you know, have communicated all along that states may use their existing monitoring programs, protocols, and approaches to do NWQI monitoring, so there will be a lot of information covered in this webinar, and it's information that, as I said, we hope will be useful. But because we talk about a particular thing in this webinar, it doesn't mean that EPA is saying you must monitor in that particular way or follow a particular design to the tee. So I just wanted to make a separation between technical insight that we think might be useful versus kind of requirements and expectations that EPA would have.

So with that, I think I'll just go right into some of the basic contextual information. We had the last webinar about two and a half months ago, and in that webinar, we had -- we laid out the basic information on NWQI monitoring, that it will focus on one watershed in each state. That will be a watershed that the state water quality or 319 agency selects. And we talked a lot about the need for, at least in a lot of monitoring designs, the need for that information on the conservation practices that are being adopted in the watershed in order to make sense of the monitoring data and try to answer that basic question we're after, which is has the water quality changed, and if so, can that be associated with the agriculture conservation practices in the watershed? So it was front and center on many of your minds, are we going to be able to get these agreements in place with NRCS folks at the state level so that the monitoring agencies have the benefit of that information? And so we have followed up with USDA on that, and they have -- with them, we've kind of worked out an important next step, I think, in the dialogue on these conservation cooperator agreements. And -- thank you.

Slide: Policy and Schedule Update

The next step is laid out here on this slide, which is basically NRCS headquarters has agreed to host a webinar, and it will be sometime in August. We haven't set the date yet. And the purpose of that webinar will be to bring together the state monitoring and 319 nonpoint source folks -- those folks that are on this call today -- but also all of the state conservationists, NRCS state conservationists, National Association of Conservation districts, State Associations of Conservation agencies, and, frankly, any others who might be involved in any of these monitoring partnerships and to really, for the first time, lay out for all of those parties what the National Water Quality Initiative is, with a particular focus on the fact that it is water quality based and there is an expectation that we'll be able to gauge the water quality results from these efforts. And that leads to the fact that NRCS can't do that themselves. They have to rely on state agencies for assistance with that monitoring.

And that, in turn, opens up the door for these conservation cooperator agreements because these agreements apply when another partner is assisting NRCS with its programs. So we covered some of that material briefly in the last webinar, but what we've agreed with NRCS headquarters is -- or they have proposed to have a fairly in-depth webinar with that large group of stakeholders to go through all of those particulars on NWQI and then to talk about the privacy provisions in the Farm Bill and then under what circumstances these conservation cooperator agreements may be entered into, review the roles and responsibilities that the parties to those agreements would have, and then possibly go through an example or two of those if we're able to do that since we have, since the last call, become aware of at least a couple good examples of those agreements at the state level. So this is the next step, and I think it's an important step in this ongoing dialogue and this really critical aspect of how will the state agencies get the information they need to do the monitoring work and do it in a way that allows us to assess the basic questions that we're getting after and in the NWQI? So the thought is that, with NRCS headquarters hosting this webinar and having all the state conservationists on there as well as other partners, that folks will leave that webinar feeling both more knowledgeable about the roles and responsibilities in NWQI and more empowered at the state level to enter into conversations with you about those agreements. So that is the next step on the conservation cooperator agreements, and that, we all know, is a very important aspect of this whole arrangement.

Slide: Policy and Schedule Update (2)

So we will, while pursuing that over the next couple of months, also be dealing with a few other important milestones on the NWQI. So the next thing I wanted to do is review these with you. We had a set of milestones similar to this put up in the last webinar. We have adjusted the dates a bit, and so you'll see that we have -- on the left-hand column, the bottom of this slide, we're asking that by August 30th that each of the states identify, if you haven't already done so, identify to your regional office the watershed where you expect to focus your monitoring efforts under NWQI. We had an earlier date in there. We moved this back because we came to understand that USDA will be making decisions on edge of field monitoring and where -- in what watersheds that will be taking place in early August, as noted here on this slide. So we thought it made sense to wait until those decisions were made, and then you all would have the benefit of that information so that if there was an opportunity to align the instream monitoring with edge of field monitoring that may be going on in NWQI watersheds in your state, you could do that. So with that, we expect that in the next couple of weeks. We do expect the webinar to occur sometimes in August, as well. And then we will be asking you to let us know, let EPA know, the watersheds where -- watershed where you expect to focus your monitoring efforts. And we'll have a really short, one-page form for you to send to your regional office, and I'll be showing a screen shot of that in just a minute.

Slide: Schedule Continued

So going on to the next slide, the next few deadlines I wanted to call your attention to is that, as I've mentioned before, we do have the ability and the funding to provide some limited one-on-one technical assistance to states that would like it. We do have the advantage of a contract through the Region 5 office with Tetra Tech, and they have very knowledgeable people, two of whom you're going to hear from today, on all facets of nonpoint source monitoring. So if there are states that are interested in that one-on-one technical assistance, we have enough funding to do eight to ten states. I know it's not a lot, but it's what we have right now in terms of funding. So keep that in mind. We'll be asking for your watershed selections at the end of August, and then mid-September or September 13th, if you are interested in being considered for that one-on-one technical assistance with the contractor, then there will be another brief form for you to send in to your regional office by September 13th, and we'll obviously be sending that out, as well, shortly. And then we will be turning that around pretty quickly, hopefully by the end of September, to let states know which ones we are able to proceed with providing the technical assistance to.

So then the next entry here is kind of the broad swath of October to March. So obviously, the states that are looking for one-on-one assistance would be getting it. We will continue also to have webinars on this initiative as it goes forward because there will be both other technical information that will be useful to present but also just making sure we're continuing the dialogue and able to hear your questions and comments and any issues that you're contending with. In this same timeframe, we don't have it here on the chart, but we would also be expecting a fair amount of activity at the state level between the state water quality or 319 agency and the NRCS office to get agreements in place wherever possible and would be hoping that those could be wrapped up by the end of the year or maybe right into January. And then the final item on here I just wanted to call your attention to -- hopefully you've all heard about it, and hopefully some or even many of you might be able to attend -- but the last week in October the National Nonpoint Source Monitoring Program is hosting its annual monitoring workshop. It's in the Cleveland area, and there's a lot of great sessions in that workshop. There will be one on

NWQI monitoring in particular, and so if that isn't on your agenda and you think you have the ability to squeeze a little bit of travel money, I highly recommend that to you.

Slide: Policy and Schedule Update: One-Page Monitoring Summary

The next slide is just a quick screen shot of about half of the form that we'll be sending to you shortly after this webinar. Again, this is just for you to identify to EPA the watershed -- the NWQI watershed where you expect to focus monitoring efforts. It shouldn't take you very long to fill out. And then, again, after that we'll be, for those of you interested, asking for about a two-page form if you do want to be considered for the one-on-one technical assistance.

Slide: Policy and Schedule Update (3)

And with that, I think I am finished with the program update. So we're going to pause at this point and see if there are any questions. Okay, there's one. Go ahead.

<u>Erika Larsen</u>
So we have one question: What type of assistance will the states have? So I think Stu can help answer that question.

<u>Lynda Hall</u>
So this the through the contractor, what kind of assistance is available? Okay.

<u>Stuart Lehman</u>
Yeah, the states that are selected for that can have assistance in a number of things, potentially, monitoring designs, if that hasn't been finalized; statistical support, what kind of statistical tests could be run; and even data display or reporting methods. Just any -- actually anything that the state would like help with in understanding in getting their monitoring results and analysis done.

<u>Lynda Hall</u>
Okay. That seems like it's all the questions that have come in. So with that, I think we'll be ready to segue to the technical presentation portion of the webinar. Over to you, Steve.

Slide: Water Quality Monitoring for National Water Quality Initiative Watershed Projects

<u>Steve Dressing</u>
Okay. Hi. This is Steve Dressing at Tetra Tech. It's a pleasure to be talking with you today. Don Meals and I will be sort of doing a tag team, so I will begin. And as Lynda noted, what we're going to talk about today is technical matters. If we slip into policy, please correct us because that's not what today is about from us.

Slide: Fundamentals of Good Monitoring

First off, just a few points about the fundamentals of good monitoring. We know that all of you, or most of you, have been involved in monitoring probably for years, so much of this will be review. The first point is the need to understand the system you're monitoring and then, with that in mind, design monitoring to meet your monitoring objectives, which should follow in suit with your project objectives. We also encourage -- and most of you are, I'm sure, aware of the need to monitor source activities, that is those things that are causing the issues that you are trying to solve. And then there are basic details on data management, QA/QC, et cetera that all need to be paid attention to from the beginning to make sure that you have the best chance of succeeding in your effort. And then there's the feedback. As you're all aware, I'm sure, monitoring of nonpoint source watershed projects is not just a water quality monitoring group exercise. It involves many other groups, land treatment people, land owners. And so it's important to have a regular feedback mechanism to keep people on board and also to learn things that can help you do a better job in monitoring your watersheds.

Slide: Monitoring Design Steps (USDA, 2003)

We're not going to go into detail on these basic 12 steps, but if you consult the National Water Quality Handbook, our good friend Jack Clausen wrote this for USDA, and he identifies 12 basic steps for monitoring design. Much of what we'll talk about today goes along the lines of those 12 steps, although we're not getting into detail on each of them.

Slide: 1. Identifying the Problem

The first step, identifying the problem, of course we think that in many cases that's something that may already have been done. But that's obviously a very important first step. The elements of a problem statement -- what's the use impairment, what's the water body, what are the symptoms, causes and sources -- all should be laid out and clearly understood so that when you design your monitoring program, it's targeted correctly at the things that are most important in that watershed.

Slide: 2. Form Objectives

Forming objectives, as I mentioned, it's important that management and monitoring objectives are complementary. For example, a management objective to reduce annual P loading to a lake by 15 percent in five years with nutrient management might be accompanied by a monitoring objective, the first one listed, to measure changes in annual P loading to the lake and link those to management objectives. And you can see a similar parallel for the E. coli example. So these two things need to -- need to fit together.

NWQI: Monitoring Objectives

For the National Water Quality Initiative projects, objectives to determine if the NWQI practices are reducing nutrient sediment and pathogen pollution. And that might be something that you're looking at concentrations, are you looking at loads, or maybe you're looking at biological indicators. Another objective, to determine if water quality is improved and then can be associated with the implementation of those NWQI conservation systems. Now, it may be, in your case -- and all watersheds are different -- that you don't plan to differentiate between NWQI and all other conservation practices. And that's fine. It just needs to be something that you decide up front because it affects your design and your data collection and the analyses that you intend to do later. Now, we're going to assume for the purposes of this discussion that you're going to focus on NWQI practices.

Approaches to Meeting Objectives

Now, we've considered various objectives that you could look at and the types of objectives. One is you want to demonstrate cause and effect. Two, demonstrate association between your water quality and your land treatment variables with some sort of statistical analysis. Three, you may want to try to infer an association in a more qualitative manner rather than through a rigorous statistical approach. Or four, just claim success with minimal documentation. And clearly, those of you who have been in this arena for probably even a couple weeks know that one is not feasible. It's not feasible because we're not a research organization. That's not what we're doing. And also, it's pretty darn difficult. But number four wouldn't be adequate. So that leaves us primarily with options two and three as the viable options for the types of objectives at that you might establish for your NWQI monitoring projects.

Slide: Demonstrate Association Statistically

Now, looking at demonstrating associations statistically, there are basically a couple of approaches that we think are worth serious consideration. One could be you're looking for a before-and-after step trend or change. This is something where we'll give example -- the first example, where you have an X percent reduction of flow adjusted median annual total P concentration in your post-BMP period versus the pre-BMP period. And you might do that with a t-test. The second type of approach would be a monotonic trend analysis, which that's a gradual time -- change over time that is consistent in direction. And for many of the pollutants we're going to look at, you want that direction to be down. And the second example illustrates what you might come up with as an example for that approach. Now, it's important in either approach to have explanatory variables to improve the relationships. Now, we're not going to be talking in detail on statistical analysis today. That could be a topic for a future webinar. We'll see if that happens. But we do have -- there's information available, and as Lynda mentioned, we're under contract to provide technical assistance. And we can get into more details, you know, through that avenue, possibly. It's important when doing a statistical approach that there's some pretty tight experimental control, and I say that within the context of watershed projects because I've seen some of the names of the people in on the webinar today, and I know you've been around for quite a while, and you know tight experimental control in a watershed project is a real tough thing to get. But in a relative sense, it needs to be tight.

Slide: Infer Association Qualitatively

Now, if you're taking an approach where you're trying to look more in an association and a qualitative sense, what you need to do is you need to look at both ends of the equation, look at the water quality end and then look at the land treatment end. So you'd want to document change in condition or in water quality variable values and also document what the implementation was of those practices, use that information to tell the story. And you might bring in explanatory variables like, for example, what was the precipitation pattern over your timeframe? What were other things that might have been happening in the watershed? This type of approach is obviously one where there's less control over the experiment. Examples might be you look at beneficial use support status and how that maybe changed from partial to full support. And then you do an interpretation of that based on what you've documented in terms of practice implementation and things like weather patterns, and obviously flow goes hand- in-hand with that. You might say something like average annual total nitrogen load was generally lower in the last four years versus the first four years. And by saying generally lower, you know how things go up and down in terms of discharge. And if you're looking at loads, that can have a lot of to do with what your -- precipitation can have a lot to do with what you find. And again, you do a qualitative interpretation based on what you've documented in terms of practice implementation and weather patterns.

Slide: Monitoring NWQI Project Ideal

Now, ideally, if we had our way, this is what these projects would look like. You'd have a two-year period where there's no implementation, that the only thing happening is things that happened before NWQI practices were put in play, put into place. And whatever those things were, they would be maintained the same way they were at the beginning throughout your monitoring period. And then any new practice implementation would all come from the NWQI, and it would be completed quickly, say within a two-year time period. And if you monitored over seven to nine years, you'd have a really good chance of showing some improvement. And you may -- there's precedent for not monitoring during the implementation years. They did that in a New York 319 national monitoring project with great success. You could or could not do that.

Slide: Monitoring NWQI Project Ideal (2)

But that's ideal, and that would support very easily an analysis of pre- versus post-BMP water quality conditions because you have a real clear cut-off between what was before and what was after NWQI. And you could also do monotonic trend analysis if perhaps the BMP implementation didn't happen so rapidly, say in a two-year period, maybe it dragged out a little bit. That's the ideal world.

Slide: Monitoring NWQI Projects: Likely

The likely world, however, is that you may find that practice implementation has already begun before your monitoring begins, and so you really don't have a true pre-NWQI baseline. Still, even in this case, anything that had been implemented that wasn't associated with NWQI should still be in place and operated consistently throughout the project lifetime. I mean, that's kind of what happens. There's -- you need to pay attention to that, but that's a reasonable assumption going in. And then it's likely, maybe, that the practices from NWQI are implemented, for the most part, within, say, four years. And again, you monitor for seven to nine years and because there's no clear implementation phase, perhaps you wouldn't have the option of stopping for a couple years in the middle.

Slide: Monitoring NWQI Projects: Likely (2)

In this situation it's very important -- and it's very important in all monitoring, nonpoint monitoring for watershed projects -- to collect water quality, land use/land treatment data, precipitation and flow data. And if you do that, your project should be able to perform some statistical analysis and interpret your water quality results. That doesn't mean you're going to get what you hoped for, but you should be able to do the analyses. And the outcomes you get are going to vary due to differences in your watersheds, what your weather is like, what your flow is like, the type of problem you have, the BMP types, and implementation patterns. For example, if you're dealing with nutrients and you use nutrient management, maybe your issue is dissolved P. Well, that's going to be different from particulate P and dissolved N. So there's a lot of variability even under common headings like nutrient management, so your outcomes are going to differ. But it's important that you examine your data, and then you look, and you might find opportunities where you can still do a pre/post BMP step analysis. That maybe -- that might happen, for example, where in your project there was very little BMP implementation in the beginning years, and maybe there's a lag in the effects of those BMPs. And then you have more implementation completed, perhaps, by five years. So you sort of have a fake pre-NWQI because those practices haven't really affected the water quality you're monitoring. You won't know that until you look at the data. Monotonic trend analysis is another possibility. Perhaps the implementation of your practices is more steady over, say, a period of five years. And if there's a little bit of a lag in the effects of those BMPs, you might see gradual improvements in water quality over, say, a nine-year, seven to nine-year monitoring period. Again, you have to look at the data to find out. But the important thing is you set things up in the beginning to be able to do these sorts of things. So now I'm going to turn it over to Don for a while, and I'll advance the slides for you, Don.

Slide: Challenges to Meeting Objectives

Don Meals

Thank you very much, Steve. This is Don Meals calling in from tropical Vermont. Regardless of whether you get the ideal or the likely scenario in an NWQI project, there are going to be some challenges to meeting your objectives. And those -- these challenges are going to be familiar to many of you who have experience in these matters. Will the BMP implementation be sufficient to cause a measurable change? Will you be monitoring for a long enough time period to overcome the lag time in the system and actually see the impacts? Can you separate what's done under NWQI from other influences in the watershed? And Steve already talked about baseline in NWQI versus other things going on. We're all familiar with the issues of variability and weather, drought versus wet years, BMP performance, how long it takes for a riparian system to grow, changes in hydrology. All those things are going to affect how well the project is going to move toward completing or achieving the objectives. And finally, there are always cost and logistical constraints, and we all, I think, live in some fear that budget cuts are going to jeopardize the monitoring or the implementation activities in any of these projects.

Slide: Will NWQI BMP Implementation Cause Measurable Change?

In the matter of is there going to be sufficient implementation to cause measurable change, the questions have to be asked at the outset, are the BMPs that are selected, are they appropriate for the correct pollutants, the pollutants that are causing the problems? Do they approach the correct sources that are the sources of these pollutants? Are these -- the BMPs targeted appropriately to achieve improvement in a reasonable timeframe? And we understand that the monitoring agencies, the state water quality agencies, will have limited ability to influence targeting, but we're going to talk about targeting in a little bit, but it's something that people need to be cognizant of. And finally, are the practices going to be implemented to a level that's enough to cause measurable change? And most people -- most of the time, if that's thought about at all, it's thought about in the context of planning models. And we'd like to emphasize that many models give a single number, a single answer, and are not particularly good at encompassing uncertainty. So you need to consider a range of possible outcomes rather than the best case or the average. And you also have to consider the temporal resolution of a model. Those of you who are familiar with STEPL, know that it's not designed to estimate actual loads for a particular year. It's designed to give an estimate of an average annual load over a 20-year window. So that has to be factored into your planning.

Slide: Critical Source Areas and Targeting

I want to address a little bit about critical source areas and targeting. Again, even though you may not have a lot of control over this, it still needs to be considered. And by critical source areas, I am talking about the confluence or the coincidence between a source of, say, phosphorus in a watershed and a mechanism to transport that phosphorus from field to water. And that intersection of those two sets could be considered a critical source area that could be targeted for treatment -- if you could click a couple of times, Steve. There are several ways to get at this. I'm not going to go into them in detail. You can look at export coefficients that are published in the literature. You can look at synoptic survey data. That red and green slide there is a synoptic survey that identified hot spots for nitrate loading in a Maryland watershed. Click again, please. You can use various GIS overlays to implement the universal soil loss equation, for example, on a watershed and identify potential hot spots. And last -- if you could click again, Steve -- modeling, for example, using SWAT very intensively, you can identify even fields that are highest priority or highest critical source areas for targeting.

Slide: Critical Source Areas and Targeting (2)

In addition to those biophysical measures of critical source areas, there are behaviors on the part of producers and land owners that need to be factored in to targeting, why appropriate or inappropriate behavior patterns are occurring in particular locations, and design an implementation program or an effort to change management based on the understanding of what is going on, what human behaviors are being exhibited in the watershed.

Slide: Lag Time is here to Stay

I need to say a word about lag time. Steve mentioned that several times. All of us know that, over the years and the decades, watershed land treatment projects have often been unsuccessful in reporting improvements in water quality. And we've laid the blame at various factors such as insufficient land owner participation, bad weather, improper BMPs, mistakes in understanding where the pollutants are coming from, poor monitoring design, inadequate number of BMPs or acres treated. And all of those are certainly true, but --

Slide: Lag Time

But lag time between an action and the response to that action is typically a large factor. And we think of lag time as the type elapsed between installing or adopting land treatment measures and a measurable improvement in water quality in the target water body. And as we said before, if the lag time exceeds the monitoring period, it may be quite difficult to demonstrate definitive results.

Slide: Project Management and Effects Measurement Components

In thinking about lag time, it's useful to try to divide it up into components. In these blue boxes are the -- what we see as the principal components of lag time. First, the time required for a practice to produce the desired effect. The time required, for example, for conservation tillage to protect the soil and reduce the erosion potential of a crop field. The second block, the time required for that effect to be delivered to a water resource, the time it takes for that reduction in sediment yield from a field or sediment soil loss from a field to be transmitted to the watershed outlet. And last, the time required for the water body to respond to the effect. That could be related to a flushing rate in a lake. It takes time for a reduction of phosphorus load to be expressed as increased water clarity from a reduction of algae blooms, for example. Those are the three main components. The kind of orange-ish circles, at the beginning there's always a project management lag phase, where it takes time between funding of a project and the first shovel in the ground. People will perceive that as a lag. And the second orange balloon there relates to how we monitor. If we're not monitoring well enough, it may take us longer to actually document a change, even if the change has occurred. So there are many components of lag time, and we need to figure out how to accommodate those.

Slide: Magnitude of Lag Time

A couple of examples in a National Monitoring Program project in Pennsylvania planted a riparian forest buffer. It took eight to 12 years for those trees to grow into enough biomass that would affect nitrate concentrations being delivered in shallow sub-surface flow. So that's a lag time in the ability to generate an effect on the land.

Slide: Magnitude of Lag Time (2)

Another National Monitoring Program project in Iowa, they actually did an excellent job in looking at lag time throughout their watershed in terms of groundwater travel times, the average being ten years to get from -- for groundwater to reach a stream from the watershed. But it ranged from two days to over 300 years, and retrospectively, they were able to determine that only 20 percent of their land treatment area was on top of areas that reached the stream during their monitoring period. They were fortunate to be able to develop -- or to demonstrate an effect, but it could have worked out quite differently. There are resources out there, and we're not going to go into lag time any further today, but it's something that needs to be considered.

Slide: 3. Design Monitoring to Address Challenges

The third step in this 12-step program that Steve introduced a while ago concerns the design of monitoring, to address these challenges and to achieve the objectives of the project. And there are some important objectives that need to be considered in design. We may or may not want to try to separate the effects of NWQI from other ongoing influences, or we may just lump everything together. We certainly need, in a nonpoint source situation, to account for the variability of weather from year to year and also the lag time issues and we need to be cost effective. There are many different experimental designs possible that address different types of study objectives. The design needs to be set before a project begins. We're going to limit discussion here to a couple of fundamental designs of single-station, either before or after or a trend situation, and an above/below design. So I'll touch on those real briefly.

Slide: Single Watershed Before/After

Looking at a single watershed before and after, this design can be used to evaluate the cumulative effects of implementing some number of practices and a variety of practices in the watershed. We can also use this design to assess changes in a relationship between, say, phosphorus concentration and flow at the monitoring station based on the BMPs that have been implemented.

Slide: Single Watershed Before/After (2)

Statistically, it's often quite simple to test for a difference between means of samples taken before the BMPs were implemented and after the BMPs, using a t-test. This is a standard t-test, not a paired t-test. It's also possible to use analysis of covariance if you're testing for differences in regression relationships between flow and concentration before and after land treatment. And as has been mentioned before, using explanatory variables like precipitation or certain flow variables in multi-variant regressions can strengthen the analysis.

Slide: Single Watershed Before/After (3)

Sampling in a single watershed before and after can be done with a single station. The samples can be grab samples, could be focused on storm events, or could be flow weighted composites in a continually flowing stream. It doesn't -- we don't have to be talking about physical or chemical variables. We could be talking about biological sampling for macroinvertebrates or fish. If loads are specified, if this is a TMDL watershed or a watershed plan focuses on load reductions, we obviously need to measure flow as well as collect samples for concentration and cover the important storm events over the course of the seasons.

Slide: Single Watershed Before/After (4)

The advantages of a single watershed before and after set up, it's relatively easy to apply. It's a single monitoring station. In addition to before and after, you can support a trend analysis approach. The design has some serious disadvantages that you have to keep in mind. It's very vulnerable to climate variability. Two or three dry years before -- in the before condition, followed by three or four wet years in the after condition, are going to skew your results and make it difficult to interpret change. It's also quite difficult when you're only monitoring at the watershed outlet to attribute changes that you do observe to a specific cause. Is it the BMPs, or is it the change in weather? This design can be strengthened by increasing the pre- and post-BMP monitoring periods to reduce the influence of one or two extreme climate years, adding covariates like flow or precipitation, ensuring that BMPs are implemented during a designated time period to create that sharp divide between pre and post conditions, and, very importantly, to collect detailed data on the BMP implementation and operation through the whole monitoring period.

Slide: Trend

Looking at a trend analysis approach, which also uses a single watershed station, outlet station, your purpose may be to determine if BMPs improved water quality. Was there a change in water quality over time, change in bacteria counts, for example, change in compliance with water quality standards, a change in load under a TMDL situation? It's -- trend monitoring in a single watershed is quite similar to a single watershed before and after design. But in general, it's assumed that there's not a real distinct implementation period, and the trend monitoring has to continue for a much longer time period, usually ten or more years versus two to six years in a before and after.

Slide: Trend (2)

The advantages of a trend monitoring approach, again, you have one monitoring station. It's widely applicable. You don't have to demand or assume sharp before and after implementation scenarios. The implementation could be gradual over time. It can account for lengthy lag times if it's continued long enough. And it's consistent with the requirements of TMDL needs if the monitoring design measures loads. There are, of course, disadvantages for watershed project evaluation. You have to track land use, land treatment, and covariates like precip and flow over the entire period of record. It can take a long time, longer than maybe a project funding will support. Most statistical analysis tools for trend analysis don't like to have big gaps in the dataset, so you hope to not have a lot of missing data. It's also very vulnerable to major land use changes. It's quite typical, especially over ten-year periods, that we see urbanization -- excuse me -- for example in agricultural watersheds, which has a -- could have a major effect on water quality. And finally, you can't change the sampling regime or the laboratory analysis method over the entire study period. You can't switch over from soluble reactive phosphorus to total phosphorus. You can't change the method in the lab.

Slide: Above/Below

Turning to the above/below design, the purpose is to assess the water quality impact of isolated sources, determine the effectiveness of the set of BMPs that are implemented at these sources, and basically what you have is two monitoring stations, as shown in the diagram. You have an above station which monitors an area that is not going to be treated just above the treated area, and a below station that monitors the area, the added area that receives treatment.

Slide: Above/Below (2)

Statistically, data from an above/below design can be analyzed by a number of approaches including a paired t-test comparing above and below values. Non-parametric t-tests, of course, can be used if the data don't meet the requirements for parametric statistics. We can compare regression relationships between concentration of flow at the two stations. And if we sample before and after BMPs, you can adapt a paired watershed approach, using both analysis of variants and analysis of covariates to compare the data from the two drainage areas.

Slide: Above/Below (3)

Again, sampling is at two stations instead of one, and they need to be paired, collected on the same schedule for the same time period. So they can be grab samples, storm samples, or composite samples, and they can -- sampling can be based on chemical variables as well as biological variables. And of course, again, where loads are important for TMDL reasons or other, you need to measure flow and sample during the high-flow events that carry most of the loads.

Slide: Above/Below (4)

Advantages of this kind of design, it's not as vulnerable to climate variability as a single watershed. It's widely applicable. It's useful for isolating critical areas where BMPs are going to be targeted, if that is going on. And, as I mentioned, if sampling is conducted before and after the treatments go in, you can treat it as a paired watershed situation which is analytically fairly rigorous. Disadvantages, the upstream area, if it's a highly contaminated upstream area, those concentrations and loads can overwhelm any small changes that are demonstrated by treatment in the treated area. There may be differences between the upper part of the watershed and the middle part of the watershed, for example, caused by geology or land use patterns. Those can be addressed by pre- and post-BMP monitoring, if possible.

Slide: Not So Useful Monitoring Designs

There are, of course, some not so useful monitoring designs. Something that's been quite common but is generally not a good idea for this kind of purpose is side-by-side watersheds, where one watershed is not treated, the other is treated, and the difference between the two watersheds is assumed to reflect treatment. And that's almost never the case because watersheds are never identical even if they are, in fact, side by side.

Slide: 4. Determine Study Scale

The fourth step is determining the study scale. In this particular case, the scale is pretty much assumed to be a watershed scale starting around the HUC 12 level. It's been our experience that smaller, more responsive watersheds that may, for example, have shorter lag times in system response, perhaps down to a HUC 14 or smaller, are going to be more likely to yield measurable changes or water quality results during a short monitoring period. Given that, watershed scale monitoring is good for trend analysis, trend monitoring, and watershed project effectiveness. Watershed scale is moderate to high cost compared to, say, a plot study or a field study. Watershed scale monitoring needs to be seven or more years in duration to be successful. And typically, but not always -- and there are ways to assess this that need to be addressed -- but typically, sampling is weekly or biweekly and often uses automatic sampling. That's sampling for chemistry. Biological sampling is, of course, different.

Slide: 5. Select Variables

Steve Dressing
Now moving on to step five of the 12 step plan, selecting variables, again, they need to be focused back at the study objectives, whether you're quantitative or qualitative, whether you're looking at condition, perhaps using biological parameters, or looking more at chemical, physical pollutant type focus. Also, what is the type of the water resource that you're sampling. We're assuming here surface waters with a focus on stream systems. What is the use of the problem? What's the difficulty and cost of analysis? Also, whether or not you could use covariates. You may find that stage will work for you just as well as flow if you're doing grab sample. And a little bit on needing to prioritize your selection of variables and keeping it simple rather than just going with the whole menu. Pick out what you need, what provides utility, and what kind of surrogates might you use.

Slide: Variables

For agricultural sources some of the likely candidates are DO, BOD, flow, sediment measures, nutrients, indicator of bacteria, macroinvertebrates. And when considering the difficulty and cost of analysis, some things are really cheap, don't cost more than the people, and actually labor is a major cost in most monitoring. But temperature, pH, and conductivity are relatively inexpensive. You need to consider do you want to go with a chemical approach or, say, a macroinvertebrate approach. Again, that ties to your objectives, but within a certain set of objectives maybe one or the other works better for you because of difficulty or cost. Sample holding times can be an issue if you're using automatic samplers, where the sample sits for a week, versus grab samples. Preservation of samples is an important consideration. Also, the range and accuracy of the methods that you're using. If you're using, for example, test strips versus an EPA method, you may find that the range and accuracy are inadequate to look -- to detect the types of changes that are most likely in your watershed. But all these things need to be considered.

Slide: Variables (2)

And as we talked about a few times already, covariates are very important. Flow is clearly important if you're looking at suspended sediment and particulate types of parameters. If you're looking at, say, eutrophication in a lake, there's a suite of parameters that you might need just to be able to tell the whole story. A similar thing with fish, that DO, temperature, substrate, and shade all have been shown to be important factors in what you find when monitoring fish. So covariates need to be considered, as well.

Slide: Which Form of P

And then things like Don mentioned a little bit about different forms of phosphorus. You need to, based on what the details are for the particular variables and the applications, make your choices. Rather than picking them all by default, make -- go through an analysis and pick the ones that work best for you and can give you a situation where you're getting more information per dollar spent.

Slide: TSS or SSC

Total Suspended Solids or Suspended Sediment Concentration. Research has shown that TSS underestimates loads by 25 to 34 percent. We're not saying you need to do SSC versus TSS. This is just another bit of information that you should factor into your decisions.

Slide: Variables Selection Process

Talked a bit about needing a selection process. These are some of the factors that you might bring into play here, what are your objectives, the cost, logistics I mentioned. Preservation, collection and analysis, where's the nearest lab? You know, the sample types that you're collecting, are you collecting grabs, automated samples? Where are they being collected? And also, how you do all of this, which variables you select, can affect what your requirements are for creating a monitoring station and those costs, as well. So considering all those factors, perhaps rank them, some kind of ordering system to determine what's most important to you. Even write down a justification for each variable, and then make your choices based upon this type of analysis. Because once you commit to it, you know, you're in for seven, nine years. And the costs do add up, and if you make a mistake, you're going to regret it later. So it's important to do this thinking up front.

Slide: 8. Sampling Frequency Issues

Now a little bit of step eight. Now we skip to step eight, sampling frequency issues. It's important to just keep in mind that the sample frequency and the number of samples over time that you need to collect to meet your objectives it's going to vary with your objectives, also with the actual values that you're starting with. That has an effect, as well. If you're looking at estimating the mean or a detection of change, we have this minimum detectable change analysis. We're not going to get into that today, but you can use information from samples who already have collected to give an estimate of how frequently and how long you need to sample to measure certain levels of change that you might anticipate. But these decisions about frequency, again, you need to make these choices up front because, as Don pointed out, say, for example, with trend analysis, you can't change what you're doing over time and still expect the statistics to support you. They abandon you if you change too much over time.

Slides: Autocorrelation

One of the things associated with sampling frequencies is autocorrelation. Many of you are probably familiar with this, but for those who aren't, it essentially means that your subsequent samples are influenced by your previous samples. It's like the kid in the back of the car. If they keep asking, "Are we there yet," you're going to give them the same answer because nothing has changed. That's kind of like what happens with autocorrelation. And what happens is that when you sample more and more frequently, you find that each sample gives you less than a whole sample's information. So your effective sample size essentially isn't as large as you think it might be.

Slide: Rho (ρ)

And a measure of this is Rho, the coefficient of autocorrelation. And it describes the relationship between the current value and its past values. And for example, looking at Tuesday's total P concentration versus Monday's, are they related -- or versus last Tuesday's? Rho measures that relationship, and the bigger Rho gets, the stronger that relationship is. And that also means, then, that each sample that you collect subsequently has a little less information, so your effective sample size is reduced. So for example, your relative improvement in your estimate, say, of a mean or a minimum detectable change decrease, actually, as the sample size increases. But it's important to know that this does not mean that less frequent sampling is better. It just means that there's a point where increasing sampling frequency no longer provides a meaningful or cost effective improvement in the information obtained. For example, if you're doing monthly sampling, you probably don't have much autocorrelation. If you go to biweekly, you introduce a little of that. And I'm telling you this based on data that have been analyzed by us and those who work with us. And if you go to weekly, you can find a pretty strong autocorrelation which in some cases may indicate to you that biweekly is probably what we need to do for a cost effective monitoring rather than weekly. But again, this varies with your situation, so an analysis has to be performed.

Slide: Lag Plot

This is an example of a lag plot, a lag-1 plot, where on the X axis you have streamflow at time t-1, and the Y axis is at time t. The line basically shows you that those two samples, t-1 and t, are very strongly correlated. So you have a strong case of autocorrelation demonstrated here. Next slide will be you, Don.

Slide: 11. Define Land Use Monitoring

<u>Don Meals</u>
Thank you, Steve. We're going to change gears a bit and move to step 11 and talk about land use/land treatment monitoring. This is an activity that is as important as water quality monitoring. To answer the fundamental question of the project, you need to monitor land use and land treatment to measure the progress of treatment, to assess changes in pollutant generation, and to explain changes in water quality. It's -- even though we can't really hope to clearly document cause and effect, land treatment is, in fact, a cause of the effect we're trying to find. So it's necessary to take a look at that.

Slide: Basic Land Use Monitoring Methods

Basic methods are pretty simple. Direct observation, drive around, look and see things like conservation tillage is pretty easy to note at certain times of the year. Cover crops, similarly. Producer records and interviews, asking farmers to keep log books, sending someone, a trusted person, out once or twice a year to retrieve those records has been useful in the past. Agency reporting, although there are sometimes issues with confidentiality, at a certain level of aggregation you can get information on what's been implemented in a watershed from agencies like NRCS. And remote sensing is possible for things that are visually observable, either from an airplane or from a satellite in some cases.

Slide: Scale

It's important to think about the scale, just as in water quality monitoring, the scale of land use/land treatment monitoring. There are several different scales that need to be considered. The first step might be called characterization. When the project is just beginning, you need an initial snapshot of land use land cover, looking at the parameters that are relatively static, such as water bodies, highway, impervious cover, and broad patterns of ag, urban, and other land uses in the watershed. There are variables in information that requires you to look annually. For example, unless you're looking at a double cropping situation, generally, at least in my part of the world, an annual look at crop type will tell me whether a field is being used to produce corn or to produce hay or soybeans. There are other kinds of information that need to be looked at weekly or on an as needed time basis to identify specific dates and times of critical activities like manure application, herbicide application, tillage -- urban areas, construction and street sweeping are other examples. And some types of land use/land treatment information needs to be looked at quantitatively, not just presence or absence, but what rates of fertilizers or herbicides were applied? How many animals are out on pasture? How many animals have access to the stream? What's the traffic on the logging roads, et cetera? So you need to look at these land use/ land treatment at a variety of scales and schedules.

Slides: Variables, Look for the Unexpected

The variables that you select to try to capture clearly have to be relevant to the water quality problem and relevant to the water quality variables that you selected. There are variables that you should expect to change as a consequence of BMP implementation, and you may need to be somewhat creative, not just stopping with acres under grazing management or acres under nutrient management, but the number of animals and the time spent grazing in a riparian zone or the amount of manure applied and when. Look for the unexpected. Don't simply look only at areas where BMPs are planned or are implemented because they're not the only parts of the watershed that contribute to what you're observing in the stream. Look for unplanned land use changes. If somebody decides to convert some ag land into a shopping center or some forest land into a corn field, those are important things to know. And you also need, if you've got a control watershed or a control area such as an above/below design, you need to look equally in the control watersheds as in the study watersheds to make sure you know what's going on in both.

Slide: BMP Verification

A related subject that is -- pertains mostly to longer-term projects could be termed BMP verification. There may be reports from an agency that says, yes, we signed this number of contracts. We put in this number of BMPs and signed off on them. A long-term project needs to look at the specifications of those practices. Were they implemented according to the standards and specification? Are they being maintained and operated even after the contract period expires? Are the management activities, such as nutrient management, are they being conducted according to the standards of the practice? And finally, are there any situations where the BMP, the capacity of the BMP was exceeded, if a high flow blew out a wascot, for example, or if fences were washed away by a flood. So that is a long-term activity, to just verify that your treatment measures are out there and working as you think they are.

Slide: Land Use / Land Treatment Monitoring

Here's an example of the kinds of variables that might be considered for a couple of different purposes. The first row of this table, the water quality variable, being suspended sediment, perhaps from crop land erosion. On a weekly or frequent basis, you would need to perhaps know the date of tillage operations, what kind of tillage equipment, where the crop canopy was in its seasonal development, and if there's a cover crop involved, whether the cover crop was adequately dense to actually provide some protection. On an annual basis you might need to know the acreage of land under reduced tillage, acreage served by terrace systems, acreage converted to permanent cover, et cetera. For nitrogen or another nutrient, you might need to look at fertilizer and manure application rates, forms, dates, methods of application on a very frequent basis. On an annual basis you might need to look at the number and acreage of farms that implemented nutrient management plans, or you might look at the annual fertilizer and manure and applications per acre or the legume acreage on a given year. Those are the kinds of variables that might be appropriate.

Slide: Analytical Approaches

Analytical approaches, a little bit less well developed than the statistical tests we commonly use for water quality data. You need to align the temporal and spatial scales of the land treatment data with the water quality data, match the data on a seasonal or annual basis, and tools like regression, if you have a number of years of data, can be important. But most important thing is to have a plan to begin with on how you're going to relate the land use/land treatment data with the water quality data that you collect.

Slide: 12. Design Data Management

And the final step of the 12-step program is to consider data management issues. Any project like this is going to generate a tremendous amount of data. It may be acquired anywhere from pieces of paper to digital forms, either downloaded to a computer in the field, laboratory reports, data pushed over a cell phone line. You need to figure out how you're going to store the data. Very important to examine the data frequently; don't let it accumulate, especially in a data logger in the field, but also in your computer on your desk. Look at those data frequently. If there's a problem, it's better to catch it within a month or two than within a year or two. Believe me, it's happened to me. You don't want to have to throw away a lot of data because you failed to look at it frequently. Reporting is very important. Nobody likes to write reports, but you need to report frequently to keep everybody informed, to make sure you look at the data again, and need to have a plan and resources allocated for major milestone reports and not let that get short-changed at the end of a project so that nobody knows all the great things that you were able to accomplish. And with that, I think I'll turn it back over to Steve.

Slide: Possible NWQI Scenarios

Steve Dressing

Okay. Just a few more slides to go. We've discussed this a little bit already, but possible scenarios for the NWQI, for example, implementation could occur after or slowly, say, during the first couple years of monitoring with an accelerated completion of those BMPs within, say, three to five years of the monitoring beginning. And in that case, you may find, as mentioned earlier, that a step change is possible to see in your water quality. This of course assumes that the BMPs implemented in those five years have a rapid response, i.e. a short lag time. Another possibility is that the implementation is essentially completed during the first couple of years of monitoring. In that case, if you have a little bit of lag time, you might be able to have a good situation for monotonic trend analysis, seeing a gradual change over the years. If your implementation drags out to, say, three to five years rather than the one to two, then maybe you'll find you need to monitor beyond seven years to show improvement. Another possibility is that implementation occurs throughout your monitoring period, there's no clear precondition or clear completion date. And, you know, just as the water quality agencies don't have control over -- a lot of control over what happens with NWQI implementation, USDA doesn't have the ability to tell farmers exactly what to do and when to do, either. So there are limitations in what they can deliver in terms of timing, and so you may find this kind of thing happening. In some cases it may be that it's worth skipping some years in your monitoring, but you still need, in the water quality monitoring, you still need to know what's going on in the land treatment/land use. But spreading out your monitoring dollars over time might be the way to do this, and of course, that then leads you to a longer-term monitoring effort.

Slide: Monitoring NWQI Projects: A Few Options

A couple of options that we see for the designs that you come up with. We talked about single-station designs, either the trend analysis or before/after, and then the above/below design. You could do biological monitoring. You know, that's generally going to be twice a year. Or maybe you do nutrients or sediment. And, you know, some of the options are monthly, biweekly, or weekly. You could do flow-weighted composites if you're looking at load, or you could do concentration. The timeframes, generally looking at something that's going to be probably a minimum of seven years, maybe nine. Again, we're not setting policy. We're just saying that is what we've observed with past projects, that maybe the first four years, up to four years, could about when the implementation occurs, and then you have to continue beyond that to see those effects. With greater lag time, that means longer. Land use/land treatment, Don just talked about. Maybe you're going out there looking at things twice a year, but there's some things, as he mentioned, you need to look at more frequently. Again, this varies with your watershed, your situation.

Slide: Cost Spreadsheet

We -- actually I -- developed a cost spreadsheet that we've used in a number of ways over the years, and I think it keeps getting better. But what we use it for is estimating the cost of monitoring programs from the beginning, from QAP development to the production of final reports. We've found that in past projects, in many cases, budgets weren't provided for people to write reports. And there's a lot of details, as you know -- those of you who work in state agencies in particular know that there's a lot of costs out there that sometimes people don't think about. This is designed to cover all those costs. Looked at equipment, services, sample analysis, which I found from various websites, costs for them in some watershed projects. We've got several monitoring designs built in to this spreadsheet, different types of variables. We'll also include land use treatment tracking. There's a lot of labor involved in that sort of thing. And although we're not showing them here, we're able to, as part of that assistance that was mentioned, we could provide cost estimates if that's something people need. And there are lots of things we can do with that that we would talk to you about at that time, but we do have the ability to give some estimates, which can be very useful in planning up front to know what's feasible for you in the long-term.

Slide: NWQI Example: Broken Sword Creek, OH

Now, here's an example. There's currently an NWQI monitoring project at Broken Sword Creek in Ohio. Just briefly, the monitoring there is designed to assess and characterize baseline water quality conditions prior -- prior to full implementation of the NWQI BMPs. They're looking at biological conditions. Those of you familiar with Ohio know that they have a very robust biological monitoring program. They're also looking at relative concentrations of nutrients and other variables. They're looking at the physical habitat influences on their biotic integrity. Clearly, they're looking at beneficial use attainment status. And one of the other things they're looking at in their current plan is to confirm or revise the causes and sources of beneficial use impairment that they determined several years ago. And this is often something that happens in watershed projects, is you have a scant database to start with, you make some assessments and judgments about your problems, but you need to get a little more data to be a little more sure. And that's one of the things going on there.

Slide: Final Thoughts on Meeting the Challenge

Now, just some final thoughts on meeting the challenges you have, just kind of a -- revisiting some of the topics we've mentioned, explanatory variables, tracking, practice implementation, how to deal with the weather, lag time, autocorrelation, and then a brief example to show you something, a project that was done in the past under the 319 program.

Slide: Separating NWQI from Other Influences in the Watershed

Separating the NWQI from other influences in the watershed, as we mentioned, you may not want to do that. But if you do, because there's less experimental control, there's a far greater need to document with explanatory variables. Because you're in a watershed, you don't have the tight research type of experimental design that, in many cases, can factor out some of the different things that could be causing your results. So in a watershed project, you need to collect the information on all these various things, these explanatory variables, so you can tell your story better. One of the things that you should be doing is inventorying the NWQI versus the non-NWQI practices that are implemented at the beginning of the project. It may be separate and catalog to the degree possible the pollutants and source magnitudes that are -- the magnitude of the sources that are addressed by those practices. Where are they? What are the delivery pathways to your water resource that you're monitoring? What's the anticipated timeframe for those practices to have an effect on measured water quality variables? And you'd also want to use the same tracking and variables that you used for NWQI for the non-NWQI practices so you're looking at things in the same way to the extent feasible. You may find that you'll have a greater likelihood of detecting the effects of the NWQI practices if there's room for -- more room for additional effective BMPs that you implement rapidly. In other words, if when you start monitoring in your watershed project and pretty much everything is done, it's on the ground, you're not going to be seeing, unless you have that lag time I talked about earlier, you're not going to be having much opportunity to effect additional change during the period in which you're monitoring. So it's important to know what your starting point is to have a sense of what your potential is for seeing changes over time.

Slide: Accounting for Weather Variability

Looking at weather variability, one of the ways, as Don mentioned, to address that is you just monitor longer. You should, again, be consistent in how you track your variables, including precipitation and flow. If you could do a baseline period, which we talked about before, that would be great. I think the reality of these projects is you may not be able to get that pre-NWQI period. The weather doesn't just affect water quality. As you know, it affects your sources, as well. It affects BMP performance and the water quality response. And Don mentioned, in tracking implementation, you know, it's important to know whether the BMPs were tested in situations beyond their design. That's an important part of interpreting your results. And you know, it's also -- you need to expect that weather is going to be wild -- it always gets wilder every day -- and have a plan to deal with it.

Slide: Dealing with Lag Time

Dealing with lag time, it's not a new topic anymore. You just need to recognize it's going to be there and even plan for it. This -- what helps here is when you know your watershed better. Consider the lag time in BMP selection. Don showed a slide with riparian forest. They take a long time to grow. Some other things, you can put them in place and they start working the next day. It's important to have a sense of these things. Also, when you're siting the BMPs, how close are they to the receding water that you're monitoring? Another way to deal with lag time is look at smaller watersheds that are closer to your sources. Again, select your indicators carefully. Don mentioned earlier about the use of models. Get a range of estimates instead of single values. And then, design your monitoring programs to detect the change that you think is feasible in that watershed.

Slide: Dealing with Autocorrelation

Dealing with autocorrelation, it's something you can't really prevent. Some people try to do that, though, by aggregating the data. In other words, you take in your weekly data and -- or daily data and aggregate it to weekly, or weekly and aggregate it to monthly, and so on. One of the problems with that is you lose information. You lose the information from those individual samples. If you sample less frequently, you have a similar problem or another problem in that you lose information because you're missing the big events. In runoff situations in nonpoint source watersheds we all know that the big storms deliver the biggest part of the loads. And if you're taking samples less frequently to avoid autocorrelation, you're more likely to miss those loads. So the best approach is you recognize that it exists, adjust for it in your data analysis. We can talk about how to use Rho and that sort of thing perhaps another time. And you can reduce autocorrelation a little bit with prudent planning, for example, doing biweekly as opposed to weekly. And again, that's not a general rule. That's just something that might be the case in your situation.

Slide: Sycamore Creek, MI (1990–1997), Willow Creek Subwatershed (Suspended Solids)

Now, for an example, Sycamore Creek was a 319 NMP, National Monitoring Program, project in the '90s, and this is from Willow Creek, one of the sub-watersheds they monitored, looking at suspended solids. Their first step, they did -- this is an example of the kind of analysis that you might be able to perform with your data if you follow, basically, the steps we've talked about today. First step was a look at changes in water quality. Their BMPs in this case were implemented gradually over time, so they looked for a monotonic trend, and Gary Grabow of NC State University helped them with their analysis. The explanatory variables they used were discharge and peak flow. They logged transformed discharge, peak flow, and total suspended solids concentration data. Those of you who have been dealing with nonpoint data know log transformation is very commonly used. They found that the TSS was correlated with both discharge and peak flow, and they looked for autocorrelation and found that they didn't have that. And then they developed a regression analysis, which you see below, which indicated a 60 percent reduction in suspended solids. So they demonstrated a change in water quality.

Slide: Sycamore Creek, MI (1990–1997), Willow Creek Subwatershed (Suspended Sediments)

Step two, correlating that change with land use. They had a few variables they tested, percent land in no-till and percent land in continuous cover, and then they added those variables in a multiple linear regression with the peak discharge and flow. They found a negative regression coefficient for percent land in no-till, which is a good thing because as the percent of no-till went up, the suspended solids went down. And they found that that was statistically significant. They also, however, because they were looking around at other things which we've also talked about, they cited an analysis of sediment sources to indicate that stream bank stabilization may also be responsible for the reductions they found in TSS. And this just illustrates why we collect all land treatment information rather than just what is contracted under a specific program. These other changes in this stream bank were not the initially the things that were focused on, but they looked at them and they found that that helped them explain the data that they had.

Slide: Working Together to Protect and Restore Our Water Resources

So that's it for the topical presentation. I just want to leave this last slide up. This workshop in Cleveland was mentioned at the beginning, and here are the details. There's a website on the bottom if you want to get additional details on that. We hope that some of you at least will be able to show up there. That's it on our presentation. I guess we're ready for the Q and A now, Erika.

<u>Erika Larsen</u>
Yes. Great. Thanks, Steve and Don, for that. And if there are questions that come up, please type the questions in the "Questions" box. We'll do our best to answer as many of those as possible. We have about 15 minutes now for questions. So we have one that's come up. This is directed to Lynda, and the question is: This is all sound monitoring design but the time step -- so for seven to nine years -- doesn't fit with the time step established under the NWQI initiative to have measurable improvement in three to five years. So how do we address this as the policy makers who will be judging the efficacy of this system?

<u>Lynda Hall</u>
Okay. That's a very good question. And before answering it, I just want to say -- add my own thank you to Steve and Don for the presentation. I know it was a lot of material for folks to absorb, but I think it was an excellent overview of the issues, issues many people on the line are familiar with but, I think, covered in a level of detail that I'm sure was helpful to many folks. And also, again, always tying it back to what does this mean for practical designs for monitoring NWQI, and what are the steps that can be taken to try to mitigate against the challenges we know that we're dealing with? So to get to this question, I think this question is getting at the tension that we always face. We face it more broadly in the 319 program, and we'll face it in the NWQI, as well, which is the tension between the realities we've just spent a lot of time talking about and listening about in terms of what it takes to get to a point, even with a lot of good nonpoint source management practices and ag conservation practices, to get to being able to document a water quality change. And we know we've been beset with that challenge in the Nonpoint Source Program all along. So I think -- but I think it's a very good question here because the NWQI is a very high-profile initiative, and there are, I think, very high expectations for its execution and for continued collaboration between the agencies at all

levels on it. And there is a real expectation for results. However, I will say I think we are fortunate that OMB, I believe at this point, and other important program overseers that would have an interest in NWQI, I think, because of the benefit of discussions we have had over the last year, year and a half, I do believe there's a pretty broad understanding that we will not be able to deliver measured water quality results in a few years within this initiative. And that, I believe, is understood and that everyone that I've engaged with at levels here in headquarters does recognize that fact. So I think we have that understanding on their part, and so they know that they'll be looking at -- they should be looking out years for measured water quality results from NWQI. But that said, I think it's a perceptive question because there will still be, I think, a keen interest in tracking progress and in having some interim measures of progress under this initiative that will be able to describe efforts underway here in the next couple or few years. What those interim measures are is a conversation that we've started between USDA and EPA. We don't have a final suite of things to discuss here today, but there will likely be a role for perhaps some modeled load reductions or some ability to track activity in the watersheds. Certainly, OMB will be interested in progress on getting monitoring underway in the watersheds. So I think there will be milestones and interim measures of progress that we'll be asked to provide in the near term while we wait patiently for the water quality results to come in.

Erika Larsen
Okay. Thanks, Lynda. We have a few more questions. One here is to better define or explain what the beneficial use support status is. So Steve or Don, can you address that question?

Steve Dressing
Well, by that we're simply talking about a designated use, for example, aquatic life, whether or not it's partially or fully supported. That's basically what we're talking about.

Don Meals
Frequency of beach closures because of fecal indicator bacteria might be an example.

Erika Larsen
Okay. And another question here: How do you account for small amounts of BMP implementation in a moderately sized system with a short timeframe for expectation of results?

Steve Dressing
That -- I guess I'm interpreting that question to be if you're in a big watershed and you don't have a lot of implementation, how are you going to get measurable results? And I think the answer to that is it's unlikely. You want to add to that, Don?

Don Meals
No, it's certainly been something that's happened before. That's why it's important to plan and at least have the expectation that you're doing enough to affect water quality.

Steve Dressing
And you may want to target the monitoring to -- assuming that that small amount of implementation is perhaps concentrated in a certain area, you may be able to target your monitoring toward it so that at least you can have an indication that, okay, we've done this much. We have this much improvement or change in water quality that we can measure. Now, if we did the whole watershed, perhaps we could expect even better, bigger results.

Lynda Hall
Yeah. And this is Lynda. I'll add to that. I mean, I think this gets back to the point that we've talked a lot about so far in earlier calls, which is this is why state monitoring agencies need the information on practice implementation, because if it is just a couple scattered practices in a watershed, you need to know that. It's not going to be -- it may not be worse monitoring, or as these folks were just saying, you want to do it on a smaller scale and try to bracket the practices more closely. So I think it just reinforces that need for that information.

I think we had another question come in which was about costs to the states for this monitoring activity. And, you know, we do recognize there are challenges to all monitoring activities right now because of budget cuts we've had across our programs. So that is recognized. Monitoring under the NWQI is a high-priority effort, and we have articulated in the 319 grant guidelines that -- the expectation that states will devote resources to this monitoring effort, either through 319 or through other programs that they're able to use and leverage. So one of the -- what we're trying to do is both put some limits on the number of places that need to be monitored. That's one important reason we're focusing on one watershed per state. There are other benefits to that as well, but certainly a major benefit is it reduces the resources required. And we're also trying to provide this information which we hope will be helpful to some of you in terms of designs and approaches that might make the monitoring as cost effective as it can be. So we know it's tough. We know it's an issue. And this is a high-priority effort that needs to be supported.

Erika Larsen
Okay and we have another question here for Steve or Don about land use changes: How does one factor in significant land use changes such as plowing up riparian grass areas and planting into corn? Would you try to put load for that area back into the model? Would the lag times see higher loads going back into the stream be similar to the lag times for measurable improvement?

Don Meals
That's more than one question. First of all, as the questioner I'm sure realizes, it's important to know that, that that happened. It can be factored into our analysis, and I'll give you an example. The Iowa National Monitoring Program project that I mentioned, with the mapping of the groundwater travel time, their BMP or their land treatment was retirement of crop land and restoration of native prairie . And at some point in the project -- I can't remember exactly which year, but toward the end of the monitoring phase -- they experienced a fair amount of plowing up of grass to put back into row crops. Whether it was driven by ethanol or commodity prices, I can't recall. But they did end up with less reduced tillage -- reduction in tilled land in later years than others. And they were able to correlate that with an increase in nitrate in the stream. So they actually developed a -- they published a regression plot of annual stream nitrate against land in -- land retired or land in prairie and were able to show that when you undid the BMP, as it were, the water quality deteriorated, which is another -- which is another bit of evidence of the effectiveness of the BMP. That may not be possible in every case, but that's something to look for and something you have to know what's going on to get a handle on. Steve, do you have anything to add?

Steve Dressing
Now, what was the second part of that question, just to make sure we've addressed it?

Erika Larsen
Sure. The second is: Would the lag time to see higher loads going back into the stream be similar to the lag time for measurable improvement?

Don Meals
Well, it depended on -- it would depend on what was actually accomplished. If it was something as simple as fencing cows out, for example, I would expect the lag time to be comparable between fencing the cows out and then letting the cows back in. If it was a -- something that the riparian buffer grew up and the stream banks healed from being trampled and eroded and then all of the sudden were bulldozed up, I would expect the negative response to perhaps be quicker.

Steve Dressing
And it's important to point out, I think, that in many of the projects we've seen over the years that deal with sediment, that there's often a failure to look at stream bank erosion and transport within a stream as part of that big picture. And there's often been misunderstanding about the sources and transport mechanisms for the sediment that's measured in the stream. You know, I'll just point out, that's a complicated situation that requires attention to all of those potential sources, and in some cases, projects have done specific analyses of sediment loss from stream banks and that to help them understand better what's going on in the stream.

Erika Larsen
Okay, thanks. And this will be our last question here. It's just a little bit more information about the one-page summaries that states need to prepare, so the target date for submittal. And the question also is: Is EPA planning to approve the content?

Lynda Hall
Okay. This is Lynda. I can take that question. So we will be following up very shortly here, within a business day or two, with an e-mail out to all the participants because we realize that, especially at the beginning there, we went through a lot of dates and information pretty quickly. So we'll be sending a follow up e-mail that will reiterate everything I said at the outset. It will show you the schedule with the date for identification of watersheds for monitoring and the other dates that were laid out there, and it will include the one-page form. It's really basic information. The only purpose for that form is that EPA has a record of the watershed where the state is expecting to focus its monitoring efforts under NWQI. So it's, you know, the basic HUC code, impairments, very brief description of whether you have baseline data for the watershed or not. So the purpose is really just to identify that watershed to EPA and so that we can start to track these efforts over time and know where we're focusing.

Okay. I think that wraps it up. We're about at the end. Thanks very much to Don Meals and Steve Dressing of Tetra Tech for that excellent presentation. They did cover a lot of information fairly in-depth, and especially with some of the questions coming in at the end here, it seemed like it sparked some thoughts and questions for some of you. So what we will also do when we send this follow-up e-mail is ask for your input and ideas on whether there are topics -- they can be topics that were covered here or other topics that you would like to see future webinars focused on. We are committed to having a few of these NWQI monitoring webinars, and I think we'd really like to take our cues from you at this point in terms of future webinars and what would be most helpful. So we'll be soliciting your input on that, and we'll give you a date by which we'd like to hear from you and we'll aim to have another webinar here within the next couple months for sure.