Building Climate Resiliency with Green Infrastructure

Webcast Transcript

Tuesday, July 22, 2014

Speakers:

- **Beth Sawin**, Climate Interactive
- **Alan Cohn**, NYC Department of Environmental Protection
- **Mikelle Adgate**, NYC Department of Environmental Protection
- **Carolina Griggs**, NYC Department of Environmental Protection

Transcript:

Slide: Building Climate Resiliency with Green Infrastructure

Emily Ashton
Okay. It looks like we have a significant amount of folks on the line, so we're going to go ahead and get started. Good afternoon, and welcome to today's webcast titled "Building Climate Resiliency with Green Infrastructure." This webcast is sponsored by EPA's Office of Wastewater Management. My name is Emily Ashton, and I'm an ORISE Fellow with the EPA's Green Infrastructure Program. And I will be moderating today's webcast, along with my colleague, Eva Birk. Thanks for joining us.

Slide: Logistics

Before we get to our presentations, I'd like to go over a few housekeeping items. Let me just advance my slide here. First, we'll have a question and answer session at the end of the presentations. To ask a question, simply type your question in the "Questions" box on your control panel and click the "Send" button. If your control panel is not showing, click on the small orange box with the white arrow to expand it. You don't need to wait until the question and answer session to submit your questions. There are a large number of participants today, so we encourage you to submit your questions as early as you would like. We will try to answer as many questions as possible at the end of the webcast. However, due to the high number of participants, not all questions will be answered. However, please feel free to contact the speakers after the webcast. Their contact information will be available at the end of the presentation. If you have technical issues, such as audio problems, please click on the "Questions" box to the right side of your screen, type your issue, and press the "Send" button. We'll do our best to troubleshoot your issue. You can also call the GoToWebinar support number listed on the screen here and give the assistant our conference ID number, also listed on the screen here. Lastly, we'd like to remind you that the views and materials presented by our speakers today are their own and do not necessarily reflect those of the EPA.

Slide: Agenda

So let's take a look at the agenda for today. What are we going to be talking about? Today we're going to be talking about green infrastructure and climate change. As many of you know, communities are already feeling the effects of climate change now. As different parts of the country become drier or wetter, green infrastructure can improve resiliency by helping

communities manage flood risk, prepare for drought, reduce urban heat island effects, and protect our coasts. There is no one-size-fits-all answer to climate adaptation. However, sharing best practices, learning by doing, and iterative problem solving can help communities choose a suite of adaptation strategies to meet environmental, quality of life, and public health goals.

So now I'd like get to that sharing of best practices and kick off today's webcast by introducing our speakers. First up, we'll hear from Elizabeth Sawin of Climate Interactive. Then we'll hear from Alan Cohn, Mikelle Adgate, and Carolina Griggs from New York City's Department of Environmental Protection. So with that, I'll go ahead and hand it over to our first speaker, Beth, and introduce her as we change to her screen. Elizabeth Sawin is co-director of Climate Interactive. A biologist with a Ph.D. from the Massachusetts Institute of Technology, she trained in system dynamics and sustainability with Donella Meadows.

Slide: The Green Infrastructure Decision Support Tool

She worked at Sustainability Institute, the research institute founded by Meadows, for 13 years before she co-founded Climate Interactive in 2010. For many years, her work involved tracking and assessing pledges in international climate treaty negotiations, but she increasingly focuses on helping people find solutions that prevent future climate change, build resilience to unavoidable climate impacts, and provide opportunities to people who need them most. Using both systems thinking and system dynamics computer simulation, her team is developing tools to help decision makers and residents think about infrastructure investments in the face of climate change. She writes and speaks on this topic to local, national, and international audiences. In 2014, she was invited to participate in the Council on the Uncertain Human Future, a continuing dialogue on issues of climate change and sustainability among a select group of humanities scholars, writers, artists, and climate scientists. So with that, I'm going to hand it over to Beth. Beth, are you there?

Elizabeth Sawin

Yes, thanks for that nice introduction, Emily, and for the chance to speak with all of you. I'm really happy to be here. So today I'm going to get to share a little bit about our work at Climate Interactive on green infrastructure, really as a tool for stormwater management. And I'm going to be talking mostly about work we've been doing in partnership with the City of Milwaukee, although, towards the end, I'll talk about our goals for scaling that up more widely.

Climate Interactive is a pretty small organization. We're a team of nine people, and our niche is helping people see what works to address our biggest climate challenges. And particularly, we focus on the transition to clean energy, food and water challenges that come along with climate change, and opportunities for resilience. And we work both in the US and internationally. Our methodology, some of you may be familiar with, is system dynamics computer simulation. What that means in a nutshell is that we use computer simulation to help decision makers, who we define broadly as everyone from a neighborhood resident to an executive or a government official. We help people play forward the options in front of them regarding climate change and see what the likely impacts are. And we want people to be able to really quickly test lots of solutions and zero in on the ones that meet their values and their vision of the future. We tend to focus on doing this by helping people discover for themselves or see what works. So we don't tend to write reports. Instead, we try to capture the complexity of systems in computer simulations -- and I'll show you what one of those looks like in a few minutes -- that allow people to have conversations about the future they want and the best

opportunities for getting there. And we tend to create opportunities for learning and cooperation through this interaction with system dynamics computer simulations.

Slide: See what works…

So a little over a year ago, we decided to bring this approach to the question of green infrastructure. And we had four reasons for thinking that this would be fruitful. First of all, we felt like people needed ways to see what they might accomplish together when it came to green infrastructure.

Slide: Why a Green Infrastructure simulation? (1)

We observed that often multiple municipalities needed to work together to bring green infrastructure to scale, or different departments within the same city, or private residents along with public organizations. We wanted people to be able to see what they might be able to accomplish by working together. We also felt like, with all infrastructure that's going to be long-lived, that infrastructure is going to end up having to perform in a world that's possibly different than today's world. And that's, in large part, due to unavoidable climate change that's already in the pipeline. So we want people to be able to ask what-if questions about the future so that they can ask, this infrastructure we're about to invest in, how is it likely to perform over its lifetime? We have a strong belief that all impacted groups ought to have a voice in infrastructure decisions. Partly that's an ethical stance, but also just a practical stance, that infrastructure decisions work better if the people who live and work in that infrastructure have a say in it. So for us, that tells us that at least some of the tools at our disposal need to be non-technical. They need to be useful beyond the sort of inner audience of planners and civil engineers so that community groups, neighborhood associations can trust them and use them and believe the data that they're based upon. So that was a goal that you'll see was embedded in how we went about building the infrastructure tool I'm going to show you in a few minutes.

Slide: Why a Green Infrastructure simulation? (2)

And finally, we felt that people needed ways to prioritize amongst all the different options what were the ones that were going to deliver the most benefit toward goals that they defined. And so, many of you probably know, with green infrastructure, there's many different types -- there's green roofs; there's porous pavement; there's rain gardens -- each with a different cost, each with a different effectiveness, each with a different set of co-benefits.

Slide: All impacted groups need to have a voice in infrastructure decisions

And it's a lot for people to keep track of in their heads or on a spreadsheet. So we wanted a way for people to quickly make different mixes of green infrastructure and see what they might get for that.

As I mentioned at the outset, our first learning ground for this approach has been in Milwaukee, Wisconsin, and we've met just a great series of partners, who are shown on this slide. So we, at Climate Interactive, and our colleague, Chris Soderquist, from Pontifex Consulting, are responsible for the simulation itself, the underlying equations and the interface. The Milwaukee Metropolitan Sewage District has been both a financial supporter and an in-kind supporter with all sorts of expertise and also really sharing their data about wastewater

and stormwater in the greater Milwaukee region. I'll talk a bit later about the Sixteenth Street Community Health Centers, which is a local partner that, in addition to being a primary care center, also has a strong environmental health program and an increasing focus on green infrastructure.

Slide: Pilot project in Milwaukee, Wisconsin

And then we've had both national and local funders who are interested in the issue in Milwaukee and then in taking some of what we're learning there and making it useful across the country.

Slide: Kinnickinnic River Watershed

So here, to focus you in on the geography of the pilot region, here's a Google Earth picture of the greater Milwaukee area. So over here on the right is Lake Michigan, and you see this outer ring of green space and then the inner ring of the city itself. Some of you may be able to make out, right here where my curser is, this is the Kinnickinnic River, which is the watershed we ended up focusing on, under the advice of the MMSD, as a really good test case for a green infrastructure decision support tool. The watershed itself that we modeled in this simulation is about 26 square miles, roughly this sort of an area, has about 145,000 people, so it's the most densely populated watershed in the region. Down here you might be able to make out the airport. So if you've ever flown into Milwaukee, that's a part of the watershed that we looked at in this study.

Slide: Map 1

Here we're zoomed in a little bit more, and this is a great tool developed actually by the city of Milwaukee. In the center is this KK watershed. It actually is a little bit broader than what's outlined here. This is the city boundaries. So other municipalities, over here in the left and a little bit over to the right, make up the rest of the watershed. But that gives you a sense of it and a sense of the densely populated nature and also the really high percentage of impervious surface. I think you can see that at this scale.

Slide: Map 2

Here's another look at population, so some of the most densely populated neighborhoods. High percentage of the population in the watershed is minority, many of them Hispanic.

Slide: Map 3

The area had been plagued with some amount of stormwater overflows and things like basement back-ups, and that's why green infrastructure is really on the minds both of the MMSD and of the community groups in the region.

Slide: Iterative Approach

Particularly because of that goal of making a tool that was useful for all the stakeholders in the region, we took a very iterative approach to developing this tool. And so a little bit more than a year ago, we made a very preliminary simulation of the watershed. Through meetings with stakeholders, we showed people what we had. We asked questions like, what's missing? Is

this how things really work? Are these the issues that matter to your constituency? What else should be shown here? Do you have any data that can make this simulation better? We'd get answers to those questions. We'd get new sets of data. We'd go home, and we'd create a new version. We'd bring it back. And so the tool that I'm going to show you today has been through I'd say between eight and ten rounds of this iterative process.

Slide: Input so far from

What that led us to – oh, here's just a list of the types of groups that have given us input so far. And you can see they range from city and regional officials to nonprofit groups, community groups, academics, foundations.

Slide: Simulation structure

This is a schematic that shows you what we ended up thinking was important to include in the tool. So what's shown in orange are the types of things that users can change. So people can allocate investment into either green or gray infrastructure, in terms of millions of dollars, and into eight different types of green infrastructure. They also can allocate support among residents, businesses, and local government. We ended up doing it this way because we heard, at least in Milwaukee, and I think it's this way in other cities as well, that it's not only a matter of money to bring green infrastructure to scale. There also needs to be public support.

So the logic of the model allows investment to flow only to the degree that it's permitted by support. So with full support, you can spend all of the money you've allocated. With partial support, you only spend part of that investment pool. Those two things together, how much money and how much support, get fed into the simulation, which keeps track of the capacity of both green and gray infrastructure in whatever scenario someone has just created. Users also get to think about what's coming at the infrastructure. So how much is it raining, in terms of frequency and intensity? Is there a seasonality effect? In a place like Milwaukee, people are concerned, in the winter, green infrastructure might not be as effective as it is in the summer. And what about things like maintenance? So people are able to change if they think the infrastructure might not perform at its peak sort of optimal effectiveness.

So those things coming together, how much infrastructure you've built, what are the conditions it's operating in, and how well is it operating, all come together in the simulation to give a readout of things like volume and number of combined sewer overflow events. And I should have said that a good portion of this watershed is a combined sewer area. Economic impacts like jobs created, impact on property values. What are the operation and maintenance costs of whatever infrastructure you've built via your investment decisions? Environmental impacts like water quality, energy savings. And there, we're tracking primarily buildings that had a green roof put on them and are having reduced heating or cooling costs. And then, impacts of people who live in the neighborhood, including things like basement back-ups, beach closures, heat island effect, and air quality.

Slide: Demo

So that's sort of an overview of the big picture of what's in the simulation. And probably the best thing to do now is to leave the slides and take you to the simulation itself to give you a

feeling for it. And we won't have enough time to look in great detail, but I can give you a sense of what using a tool like this feels like.

Slide: Differing Green Investment

So in all the outputs that you'll see, you're looking ten years into the future in days. So 3,600 days is ten years. This is the main screen, where people set both the budget to be invested, and the default is based on a study that the MMSD had commissioned for the watershed. It adds up to about $180 million. We've set it up to invest that money over five years. So I'm going to push "Run," and I know there's the potential of a delay over this webinar line, so apologies if this is slow for you. What's happening now is we're running a baseline. And because I haven't set any support from residents, businesses, or local government, in this first run, we didn't green infrastructure. What I'm going to do now, by moving these sliders to about 30 percent, something like 40 or 50 percent, something like 60 or 70 percent, and push "Run," now we've allowed a fraction of these dollars for different types of green infrastructure to be invested. And we're looking here at a measure of the theoretical capacity of, if all that new infrastructure were empty, how much millions of gallons could it absorb? So you see that building up over the investment period, and then it plateaus. I picked these percentages, 30, 50, and 70 percent, because the last time we were in Milwaukee, we surveyed a group of people, and this was sort of their gut feeling of the current state in the watershed of support for green infrastructure. We can play with that a little more. We can say, "What if things change, and there really was widespread support across all of these sectors?" So we'll run the simulation again. So now, instead of spending a portion of this $180 million over five years, the simulation is spending it all. So of course it makes sense that there's just more projects, more total capacity.

Slide: Environment Outputs

What I'm going to do now is page through some of the outputs that we like to show people to compare these three worlds. So remember, dark blue for no investment, red for kind of an intermediate investment, pink for the investment that the MMSD would love to see happen in the watershed. So one output that's very important is the change in the number of combined sewer overflow events. And here we're looking at a cumulative count of millions of gallons. So every time there's an overflow, the line ticks up. So this is our baseline, in blue, improves with that intermediate scenario, improves a little bit more with full investment. We also let people look at things like number of days exceeding water quality goals for things like nutrients and total suspended solids. We have another page that looks at outputs that people in neighborhoods care about, things like basement back-ups, flooding of the river beyond its banks, beach closures, air quality, improvement in the urban heat island effect. And without looking at each graph, because we just don't have the time, I want you to get a general sense of a whole number of indicators and the ability to see that, with more green infrastructure, a lot of these things get better.

Slide: Economic Outputs

We also show, think it's important to show the economic and financial implications. So there's both spreadsheets and graphs about spending. Probably the most important one is here, which is cumulative dollars. This is both investment and operations and maintenance, cumulatively across both the gray and the green infrastructure. So the blue line is just

spending to maintain what gray infrastructure we started out at the beginning of the simulation, has operations and maintenance costs. With a little bit more green infrastructure, costs go up, both in investment and O&M. More green infrastructure, makes sense there's more cost. Down here in this lower panel, we're tracking some of the other economic variables that change with these infrastructure decisions. We show jobs for both construction and maintenance of gray infrastructure. We didn't add any more gray in this scenario, so that's flat. Hard to see much difference, but there's slight changes in MMSD's processing and pumping costs. If there's more green infrastructure, they're handling a little bit less water every year. This shows the cumulative savings in energy that accrue to those buildings with green roofs, changes in property values based on a very simple logic.

Slide: Social Outputs

Probably this could be made more detailed, but just based on what's been seen around the country, that if you have more green space, property values tend to increase. So the scenario with the most green infrastructure sees the biggest effect there. These are the jobs. First you're seeing the construction jobs and then, in the second half of the ten years, the maintenance jobs that come with that additional green infrastructure.

If we go back to this page, if we had more time, one thing we could do would be to play around with this allocation of millions of dollars, asking, well, what if we had less green roofs and more porous pavement? Or more rain barrels and less bioretention? Can we boost this capacity for the same amount of dollars? How do those other co-benefits shake out? And you start to see interesting things, like porous pavement may really help with the amount of water, stormwater that can be managed, but you're losing some of those other values because you're not having the living green space that's helping with things like air quality and urban heat island effect.

Now, one question that you should be asking yourself as I show you things like this is sort of, why should I have confidence in these results? I might want to bring results like this to my constituents. They're going to want to know why they should have confidence in them. In that iterative process, we do as much comparison to historical data as we can. And that's what builds our own confidence that the results here are helpful. I don't have time to show you all those tests, but to give you a flavor for that, I want to show you one of them. So I'm going to go to a different view. I'm going to flip this switch that says "Hughes Historical." So far, in the simulations that you've seen, for rainfall, what we've been using is a random number generator that produces rainfall that's typical of the current rain patterns in Milwaukee. When I flip this switch, instead of that random rainfall, now I'm going to use historical rainfall for a ten-year period. And it's a period where we also had data from the MMSD on the frequency and the volume of their combined sewer overflow events. So if our simulation is working well, you're going to see, in black, the historical overflow events, and then, in blue, what the model is generating when it runs with historical rainfall. So what we're looking for as modelers is having those two lines fit as well as they can, both the amplitude and the frequency. And at this point, we've calibrated and fine-tuned things to the point where we feel pretty good about that. So it's that sort of test, and we can page through a bunch of other comparisons that we made about other variables, and you'll see better and worse sets. But on the ones particularly about where the water goes and the flows of water, we're feeling pretty confident about that. And that's something we could talk about more in the question and answer period if you'd like.

I want to show you one more comparison because it's something that people ask us to do a lot. So first I'm going to rerun the baseline. And then the question we're going to look at is, what if you take your same amount of investment, and you put it into more gray infrastructure versus more green infrastructure? People would like their constituents to understand what you might get out of both of those investments. So I'm going to go to a different view here, and what I'm going to do is add millions of dollars over that same five-year period to different parts of the MMSD's gray infrastructure. So I'm adding storage and conveyance and processing capacity. In the simulation, what that means is that we're spending money to build more types. And Milwaukee has what they have a deep tunnel for storage, so we make that a little bit bigger. So I've put that in. We're back now. This is the baseline that we've seen all along. And we're looking at overflow events. When we push "Simulate," hopefully without too much of a delay, you'll see a red line now. So the difference between the red and the blue line is what that investment in more gray infrastructure is getting for the watershed. So now we want to go back and turn off that investment, and we have to do that sector by sector. Checking those – okay.

And now we'll go back to the original page, where people set green infrastructure investment, and we're going to give full support. So we'll see that 180 or so million now invested in green infrastructure. So that's what now showing in pink. You see at the bottom here, in blue, is our baseline. In red is the gray infrastructure scenario, so no green in either of those. The first thing that we should check is that I did the dollars right. So I did, so here the baseline, in blue, is the least spending of all. Superimposed, these two lines that are pink and red, this is the cumulative spending in the green infrastructure scenario and the gray infrastructure scenario. So that's just saying that these are pretty comparable scenarios. We've got a certain amount of money, and we spend it on one thing or the other.

So let's quickly page through some of the outputs. So here are jobs from green infrastructure, and here we were able to use data that the MMSD had collected about projects in their area, how much construction and maintenance hours went into different types of infrastructure. So we're looking at 180 or so at the peak of jobs in construction, and then plateauing at something like 70 jobs in the maintenance phase. So that's for the green infrastructure scenario. Here's the gray infrastructure jobs. The scale is different. So up here, this says 40, so the data that we have, fewer jobs in both the construction and the maintenance. The processing costs both get better, a little bit. You only see the fuel savings in the green infrastructure scenario. That's because we're looking mostly at green roofs. We only see the property value improvement in the green infrastructure scenario. And we can page back through, if we had more time, through the environmental impacts. So we can see that both scenarios are helping, and important to notice, none of them are completely bringing combined sewer overflows to zero in our analysis. Both are helping about the same amount. Both are helping with water quality. If we look at things like basement back-ups, the vast improvement we're seeing with the green infrastructure. Urban heat island effect, air quality, those are coming along much more with the green infrastructure scenario than the gray. There's a few other things we think are important for people to be able to test. I mentioned green infrastructure effectiveness. We won't have time to do that, but you can see here that there's an input screen where people are able to say, well, I really don't think porous pavement is as effective as you say. Cut that back to 75 percent; rerun the scenario. So for each type of infrastructure, users can change the effectiveness. They can also turn on, if they want, this effect that says that during part of the year, the green infrastructure is not as effective as during another part of the year. And they could say, how much less effective is it? There's another view where people are able to

change the anticipated precipitation. So you could make it more like Milwaukee is expected to be in 2030 or 2050. You can adjust the severity or the frequency of the precipitation events.

So that is a whirlwind tour through the green infrastructure tool, and in the last few minutes, what I'd like to do is tell you a little bit about, from this base, where we see going with this work next. And there's three general areas that I'd like to focus on, so I'm going to go back to the slides. So the first goal -- and I have a feeling, after that very quick demo, that probably many of you are with me in this goal -- is that we've decided we need to develop a much more simple, less graph-intensive interface. So I said to you at the outset, one of our goals is to help people see the full suite of benefits that could come along with green infrastructure. We can show them that now with the tool we have. I'm pretty convinced of that. But to show them that, they have to have the patience and understanding of graphs to follow through – I haven't counted them up lately, but it must be six to ten different graphs, each one for a different benefit. What we've found as we've used the tool in conversations with people in Milwaukee is that some very data-oriented people love it and find it really powerful, but many people, including the types of community leaders and non-technical experts we really want to engage, frankly, their eyes glaze over a little bit with too many graphs. And so we feel like the next challenge for us is how to keep the rigor of the analysis but give people more of a quick at-a-glance way to get the big picture. And so we haven't implemented this in the modeling software yet, but I wanted to show you some of our thoughts about mocking this up just as a design at this point.

So what I'm hoping you're seeing now is a slide with two sets of icons. So picture each of these as a different simulation run. What we've done is develop icons for many of the benefits, so sewer overflows, air quality, basement back-ups, et cetera. And we've created a schematic, where the further to the right the icon ends up indicates the further extent of that particular benefit. So if the screen shot on the top is one scenario and the screen shot on the bottom is another scenario, what we're hoping people will see pretty quickly is, well, if you were only focused on sewer overflows, maybe you'd want to do this investment, the pattern here on the bottom. But look, a lot of other things that we care about aren't coming along with it as much as the first scenario, where we don't get as much sewer overflow benefit, but we're getting a lot of other things we also care about in our community. And maybe people wouldn't be satisfied with either of these, and they'd go back and fine-tune it and find something that was even more of a middle ground. So again, one thing to emphasize is we're not trying to do a study and tell people the optimum infrastructure decisions for their community. We want to empower them to experiment with that for themselves, and we think a big percentage of the value is the conversations that come along the way. So our ultimate vision over the next 12 months or so is to do the computer modeling work to move out of that more graphically-oriented output into something that is more based on icons and graphics and more at-a-glance.

Slide: In development – 'at a glance' output

We're also, with that same idea, thinking about what are the ways that we can allow people to compare a number of scenarios all at the same time. So what we're thinking here -- same set of icons in the same order -- each of these lines represents a scenario someone might have created. So at a glance, you might say, well, although this gray scenario was really good on sewer overflows, we're missing out on a lot of other possibilities. Take a look at this dark green one. It's a little bit worse, but look at what else comes along in that scenario. So we'll be, both

in Milwaukee and other places, building out the tool to have this kind of interface and seeing how that works for people and how it fosters conversation.

Slide: 2014-2015: 2nd goal

The second goal that we have for the next year is to work with partners in Milwaukee to test what so far is still a theory, that giving people this ability to drive their own learning and have their own conversations about infrastructure is going to lead them towards the infrastructure decisions that work really well for them. So we're excited to be partnering with the Sixteenth Street Community Health Centers and the Milwaukee Metropolitan Sewage District over the next year in the KK watershed to structure a series of community conversations that have this simulation tool at its core. So even though it's only 26 square miles, this watershed encompasses decision makers from six different municipalities. The county owns lands, particularly park lands. There's business groups, neighborhood associations, nonprofits. So we'll be carefully selecting and bringing together representatives of all those constituencies, but really in service of their own testing of what might be possible and their own development, we hope, of a shared vision for their communities.

Slide: Catalyzing GI investment in Milwaukee

We're not expecting the simulation to do it all. So the project is being designed to be complemented by both technical support and planning expertise and field trips and site visits to see things like buildings with green roofs or rain gardens. And particularly, we're focusing on bringing together different cross-sections of the watershed that don't necessarily talk to each other, don't necessarily plan projects together. And we're working toward, and think it's quite possible, that we may have an implementation fund available at the end of this period of engagement that's specifically earmarked for projects that are developed through the process of using the simulation to build a joint vision of green infrastructure in the watershed. So that's over the next 12 to 18 months, and I think we're going to learn a lot that will both improve the tool and test the theory that we've seen work in other systems but haven't yet tested in green infrastructure, that you can bring people into a shared vision of investment and action through using things like computer simulations.

Slide: 2014-2015: 3rd goal

The third and final goal that I want to talk about is, I would say, our broadest goal. And so we want to make sure, and our funders have been intent on this from the outset, that what we're learning in Milwaukee becomes useful around the country. And we want to learn what it will take to build off of the core of the Milwaukee tool to make different customized versions that are useful in other cities. And here's what we're thinking about how to get towards both of those goals. We're planning, later this year, to launch an online learning community that we picture being made up of green infrastructure advocates that come from municipalities, from regional agencies, from community groups, from environmental groups. We're going to bring these folks together via webinar, pretty minimal time commitment, we think a few hours per month.

Slide: Sharing insights and customized tools around the US (1)

What we'll be offering is more time, first just to explore the Milwaukee tool, so more that we can do in an event like this with much more back-and-forth communication about what are some of the assumptions, what's some of the data in the tool. We'll be offering access to the Milwaukee tool so people can download it and then offering the support and training they'll need to use it. So there, the experiment is, can you have effective conversations in Atlanta or Houston using kind of, as an exercise, a tool developed somewhere else? Can you bring people together and say let's take a journey to Milwaukee. Let's see what happened there, and does that lead us to want to learn more, understand here in Houston or Atlanta? So we're betting that that will be useful, but that, again, will be an experiment. And then, from within this learning community, we'll be looking for a few cities where there's a team who is willing to invest more time – again, probably it will mostly be online, phone, webinar, and e-mail – to share with us the data about both their gray infrastructure system and the potential for green infrastructure and to see if we can basically swap out the parameters that make this tool in Milwaukee and make it actually a tool that represents, again, say Atlanta or Houston. So we'd be changing precipitation patterns and percent impervious surface and size of the storage and size of the conveyance and so on. So again, pretty much like everything in this project, that's an experiment, how easy or hard it will be to re-parameterize the tool. But that's the most effective path we're seeing right now towards that goal of making something that's genuinely useful around the country.

Slide: Sharing insights and customized tools around the US (2)

And so there may be people on this webinar who could help with part of that. So certainly, if you think you'd like to learn more about what that learning network might look like and what might be involved, the easiest way to keep in touch for now is we've set up a very simple web form on our website. You just type in your name and e-mail, and we'll be in touch once we're ready for the call for applications to that network. We also think that that whole process will be richer and more effective if it's in partnership with others. So we're looking for one or two different professional associations or networks who might like to, in some way, co-host or co-sponsor these learning sessions. So you'll get my e-mail at the end of the webinar, and please be in touch if either of those things would give more lift to your work. I know it would help ours.

Slide: Thank you

And that brings me to the end, or at least the beginning of a description of what we've been up to. Here's my e-mail, and, yes, please be in touch if there's any way that our work could help yours.

Emily Ashton
Thanks so much, Beth. We had a lot of really great questions coming in. It was a really great presentation. So we'll get back to you at the end of the presentation with some of our audience questions, but thanks so much for that great presentation.

Elizabeth Sawin
Thanks.

Slide: Poll

Emily Ashton
Okay. At this time, I'd like to go ahead and run a poll to our audience before we get to our next speaker. So I'm just going to send that out now. If you can go ahead and take a moment to answer our poll, and then we'll go ahead and move on to our next presenters. Thanks. All right. So it looks like we have the majority of our audience voted. I'm going to go ahead and close that poll.

Slide: Green Infrastructure and Climate Change in New York City

And at this time, we're going to go ahead and introduce our next speakers from the New York City Department of Environmental Protection. First we're going to hear from Alan Cohn, who is the Director of Climate and Water Quality at New York City Department of Environmental Protection, where he develops cost effective solutions to advance resiliency and prioritize investments in water and wastewater infrastructure. He leads efforts on flood protection, coordinates regional and national climate change initiatives, promotes green approaches to drainage and water quality improvement, and advances studies of climate change impacts on water supply, stormwater management, and wastewater treatment. Alan works closely with New York City government agencies to coordinate citywide resiliency and waterfront planning efforts and with the Water Utility Climate Alliance to advance climate research, decision making tools, and flexible, adaptive regulations. He managed development of the New York City Wastewater Resiliency Plan and contributed sections of New York City's Comprehensive Waterfront Plan, Green Infrastructure Plan, and PlaNYC: A Stronger, More Resilient New York.

We're also going to hear form Mikelle Adgate**,** a project manager in DEP's Office of Green Infrastructure. In this capacity she develops outreach and engagement strategies for the New York City Green Infrastructure Program, including environmental stakeholder engagement, neighborhood construction notification, and long-term control plan public participation planning. She also drives program and project development for DEP's Green Infrastructure Grant Program, where DEP has committed over $11.5 Million to private partners. Mikelle earned a Master's of Public Administration degree from New York University's Graduate School of Public Service.

Also presenting is Carolina Griggs, Deputy Director of Planning Projections and Demand Management in the Sustainability Division. She has worked on stormwater, wastewater, climate change, and water demand management planning projects. Previously, she has served as an analyst in New York City's Office of Management and Budget Environmental Unit and worked in debt capital markets and agricultural and energy commodities markets. She earned a Master's of Public Administration degree in Environmental Science and Policy from Columbia University and a Bachelor's degree in Government and International Relations from Wesleyan University.

So we're going to go ahead and bring our New York City friends on the line. Are you guys there?

Alan Cohn
Yes, I'm here.

Emily Ashton
Okay, Alan. Go ahead and take it away. Thanks so much.

Alan Cohn
Great. Thank you. So just briefly, I'll provide a quick outline of what we'll be speaking about today. After providing an introduction to DEP, including of description of our water and wastewater systems and how we're planning for climate change, I'll be turning it over to Mikelle to talk about the New York City Green Infrastructure Plan and Program and over to Carolina to talk about quantifying local co-benefits of green infrastructure.

So DEP, or the New York City Department of Environmental Protection, our mission is to protect public health and the environment by supplying clean drinking water, collecting and treating wastewater, and reducing air, noise, and hazardous material pollution. DEP has demonstrated green approaches, including our Watershed Protection Program, which is so successful at protecting the integrity of our water supply that New York City remains one of only five large city in the US that receives a filtration waiver from the EPA. While the system is subject to turbidity from heavy precipitation, there's built-in flexibility and redundancy so that water quality can typically be managed through operational changes, such as relying more heavily on one reservoir when another is impaired. Maintaining DEP's filtration avoidance is a high priority, as the alternative is a multi-billion dollar filtration system and the associated operating costs, energy use, and greenhouse gas emissions.

Slide: A Brief Introduction to DEP

The wastewater treatment system, comprised of 14 treatment plants, treats an average 1.3 billion gallons of wastewater per day. On a wet day, these treatment plants can function at twice their dry weather capacity. Sixty percent of the city's land area is served by combined sewers that are designed to spill into nearby water bodies in order to protect the wastewater treatment facilities once they've reached twice their capacity, which is why is it known as combined sewer overflow. Over the last decade, DEP has invested nearly $10 billion to upgrade wastewater treatment plants and reduce combined sewer overflows, and the cleanliness of New York City's harbor water continues to improve to levels not seen in over a century.

Slide: A Brief Introduction to DEP

Furthermore we are investing in protecting these facilities from storm surge and sea level rise as most of our facilities are located along the waterfront or in low lying areas. Realizing the climate risks to New York City infrastructure, the city institutionalized climate planning with the launch of PlaNYC, New York City's long-term sustainability plan, back in 2007. Along with PlaNYC, the city established the New York City Panel on Climate Change, a body of leading climate and social scientists charged with making climate projections for the city, the first of its kind in the country. A year later, DEP issued its own Climate Change Assessment and Action Plan, which outlined the potential risks of climate change and identified near-term and long-term actions that the agency would take to enhance its resiliency as well as understanding these risks.

Slide: Planning for Climate Change

When Sandy hit, DEP was already in the process of performing a detailed climate study for representative wastewater treatment plants, pumping stations, and drainage areas to determine the potential likelihood and severity of various risks, including storm surge. After Sandy, DEP expanded that study to include all of its wastewater infrastructure across the city to systematically determine risks and resiliency measures to help prevent future disruptions. "PlaNYC, a Stronger, More Resilient New York," released in June 2013, describes the city's holistic resiliency approach. Later last year, DEP also released the New York City Wastewater Resiliency Plan, which describes our approach to protect critical equipment and reduce the risk of damage and loss of services.

The New York City Wastewater Resiliency Plan includes details regarding DEP's efforts to incorporate the latest climate data, not only on sea level rise and storm surge, but on the rainfall that contributes to increased flow at wastewater facilities and combined sewer overflows. We have a lot of data to help us understand how climate may be changing today as well as what might happen in the future. On the left, we see an increase in precipitation around 1970 towards more variability and more extreme events. On the right, the New York City Panel on Climate Change's projections show on the order of a ten percent increase in precipitation. DEP models observe rainfall to understand how it relates to combined sewer overflows as well as the efficacy of various gray and green interventions to mitigate CSOs. Following our review of recent reason rainfall observations, we replaced our previous typical year of 1988 with 2008, a year that is more representative of the last 40 years of observation. Ninety percent of our rainfall events in 2008 were under one inch, and 70 percent were under half an inch, which is important for designing green infrastructure as it is designed to capture the first inch of precipitation.

Slide: The NYC Green Infrastructure Plan and Program

And with that, that brings me to our next topic and the focus of the presentation, green infrastructure, for which I will hand it over to Mikelle.

Slide: Learning from the Past, Planning for the Future

Mikelle Adgate

Thanks, Alan. So to piggyback on what Alan was explaining about New York City, you can see in this map what percentage of New York is served by combined sewers. So that's most of Manhattan and the Bronx, as well as Brooklyn and Queens. In terms of how we're implementing the Green Infrastructure Program, we're targeting our resources and efforts on the waterways that are in most need of water quality improvements.

Slide: Water Quality in New York City

So for those of you who may be familiar with New York City, some of the waterways highlighted in red here include the Gowanus Canal, Newtown Creek, Jamaica Bay, Flushing Bay, and Bronx River and others.

Slide: A Sustainable, Hybrid Approach to CSOs

In terms of the sort of precursors to the Green Infrastructure Plan, Alan mentioned PlaNYC, which was released in 2007. In 2008, DEP released a Sustainable Stormwater Management Plan, and the 2010 Green Infrastructure Plan really built on those two earlier documents and called for a hybrid approach to mitigating combined sewer overflows, using both cost effective gray infrastructure upgrades as well as targeted investments in green infrastructure.

Slide: 2012 Amended CSO Consent Order

In 2012, DEP modified our consent order with the New York State Department of Environmental Conservation and essentially incorporated green infrastructure implementation into our regulatory requirements governing CSO mitigation. The consent order requires that we manage one inch of stormwater runoff from ten percent of the impervious area of the combined sewer areas of the city by 2030. It's done in five-year increments, so our next – our first milestone is coming up in 2015. So we are currently working in building green infrastructure to meet that 2015 goal.

In terms of our program and the amount of resources that have been devoted to it, as well as all of the different strategies that we're incorporating to comply with our regulatory requirements, you can see that we've budgeted over $700 million in the city's ten-year capital plan for green infrastructure implementation. We primarily build in the right-of-way on the city streets and sidewalks. We also retrofit city owned properties such as school yards, public housing, and park lands. We have a grant program, where we provide funding for private property owners, and there's also several other program elements, including research and development, O&M and asset management, as well as outreach and engagement in the neighborhoods where we're building green infrastructure. This effort is led by DEP's Office of Green Infrastructure, but we work very closely with other bureaus within DEP as well as other city agencies. Given the scale of our program and that we are primarily working on city owned property, we work very closely with the Department of Transportation and the Department of Parks and Recreation, and the Green Infrastructure Program really is a full-scale interagency effort.

So to give a better understanding of how this planning and design and construction is taking place, it would be helpful to understand our area-wide approach to green infrastructure implementation. So if you think back to that earlier map that showed the waterways such as the Gowanus Canal, which is what is sort of in this black call-out box, you can see that we identified specific CSO outfalls, and these were selected based on their frequency and volume of CSO events as well as the water quality of the waterway itself. So our engineers backed out from the outfall and drew the tributary area lines to show what portion of the area was tributary to that specific outfall. So in the larger call-out box, you can see that everything that's in blue is tributary to the outfall RH-034. Then we go through and we look at all of the opportunities to implement green infrastructure in that blue area. And that allows us to focus our resources on specific outfalls, try to implement as much green infrastructure as possible, and essentially achieve efficiencies not only in cost, but also the design and construction.

Slide: Area-Wide GI Implementation

So the primary way that we're working to meet our regulatory goals is building in the right-of-way. A significant portion of New York City is comprised of streets and sidewalks, and so we

build what we call right-of-way bioswales, which are the two photos on the left. If you were walking past them, they might seem similar to standard street trees or planted areas. But they're excavated to a depth of five feet, and they're back-filled with stone and soil to take in stormwater runoff that's coming along the curb or the sidewalk. The two photos on the right are examples of our stormwater green streets. They're a slightly different design in that they are designed to meet the under-utilized roadside space of the street. So while the bioswales can be put in wherever we have the appropriate hydraulics or existing street conditions, the stormwater green streets are more unique designs.

Slide: Right-of-way Green Infrastructure

In addition to the right-of-way, we also work with city agency partners to retrofit city owned property. So this is an example of one of our schoolyard projects that was actually an interesting partnership with the Department of Education, the School Construction Authority, as well as the Trust for Public Land.

Slide: Public Property Retrofits

In addition to public property, we do have a smaller grant program where private property owners can apply for funds. And if selected, DEP will cover the design and construction costs for their green infrastructure practice.

Slide: Green Infrastructure Grant Program

And lastly, we do have a very robust maintenance and asset management program.

Slide: Maintenance of Green Infrastructure

Because we have made the case that green infrastructure is an active piece of infrastructure that we are utilizing to manage stormwater runoff and mitigate combined sewer overflow, it was recognized very early on that dedicated maintenance crews would be necessary to ensure that the systems were functioning as designed. So we work closely with the Parks Department on maintenance for all of the green infrastructure in the right-of-ways, and for our projects on city owned properties such as public housing or park land, we develop specific agreements with the partnering agency. And with that, I will turn it over to Carolina to talk about our co-benefit study.

Slide: Quantifying Local Co-Benefits of Green Infrastructure

Carolina Griggs

Hi. So given the scale of the Green Infrastructure Program that Mikelle described, both in economic and physical terms, we committed to measure and monitor the program's effectiveness. So you can find, if you're interested, some preliminary monitoring results or reports on the DEP Green Infrastructure website. There are reports from 2011 and '12 on our stormwater pilots, and there's also more information in our latest 2013 Green Infrastructure Annual Report. But in addition to monitoring the stormwater, the effectiveness of green infrastructure in managing our stormwater, we were also interested in the additional benefits of green infrastructure. And these are what we call – what we've decided to call co-benefits. So these are the non stormwater benefits.

Slide: Green Infrastructure Co-Benefits Study

So in 2013, we launched an effort to identify and quantify the environmental, social, and economic co-benefits of green infrastructure. We first went through a process of deciding which benefits we understood resulted from green infrastructure implementation. You can see these listed on the upper left side of the slide, carbon sequestration, urban heat island mitigation, and reduced energy demand being the most relevant to our topic of climate resiliency. And then we decided on the methodology or the analysis that we wanted to conduct in order to understood and quantify these benefits. And these were -- we wanted to conduct a field monitoring in our pilots, so we wanted to collect preliminary data and identify data gaps for further study. And we also wanted to conduct a literature review to support the development of metrics, quantifiable metrics. And finally, we wanted to conduct a lifecycle analysis to quantify the net carbon dioxide emissions. And we wanted to do these analyses for all of the green infrastructure practices that our program is and has invested in, and these are listed on the right side of the slide.

So the first analysis of this pilot monitoring was interesting. We were interested in very specific New York City monitoring, and that's why we conducted this. And we found some interesting difficulties, such as measuring temperature in a city that has different wind and shade patterns in the different practices. So we went with infrared, in the end, and you can see some of the temperature differentials that we found in our pilots listed here. You can see vegetation in this picture is ten degrees lower than bare soil, and that is about ten degrees lower than the asphalt. In the literature review, we found metrics that we could use in a calculator later that you'll see. Here you can see carbon sequestration. We found methods to correlate vegetation with carbon sequestration, carbon dioxide sequestration, and the effects of increasing albedo and vegetation coverage on urban heat island and the other – the metrics for the other co-benefits.

And the third part of the study was the lifecycle analysis. In this slide, you can see these are the inputs that one can create to put in the software that will give you outputs, environmental impact outputs. So here you have a 20' by 5' bioswale with a tree, and these are the materials. And it's basically an evaluation of the energy and materials needed to construct and maintain this green infrastructure practice in its lifetime. So once you put that into the lifecycle analysis software, you get outputs, environmental impact outputs. And we focused on carbon dioxide equivalents in order to create our tool.

Slide: Cost and Benefit Comparison Tool - Beta

So this is a snapshot of the tool which we are developing now. We're still in beta version, and I would love to get comments. If you want to have a look at it and review it, you'll see my contact information at the end of the presentation. But I will – to get you the actual tool here and show you a little bit about how we've laid it out.

Slide: Demo

So up here on these tabs, we have the different green infrastructure practices that I mentioned earlier. And here we have the benefits. And if you click on the benefits, it will tell you what we found in the literature review, as well as in our monitoring, regarding that benefit in that practice. And the idea here is to be able to quantify the benefits and costs. So we have here, you can insert different practices of different sizes and calculate the output. So here I've

started a right-of-way bioswale. I've labeled it 25 years, and it's a 75-square foot footprint, managing 4,000 feet. And I've given it a 25-year life span and 100 percent herbaceous and shrub cover and one tree and some other non-quantified but sort of quality inputs. And once you put those in, you can hit "Calculate," and it will give you these outputs. And we kept everything in their own units and metrics. We didn't want to convert anything to economic values, except for the actual costs and some other easily – or sort of easy to quantify economic values. And here I have another bioswale example, and I just gave it a different lifespan, 50 years, and it will give you different outputs. And when you've inserted so many different types, you can actually compare them in a graphic area where we're actually still developing. But the idea is to be able to compare different green infrastructure types and their outputs in a more graphic, user friendly way. So here you can see the different bioswales, different years. The one with the shorter lifespan will produce more carbon dioxide just because it's not having as many benefits over the lifetime. And even though we've only done this for green infrastructure in our different practices, we are very interested in doing this for our grey infrastructure at some point. And here, just to give you an idea of how this tool is set up, every question mark has more information on how that number was calculated or come up – how we came up with that number and those formulas. And the "Tool Setup" has the assumptions that we used with more information on where those numbers come from, including studies.

So that's briefly a look at the – our co-benefits comparison tool. And I think there's some work here to do still and look forward to anyone who is interested in reviewing this and working together, as well.

Slide: Conclusion

So finally, I'm just going to go back to conclude our presentation. So we're committed to studying not only our stormwater benefits of the Green Infrastructure Program, but also the additional benefits. And this is our first attempt to do such a thing, and we're looking forward to keeping working on this and make sure that we have the best quantifiable results that we can get and communicate them and use them in our planning of this program.

Emily Ashton
Okay. Thanks, Carolina and Mikelle and Alan. I'm going to go ahead and switch the presentation back to me, and then we'll get to the questions and answers. Sorry. I'm just having one little technical difficulty here. All right.

Slide: Speaker Contacts

So hopefully my screen has loaded now. Sorry about the delay. So first, I just want to thank our New York City presenters. We will be posting the slides after the webcast. So I know there was a lot of questions about whether the presentations will be available, so we will be posting the slides on our Green Infrastructure website. And I would like to go ahead and get started with the question and answer, and the first three questions are for Beth. So Beth, are you on the line?

Elizabeth Sawin
Yes, I am.

Emily Ashton
Okay, wonderful. So the first question we had, I know you did bring up the precipitation screen in the tool, but there was a lot of questions about how to further incorporate climate change projections for precipitation, talking about frequency and duration, and how would a community really use this tool to get started talking about climate change in their community.

Elizabeth Sawin
Thanks. That's a great question. Yeah, I wish that I had had more time to show some scenarios where you could play with the precipitation severity and frequency. What we see playing out in practice is we tend not to lead with those scenarios about potentially more extreme events but often wait until the question comes from the audience. And it's more and more on people's minds, I think. And then the feature is right there to go and take people to look at, what if we made the same investment, but the severity and frequency was more like downscaled predictions for Milwaukee in 2030 or 2050? And there, that's not analysis within our simulation. We're just relying on other studies that have been done. And I think, for most parts of the country, that information is more and more available. And what people see, of course, is that they're hard won investment and millions of dollars spent get eroded as the system is hit with more severe and more frequent precipitation. And I think that's the window of opening for not only do we need to think about how to be more resilient in this community, but also, how do we act at the roof of the problem, and what's our part of reducing greenhouse gas emissions? But generally, you know, waiting until the group opens the question for themselves I find to maybe be the most effective way in.

Emily Ashton
Okay, great. Thanks so much. Another question we had was about a spatial component to the tool. So is there an assumption that green infrastructure is equally effective throughout the watershed?

Elizabeth Sawin
Yeah, also a really good question, and I probably should have been more clear that in system dynamics modeling, in general, we get great resolution about dynamics over time and very, generally, fast-running, simple tools that run on laptop computers. But we give up one thing to get those other things, and that is spatial resolution. So our tool won't be the one that people are going to use to decide exactly where to site green infrastructure. And if we're successful, we think that – we know that in Milwaukee it's the case that there are many other tools ready and waiting with that kind of spatial resolution. So in general, we're doing sort of averages, if that makes sense. So there are some sites that are lower in the water table, some sites that are higher. The effectiveness will be different, and we're trying to pick an average because we don't have that spatial view. And as people learn about the potentials of green infrastructure out of working with our tool, then we'll be thrilled for them to get handed off to hydrologic and other spatial planning tools for more resolution.

Emily Ashton
Great. Thanks for that follow-up on that. Another question we had was, "Do you anticipate a version of the tool for separated sewer systems in addition to the CSO component that you talked about?"

Elizabeth Sawin
Yeah. In fact, I think we're part way there. So the watershed that we modeled has both combined and separated sewers, and so we had to represent both in this tool. And so I think if we were trying to represent another watershed that was all or a majority separate sewer systems, I think we've got the groundwork to begin to do that.

Emily Ashton
Wonderful. Thanks so much, Beth. So actually, we're going to go ahead and move on to some questions for our New York City colleagues. Alan and Mikelle and Carolina, are you on the line still?

Alan Cohn
Yes.

Emily Ashton
Okay. Wonderful. So one question we had was wondering if you can talk more about different incentives that have been effective when working with public partners like the school district and if you have any lessons learned about that.

Mikelle Adgate
Sure. When we first started talking about green infrastructure, a lot of city agencies were very excited about the prospect of it in terms of improved drainage on the site. But since we've been able to add funding for the stormwater management practice of existing initiatives – so again, with that one photo of the Trust Republic Land Project, TPL has a program where they convert schoolyard space into playgrounds. And so we were able to add additional funding to that for the stormwater management practice. So between schoolyards as well as working with public housing and being able to see improved landscaped areas and improved drainage on site, that's been important for the incentives.

Emily Ashton
Great. Thanks so much. And I know you guys mentioned that if anyone wanted to help beta test the tool, they could get in touch with Carolina. But another question we had was, "Is the lifecycle analysis tool being developed as sort of an open source, and can it be used by other municipalities at this time?"

Carolina Griggs
So it's not complete yet, so we still haven't – it's a link, it's a web link, and I can send that out to who is interested in providing comments. But it's not in its final version, and we have changes to make still. But we expect to have that in the early fall. So you can certainly start playing with it, and eventually we hope to have one of the links published on our website.

Emily Ashton
Okay. That's great. And to our audience, if anyone is interested, the contact information is on the screen right now. Since we have a few minutes left, I'd just like to bring up some new web content that EPA has just posted. Let me look here. I'm just waiting for my screen to load. And as you can see, we have redone our home page a little bit and added some new content that is the topic of today's webcast, and that's climate resiliency. And you can find that content under the "Build" tab. It's right here, and I've actually already brought it up on this tab here. Let me

just make sure that my screen is catching up. So we've been working really hard to try to get this content out, and there's a lot of new things here that you can explore about some of the topic areas that we mentioned and how green infrastructure can really help with all these things related to community resiliency. Let me bring back up the slide. And I think, since we are towards the end of the webcast, we're going to wrap it up. I'd really like to thank our speakers today, Beth, Alan, Mikelle, and Carolina, for joining us, and especially to all of our participants for listening in. Please join us for our next webinar, which will be on September 3, 2014, with the topic of "Green Infrastructure and Smart Growth." This ends our webcast for today. We thank everyone for joining us.