MEETING OF THE LONG ISLAND COMMISSION ON AQUIFER PROTECTION

SEPTEMBER 17, 2015

2:06 p.m.

260 Motor Parkway

Hauppauge, New York

Kristi Cruz
Court Reporter

A P P E A R A N C E S:

Stan Carey,
Nassau-Suffolk Water Commissioners Assoc.

Frank Koch
Vice-Chair, Long Island Water Conference

Mike Levy
Long Island Water Conference

Walter Dawydiak
Suffolk County Commissioner of Health

Don Irwin
Suffolk County Commissioner of Health

Chris Ostuni
Nassau County Legislature Presiding Officer

Michael White
Nassau County Legislature Presiding Officer

Sarah Meyland
Nassau County Legislature Minority Leader

Jared Hershkowitz
Suffolk County Presiding Officer

Brian Schneider
Nassau County Commissioner of Public Works

Steve Colabufo
Suffolk County Water Authority

Walter Dawydiak
Suffolk County Commissioner of Health

Don Irwin
Nassau County Commissioner of Health

Paul TeNyenhuis
Suffolk County SWCD

A P P E A R A N C E S: (Cont'd)

John Masterson
USGS

Sandra Eberts
USGS

Don Walter
USGS

Chris Schubert
USGS

P R O C E E D I N G S

MR. CAREY: I'd like to call the meeting to order.

My name is Stan Carey, I'm the Nassau-Suffolk Water Commissioners Association representative. I will be filling in for Jeff Szabo today. Chairman Szabo had an emergency last minute and is unable to attend. Unfortunately I'm only here for about 45 minutes because I have another obligation this afternoon, so I plan on getting through most of our business. We were waiting until we had a quorum, and we have one now, so we'll get through most of the business. I asked John if he would mind doing his presentation at the end, and he said it would be fine.

With that, we will start with the introductions.

Again, Stan Carey, Nassau/Suffolk Water Commissioners

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Association.

If you could before you speak, anyone, the lady asked me if you could just say your name before you speak so she could record the minutes properly.

MR. SCHNEIDER: Brian Schneider, Nassau County Executive's Office.

MR. DAWYDIAK: Walter Dawydiak, Suffolk County Health Department.

MR. DALE: Dorian Dale, Suffolk County Exec's Office.

MR. TENYENHUIS: Paul TeNyenhuis, Suffolk County Soil & Water Conservation District.

MR. IRWIN: Donald Irwin, Nassau County Department of Health.

MR. TERRACINO: Stephen Terracino, U.S. Geological Survey.

MR. WHITE: Michael White, representing the Suffolk County

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Legislation Presiding Officer.

MS. MEYLAND: Sarah Meyland, representing the Nassau County Minority Post.

MR. HERSHKOWITZ: Jared Hershkowitz, Suffolk County --

MR. KOCH: Frank Koch, Long Island Water Company.

MR. OSTUNI: Chris Ostuni, Nassau County Legislature.

MR. CAREY: Thank you, everybody.

Is there anyone from the public that wishes to address the Board or comment on LICAP at this time? No one? Okay.

The third item on the agenda is to appoint a vice-chair of LICAP. We had a change from the Long Island Water Conference. However, I do not believe it's necessary that we do that. The bylaws state that it's automatically, the first two

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years, the representative from the Long Island Water Conference. The conference did send a letter. If we need to get another copy for the Commission, we'll do that. But Frank Koch is actually the official vice-chair.

Welcome, Frank.

MR. KOCH: Thank you.

MR. CAREY: Being this was his first meeting, I didn't want to just tell him you're running the meeting when he walked in the door for the first time. I want to get through and stay as long as I can, and Frank will probably --

MR. KOCH: I'll try and bring it home.

MR. CAREY: Minutes from the July meeting, 2015. Do we have a motion from someone so we can approve them?

MR. SCHNEIDER: I make a motion.

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MR. WHITE: Second.

MR. CAREY: Brian Schneider made the motion and Michael White seconded it. All in favor?

Approved.

That brings us down to number five. We're going to wait for the presentation until the end.

Number six, discussion on the Long Island Water Conference Water Quality Symposium on October 22nd. The Water Conference had requested a speaker to give a brief report on LICAP, where we are in some of our deadlines and how we were formed. So I just wanted to bring it back to the Board to see if anybody wanted to volunteer to give that presentation on October 22nd at Bethpage State Park. If not, either Frank or I will handle that

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in October. Just wanted to bring it back and just not speak on behalf of LICAP.

That brings us to number seven, the subcommittee updates. Steve Colabufo, Water Resource Infrastructure Subcommittee.

MR. COLABUFO: Yes, hi. We have a new chairman of the subcommittee, and we wanted to take this opportunity to the August 12th meeting to follow up with the progress. At that time the joint subcommittee meetings were held on August 12th, September 9th. On August 12th August 12th we had a presentation by Water Authority intern Ron Theofeld on the history of water management plans on Long Island from the late '60s until now. It's kind of interesting to see the similarities and how it's evolved over the years.

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As the subcommittees, we have final outlines for the water management plan, or final overall outline, and we have authors for all but one of the 16 subtopics that were as part of that plan. Bill and I are looking at getting authors for the remaining subtopic, and I believe tomorrow there's a person who may be able to contribute.

The September 9th meeting was held recently. We had requested all the prospective authors of the subtopic submit the outlines by that meeting. Most did; some didn't. We did discuss the outline at the meeting regarding the reports. Hopefully each month several offers will come forward and talk a little bit more intimately, shall we say, about their specific reports. We expect to have the remaining

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outlines by next meet in October, and we hope to have a work draft of all the reports by the end of the year. That may be a little bit ambitious, but we'll try to do that.

The tentative plan is to have all reports finished by the end of 2016 and in the process of finalizing the ultimate plan, which is due I believe in the spring of 2017. So the subcommittee chairs are in the process of getting all the information, handing out offers where necessary, and we will be in the process of over the next six months or so.

MR. CAREY: When is the next subcommittee meeting, Steve?

MR. COLABUFO: It is the 14th of October.

MR. CAREY: Thank you.

MR. HERSHKOWITZ: Could I

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just ask for a clarification? We've gone over this a few times and I'm not real clear on it.

When I read the resolution from legislatures, there are clear directives, and we seem to have moved into this construct of reports from the subcommittees, okay? Now, I guess they could be certainly part of the package that we submit to both legislatures, but it seems inherent or implicit from the resolutions that we propose actionable items relative to the issues facing both Nassau and Suffolk County. Even though in these reports some of them are, most of them aren't actionable items. In speaking with legislatures, this is what I hear they want, or at least that's what they say they want and that's what they meant.

Whether the actual

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resolution and what they meant are the same or not, it just makes sense to me that these reports that we're preparing should all, every single report should result in a recommendation on an actionable item. I know we have recommendations sections in the report that we're going to be submitting, but I think that those recommendations should relate back to the reports and that the reports should be evidence for an actionable item.

MR. CAREY: Okay. So, I mean, myself, I would agree, you know, it's good to sum up the reports with goals and objectives and actionable items, but I'm not sure that we should tell the legislatures how to implement them. So if we get to that level and a decision needs to be made, I believe it would be amongst the

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voting members of LICAP to make that decision on how they want to finalize their reports.

Is there any other business that the Board would like to discuss today before we get into the presentation?

Okay. I'll introduce John Masterson from the USGS.

MR. MASTERSON: Thank you. Thanks for giving us the opportunity to talk about a large study that we did for the North Atlantic Coastal Plain, and I'll talk about how Long Island fits into this.

Again, thanks for inviting us here, and I'm going to talk about this regional study we had done and give you some ideas of how Long Island fit into this bigger picture.

I'm first going to talk about the program that funded it,

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it's called USGS Groundwater Resources Program; I'll talk about the National Goals Program; I'll give you an overview of this NACP study; then I'm going to compare and contrast Virginia and Long Island and talk about sustainability, and I'm going to point out how Long Island looks pretty good compared to Virginia.

Then I was asked to talk about sea level rise, and I'm going to talk about some studies we've done in the past on sea level rise in similar systems, and then I'm going to introduce Sandy Eberts, who runs our mapping and modeling group for another national program, the NAWQA Program, National Water-Quality Assessment Program, and Sandy's going to talk about some new work that's starting here that's specific to Long Island.

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So if we start with the Groundwater Resources Program, the 66 principal aquifer systems in the country, and we want to quantify the resource, see how resources changed, and develop tools to figure out how it's going to change in the future.

What we're talking about is only quantity -- or sustainability from a quantity standpoint. And that's important. We're not talking about water quality in this effort.

So what we do with this national work is compare and contrast -- I'm going to use my broken easel pointer here, so I hope I don't smash your screen. We want to compare and contrast systems like the North Atlantic Coastal Plain with Central Valley, Florida, High Plains, and see how the resource differs across the

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country.

This is part of the national effort. It doesn't mean a lot when you're sitting here at the LICAP meeting, but this is what we're doing for the big picture, and I want to talk about how it relates to Long Island.

We start with this NACP study, and this is a -- the study area goes from Long Island down to North Carolina, and it's bound from the west, what's called the fall zone, which is the contact between the piedmont and the coastal plains. Now, you don't have that here on Long Island, but that's more like a cross-section from New Jersey. But you've got this layered system of confined aquifers and confining units, and then you've got your Upper Glacial on the top. The whole system is bound to the east by the boundary

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between fresh and salt water. So that's the general model for the system.

(Discussion held off the record.)

MR. MASTERSON: What I was saying, the approach that we're taking is to develop a conceptual model for the system, to understand the geology, understand how water enters and moves through the aquifer. And then we take that information and we use that to inform a numerical model, and we use the model for our water quality assessment.

So this is an annotation of that conceptual model. We know the water comes in through recharge, with wastewater return flow, moves through the aquifer, releases in the stream flow or discharge to the coast. If it's captured by pumping, we also get

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an additional source of water, which is the release of storage, and I'm going to be calling that groundwater depletion. I'm going to really try and focus on that today.

Again, this works much better when you go down the coast of the other states. But for Long Island, pretend this is Long Island Sound over here (indicating). But that's our conceptual model.

So what we do is we build a conceptual model. The last time a groundwater model was built for this system was in the late '80s. It's a huge model. You can see where Long Island is in relation to the rest of the model. Their model was seven miles by seven miles. The computing capabilities now allow us to do a one mile by one mile, but it's still on a

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scale that we're not going to be able to tell you the effects of local pumping on Long Island in a particular well field. But I am going to show you some island-wide analyses that we're able to do with a tool like this.

So we start with the population. This is the most densely populated system in the country. We pump about 1.5 billion gallons a day of water from the system. Long Island, you can see, is pretty well represented. Long Island accounts for -- just Nassau and Suffolk pumps about 30 percent of the entire water use for the NACP aquifer system.

So what we want to do is develop the model, pump these wells, and look to see what is the storage release, and also to see how the other components adjust to

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this pumping, and that's the focus of this. How do the budget terms adjust when you pump the system.

So we talked about sustainability, has the aquifer reached equilibrium with respect to pumping and recharge, in other words, the groundwater depletion negligible. You reach some point where you're no longer depleting the groundwater system, and if you are, can you live with what you have, can you live with that condition.

So what we see here, this is the pumping -- each bar representing pumping. For this pumping period, the historical period goes from 1900 to 1985. Our period of emphasis goes from 1986 to 2013. If we go from 2013 to 2058, that's our future condition.

So we pump the system, and

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if you pump it, there's going to be a corresponding response to the aquifer system, and that's what we see down here. You've got orange, blue, green, and purple. The orange is coastal discharge. So you get a reduction in coastal discharge, you get a reduction in stream flow. You can't see it, but there's a reduction in storage, and you're putting water back as wastewater, so that's adding it back to the system.

If we sum all this up, what we get here is for the historical period, we pumped 14 trillion gallons a day of water, and we want to see how the system adjusts, and what we get is about 9 trillion gallons less going through the coast, we get about 1.5 trillion less going to streams. But the point I want to make is the storage.

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Can you see any of these numbers back there, by the way?

AUDIENCE MEMBERS: No.

MR. MASTERSON: The green is the storage. We've got about 1.3 trillion gallons of storage lost when you pump 14 trillion gallons. That's historically. If you look at the period of emphasis, you add another 13.4 pumping, and you can see how the system adjusts here. We start to get -- the green pie is starting to get small. That's your groundwater depletion. Then when you get to the future, the pie gets a lot smaller even then, and that's 17 trillion.

So thankfully -- you can see this now. Okay. Here we have the same numbers boiled down to a table. 14 trillion pumped in this historical period, 1.3 trillion in storage depletion, that's 9 percent

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of the total. 1900 to 2013, 27 pumped, 2 trillion depletion, for a total of 8 percent, and on down.

The story here is it's getting better over time. You're getting less and less storage depletion, but it's coming at the expense of coastal discharge and stream flow.

When you look at it by those periods, I think it's a better way to look at it. It's not a lineal response. So you can see as a difference from the historical, to the current, to the future, the depletion's getting better. And this is the coastal plan. You're sitting here saying, you know, we want to hear about Long Island, and that's what we did here. We wanted to look at these different systems from Long Island to New Jersey, to Delmarva (phonetic), to Virginia, to North

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Carolina, and compare and contrast these system to see how it fits into the bigger story.

Long Island I said pumps about 30 percent of the total pumping in the system. Most of it is public supply. Virginia only pumps a third of what Long Island pumps, and most of that is for industrial pumping, which is there the big pulp and paper mill industry, and that's where they use all their water.

The Long Island system, you've got the Upper Glacial sitting on top of the Magothy and then Raritan underlying the Lloyd. Virginia, all of this, this little bit here is from the Upper Glacial down to the Raritan. The Potomac is the same as the Lloyd.

The Potomac is about six times bigger than the Lloyd. This is where Virginia gets all its

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water, and I'm going to show you how Virginia, the system's going to affect it from pumping there, and think about the Lloyd when I show that.

So for Long Island, most of the pumping is the Magothy, and that's shown here in pink. You have some pumping in the Upper Glacial shown in blue.

This is the pie chart that we're showing for the total coastal plain. It pumped about 17 trillion gallons of water from 1900 to 1985, another 4 trillion from '86 to 2013. Then I ran 2013 out for another 40 years, and that's how I came up with the 5.3 trillion. So it's a future condition, but it's based on keeping the current pumping.

What you see is most of it is discharged to the coast. It's capturing water that otherwise

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would have discharged to the coast, that's about 80 percent of the total. A little bit on the stream side. You're putting water back, that's the purple, and there's storage depletion.

Groundwater depletion that you lost and you're not getting back is about 400 billion gallons of water from 1900 to 1985. From '86 to 2013 it shrinks to 63 billion, and in the future there's no more storage loss, you've kind of reached an equilibrium.

So here it is in a table form. 420 billion lost, 6 percent of the total. You pump 11 trillion from 1900 to 2013, it's about 480 billion, and it's about 4 percent. If you run that out into the future, you pumped a total 16 -- again, this is based on assuming the same pumping rate as 2013, about 17 trillion

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gallons. You're still only losing -- the loss is the 480 billion.

So your groundwater depletion is only 3 percent from 1900, but if you look at it in terms of the periods I'm showing historical, the current, and the future, the storage loss from '86 to 2013 is only about a percent, and going forward, you basically reached an equilibrium. If you keep the pumping the same and the recharge the same, what you've lost to the coast, what you've lost to the streams, that system is an equilibrium.

Virginia's a different story. Most of the pumping is from the Potomac, which is like the Lloyd. They have a light green pie that you didn't see for Long Island. This is water that they're borrowing from North

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Carolina, I guess is the way to put it. Water's flowing from North Carolina into Virginia, and this is their pie, their storage loss, it's about 22 percent, the big green pie. It increases to 25 percent in the current, and even increases more in the future. So Virginia, they're not at equilibrium, they're continuing to lose water.

This is the table for Virginia. You'll notice the pumping is much less. Long Island is about 7 trillion, if I remember my numbers, 4 trillion, and then another 5 trillion. Much less being pumped from Virginia. But the depletion continues to go up and up in the Virginia system because the storage loss from the system hasn't equilibrated.

If you look at the separate periods, remember I said

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Long Island is doing much better for the last period with zero. Virginia keeps on losing water because of where they're pumping their water from.

So if you compare and contrast the two of them, you see a lot of orange for Long Island and a lot of greens in Virginia. So the water you're capturing that would have gone to the coast, in Virginia they're just depleting water from storage and borrowing water from their neighbors.

Now where that storage loss is occurring, this part is a cumulative plot. So it means if you're looking right here at the end of the historical period, that bar is the summation of everything that happened before it. 2003, that's the summation of everything that happened from 1900. What you see here on Long Island, it

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started to go down. You're putting water back into storage here. You've cut your pumping back, and water levels are starting to come back. This blue is the storage loss in the Upper Glacial. The yellow is the storage loss in the south shore confining unit, and maybe to a lesser extent the Raritan. The dark color is we lump the storage loss from the Magothy down to the Lloyd. So you see it's very little compared to the Upper Glacial.

Virginia, it's a totally different plot. You can't even see the blue, the light blue in Virginia. The dark blue is mostly from the Potomac. The yellow is the storage loss from the confining units.

So they're dewatering those confining units, and what

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happens is the confining units are clay. Like a house of cards, the structure. When you change the pressure in the confining unit, the house of cards collapses. When it collapses, you get land subsidence. The most extreme case is Central Valley, where they have tens of feet of land subsidence from collapsing those minerals.

Here in Virginia, I don't know how closely you follow the sea level rise story, but lower Chesapeake has the highest rate of see level rise on the east coast, and part of that is attributed to the over-pumping of the Potomac and the confining of its collapsing. You're not going to have that problem here with the current pumping on Long Island. You can see that the storage loss and confining units are really small.

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So because we're here on Long Island, I decided to do a little back-of-the-envelope calculation. I take the 11 trillion gallons of water pumped, it's about 500 billion gallons of storage loss, 4 percent of the total. So if you take the total area of Long Island, it's 1,400 square miles. The specific yield is, think of it as the effective porosity, the effective drainage of the porosity. .2 is a pretty standard term. You do the simple math, you come up with about a 9-foot decline in water level. So it's as if you took 9 feet off total water table across Long Island. The thickness of the Upper Glacial and the Magothy combined is about 700 feet, so it's about a one percent. You took one percent off the top for all the pumping from 1900 to 2013.

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Now, I don't know if you can see the yellow line in the back, but this is a hydrograph, two wells of Nassau/Suffolk line. The yellow well is the Nassau well, and then you have the Suffolk well that kicks in. It goes back to 1940, and you see possibly three to five feet of water level change just from recharge. Remember, the total loss from pumping was 9 feet. So here you've got 2 to 5 feet just from changes in recharge.

This is the 1960s drought. You come out of the '60s drought, now you've got changes in water levels that are on the order of 8 to 10 feet. So you're almost gaining and losing water from precipitation in the system as much as you lost from pumping across the entire 113-year period.

The news isn't so good in

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Virginia. This is the Potomac aquifer. And actually the Lloyd, I mentioned in the beginning, is part of that. You can see all the drawdown is really occurring in the southern part of the study area.

This is a hydrograph. That's one of the big paper mill industry complexes behind it. Water levels have gone from about 110 to 180 feet. They dropped -- I should say that's a depth of water. Water wells are not responding to recharge there. They're continuing to drop; they're not renewing that resource.

If we look at this, this is from the model, we've got the two head maps from period of emphasis and our future period, and you can see Virginia is still getting red. They're still

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depleting storage, water levels are continuing to come down. The Lloyd, this is a binning effect. That really shows about one to two feet change in the Lloyd. There's no change in the Lloyd compared to what they're seeing in Virginia. Even though it's one continuous aquifer system, you can see how much Virginia is being affected by overusing the Potomac.

So if we compare and contrast them, this is what we needed for the national program, we needed to know this storage number. We looked within the study area, the geographic regions, you can see Long Island 6, 4, 3 percent, and you see Virginia, 23, 24. Virginia is continuing to deplete their storage. It's probably the worst case scenario in the NACP.

When you look at it by

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period, you can see that Long Island, like I said in the beginning, we're down to about a zero depletion going forward, whereas Virginia, that's not the case.

MR. DAWYDIAK: I have a question. Does that mean that our aquifer is now 91 percent as full as it would be without any pumpage?

MR. MASTERSON: Yes, and that's because of the -- well, the aquifer is, but the response is different. I'll get to that maybe on the next --

MR. DAWYDIAK: I meant '93.

MR. MASTERSON: What you have is, you've got a system where you've reached an equilibrium, that you've got less water discharging to the coast and less water discharging to streams. But

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that's why you've got a water table that's not much lower, but you've reduced the discharge significantly to the abeyance and the streams. That gets to the second point here: Is that condition acceptable? I know for shellfish, it requires a certain amount of salinity. You change that by taking that water out.

We know that, you know, this gets to the other point. Quantity is only part of the consideration. You need to consider other issues. We didn't address quality in this study, but I want to point it out and lead into the next topic, the next talk you'll here hear.

We know that if you're pumping near the coast, if you over-pump it, especially down in Long Beach area we've got some work going on, Fred Stumm in our

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office, you run the risk of saltwater intrusion. Amphogenic contamination, it can either be wastewater, non-point source, or you have contaminant plumes. When I worked down here in the late '80s, I worked on the Grumman site, and those are non-point source plumes, you need to be aware of those.

And then we have these ecological constraints. This is a term we throw around in New England. You've got these valley fill systems with a river in the middle, and the pumping is limited by how much you can reduce stream flow because it affects the fish life, fish population. There may be some tie in here with the shellfish and the stream in terms of ecological constraints and how much you can actually withdraw.

So this is the saltwater

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story. Fred Stumm in the Coram office helped us with this. We know the interface is close to offshore Long Island, particularly on the south shore. You know if you pump close to the interface position, you're going to draw in saltwater. It's not a sustainability issue across the entire island, but it is locally. This study that we're doing here is a regional study, so we're dealing with the pig picture. So I wouldn't consider this is a real constraint on the sustainability regionally, but locally, of course it's a consideration.

The other thing is water quality. This cross-section shows when you pump a well, no matter where you put the well, the source of that water came from the water table and ultimately came from land surface. What we do with our

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models, we can map, at land surface, the contributing area to that well. We cover a whole mosaic. You have a bunch of wells you're pumping, we can put the puzzle piece together and tell you where at land surface your water's coming from. If you know the level of your water quality, you can marry that to a water quality map and you can figure out if you've got contamination concerns in your system. This is part of the -- the USGS did a state of the aquifer map, and this is one of the figures from that website.

We know wastewater is a big issue here. We looked at wastewater changes cross the entire NACP, but by far Long Island was the most interesting story. You see the blowup, you see there's a lot of septic in western Suffolk. You look at

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Nassau, and it's blank. That's because of the sewers in south Nassau back in the '70s and '80s, and you have no more wastewater return flow occurring in the south Nassau area. So you've improved the water quality, but you've also affected the sustainability to a lesser extent.

There was a talk this morning by Don Walter that works in Massachusetts, the issue was the nutrient loading to the embayment. This is part of why you're turning off the wastewater, because you want to eliminate this. We can do the mosaic, the contributing areas to each these abatements and figure out the total maximum daily loads to determine whether or not you need the sewer. That was part of the morning discussion. So that speaks to why you want to deal

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with the wastewater.

And then this is the story in south Nassau. When you stop putting water back into the system, you see the water levels decline by about 10 feet, and that's what this hydrograph shows here. Any streams that rely on groundwater are going to be impacted, and the Meadowbrook was severely impacted once the sewering occurred in Nassau and those water levels dropped.

So one model, we wanted to look at what would happen on Long Island going forward if you sewered all of Suffolk County. And if you did, this red is 8 to 10 feet of drawdown. We're somewhere located in here (indicating). We've got the Nissequogue and the Connetquot, you can see it's right between the two drawdown cones.

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If you sewer this area, you lower the water levels by 8 to 10, 3 to 5, 1 to 2, feet shown with these color bands, you're going to affect the water quantity in the Nissequogue and Connetquot, while you improve the water consult.

As part of the groundwater resources study, we looked at the quantity side of it; we didn't address the quality. You can't have sustainability without quantity and quality, and you'll hear, when Sandy gives her presentation, how we came up with some metrics to help assess vulnerability from a quality standpoint using groundwater ages.

So the bottom line, the Magothy, from a quantity perspective, is much better than the Potomac down in Virginia. But because of that, you also have to

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live with -- well, and that's really because of the connection between the Magothy and the Upper Glacial without intervening confining going. But because that's missing, you then have concerns about contamination, you've got concerns about hydrologic response, where you're pumping and lowering water levels, and therefore affecting stream flows.

If you then decide, well, the quality is such that we can't use it, if you go to the Lloyd, you've got to realize the Lloyd's going to respond more like the Potomac did in Virginia than the Magothy does, so the yield is going to be much different than what you're accustomed to.

We could take a few questions or pivot into the sea level rise discussion. I've got

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some slides. Brian?

MR. SCHNEIDER: This is Brian Schneider.

John, did you run any type of runs considering reduced pumpage, like through just nominal water conservation issues, like what would happen if you ran your model out just using the same pumpage through 2043, but what if there was a reduced amount of pumpage through water conservation?

MR. MASTERSON: You know, we struggled with how to do that future condition, and because of the size of the study area from Long Island to North Carolina, we couldn't get that information from everybody, how they'd like to see the system changed. So we use it as a starting point, as a demonstration, with the hopes that a group like this would say let's

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turn the pumping off in this area in Long Island and see what that looks like.

So we haven't done it, but we have the tool available to do it.

MR. DAWYDIAK: The question is what is this agricultural pumpage factory in any way --

MR. MASTERSON: It was, yeah. We represented the draws from agriculture in the model.

MR. DAWYDIAK: The lowers have historically been pretty hard to get at, so --

MR. MASTERSON: We have a way to estimate it based on crop demand.

MR. DAWYDIAK: Are you going to be talking about sea level rise in so far as it relates to sustainability and aquifer use?

MR. MASTERSON: Yes.

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MR. DAWYDIAK: Okay. Precipitation changes, also?

MR. MASTERSON: No, not for the sea level rises discussion. We didn't look at changes in what you'd expect for recharge all the time for this analysis.

MR. DAWYDIAK: Did you also put a paper out that the nature of precipitation is changing and we tend to get more intense storms, more out of the evapotranspiration regions with higher rates of recharge? Is that an accurate --

MR. MASTERSON: There are some areas where they're seeing that and others where they're not. It's so -- there's such a wide uncertainty band, and we didn't attempt to look at that in this analysis. But it's easy enough to do that sort of work; we just

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haven't done it here.

MR. DAWYDIAK: Thank you.

MR. MASTERSON: Sure.

MS. MEYLAND: Given that disparity in size and actual quantity of resources between Nassau and Suffolk, how, or can you work to try to separate the two conditions, or is it that the Suffolk side of the equation overshadows what's going on in Nassau?

MR. MASTERSON: Well, we can -- we could turn the pumping off in Nassau and leave it on in just Suffolk and look at the two as sort of a change model to assess what effect Suffolk has in Nassau. It would be similar for what we did for Virginia and North Carolina and figure out what's moving across the county line.

MS. MEYLAND: I'm thinking in terms of sustainability.

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MR. MASTERSON: I'm not sure how -- this probably wouldn't be the tool to do it. I'm just trying to think of how to do it with a subregional model.

MS. MEYLAND: Because it's too small an area to really --

MR. MASTERSON: With this tool, yeah.

MS. MEYLAND: Okay.

MR. HERSHKOWITZ: Did you look at when you lower the water level in the aquifers, is there an increase in contaminants being brought up from the bottom or changing the hydraulic spring that more contaminants have settled?

MR. MASTERSON: We only looked at the quantity in this assessment. We're going to look at ages as a metric for contamination vulnerability in the next session that we'll hear about. But no, we weren't able to

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do it here.

Ready for sea level rise?

I've been looking at the effects of sea level rise on a coastal system for about ten years now. This cartoon is actually of getting a little dated, but this is sort of the range of what people expect to see in terms of sea level rise on the east coast. I'm not even sure it's east coast or if this is global. Six feet to about a foot and a half -- a half a foot to six feet, I should say, is the range. And we're looking really at about a meter, two to three feet is what we're using for our analyses to be done in systems similar to Long Island. What we expect is if you raise sea level, the water table will go up, and it should go up in unison with the rate of rise of sea level. Where that's a concern is where you have

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cesspools or basements that could be vulnerability to a rise in the water table.

That will happen away from surface water features. If you've got a surface water feature, you're going to get -- like a stream, you'll get more stream flow, but the water table won't rise. But what you could get is some upcoming saltwater beneath it in you've got a lens, a freshwater lens system like on the forks. You can also get some lateral encroachment if you've got a real low wind area along the coast and sea level encroaches inland, you can get some saltwater intrusion that way.

So here in Long Island, this is part of that state of the aquifer map. You can see the depth of water here in red is everywhere the depth of water is

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less than 10 feet. So if you raise sea level by 3 feet, the simplest way to do it would be subtract 3 feet off the depth of water, and that would be where you would expect to see the new water table. But the streams complicate it, like I showed in the cartoon. You really need a flow model to get at what that response would look like.

We did this work at -- again, the model I built goes from North Carolina and Long Island. We looked at that change in sea level position, we used about a meter, and the reds here is the increase in the water table. So the dark red means the water table went up by the same amount as the sea level rise, and then the oranges and the yellows are less. If you look all the way through in Long Island, you can see the

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center of the Island is less. It's about a two-foot change to a three-foot rise in sea level, and that really is because of the Nissequogue, Connetquot and Potomac. We didn't represent all the other streams in the system. We couldn't at the scale we were working at. So I wouldn't use this as a this is what's going to happen on Long Island, but it gives you some sense of how the streams affect the system.

Now, we've done some work in other parts, like on the Cape, Assateague, New Haven, that I think would give you some idea of what you would expect to see here on Long Island. The outer Cape is more like the forks. The mid Cape is like the main part of the Island. There's some work in New Haven, which is a reality setting, which is good for the city. And

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Assateague Island is a barrier island, similar to Fire Island. So this is the work on the outer Cape. This is like if you were standing in Riverhead looking out to Orient. But in the Cape, it's you're in Eastham looking out to Provincetown.

We've got a bubble of freshwater sitting atop saltwater. This is the hydrograph from the well near the coast, and the water levels are going up about the same rate of rise that we saw at the Boston Harbor gauge. So we knew that the water table was sort of mimicking what we saw with the increase in sea level rise at the title gauge.

When we looked at that, the model we developed, this is where we came up with this concept that everything would go up in unison, except for around these

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surface water features; it could be a wetland, it could be a pond, it could be a stream, or an area where the water table is awfully close to land surface to start, and we started seeing up-coning of the interface position. So we documented that in a server report, and then we wrote on the mechanics of this response in a groundwater article.

We then applied this to the Cape. Don Walter, who spoke this morning, just finished the sea level rise study for Cape Cod. What this shows is what I couldn't do for Long Island at the detailed scale. Don represented every little stream and wetland that he could in the model of Cape Cod, and in doing so, he could look to see how the system responded differently depending on where you had surface water features and

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where you didn't. Where you didn't, the water table went up in unison. Where you did, there was an effect. That's really the point of this slide, just to say that that's something we've done on the Cape and something that easily could be done here.

The reason he did that work is because the Association of Preservation of Cape Cod, they were looking at sewer. They want to know long-term planning what do we need to sewer Cape Cod. So what this series of histograms shows is the area where the depth of water is less than five feet. So on Cape Cod now, it's about 7 percent of the total area has a depth of water of less than five feet. You raise sea level two feet, that goes up to 9 percent. If you raise it by four feet, it goes up to 11 percent. And if you

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you raise it by six feet, it goes up to 13 percent. Now, six feet of sea level rise would obviously create other concerns, but someone would still be living there, and they wanted to know what the system's going to look at for their, like I said, their long-term plan.

I did a study on Assateague Island, which is off the coast of Maryland, it's a barrier island system controlled by the parks service. So their real concern out there was the groundwater dependent species. There's no public supply out there. They're really worried about the vegetation and how it could be affected by a change in the water table.

This panel here on the right is really the site one. There's browns, and the browns go

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to blues as we go from a current sea level position to .2 levels, .4 meters, and .6 meters. So we're only talking about a two-foot change in sea level position. The vato zone, the unsaturation zone is still thin out there, that the water table gets pushed up into land surface. It can't rise anymore, and what happens is this is cross-section across here that shows the freshwater lens in blue, and that's saltwater. The freshwater lens basically goes away as you push the water table up into land surface. That has some real implications for some, like I said, on these groundwater-dependent ecosystems.

This is the current system. You'd be amazed at how much time and money was spent on this cartoon, with thousands of

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artists worrying about every little tree and bush, but apparently it's right.

So this is the current condition. You see the salt marshes get inundated, and bad things happen to pine trees that require a certain unsaturated zone and shrubs go to grasses and so on and so forth. So that was a pretty interesting study from an ecosystem response.

That led to -- we got a paper out on that, and it led to a study that the park service wanted to see done not only for Assateague, but for Sandy Hook and Fire Island. This work in Fire Island is being done by Chris Hubert and Paul Masute (phonetic) as part of a parks service funded effort. Chris had developed a model for Fire Island some years back, and right now

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they're updating that model and they're doing a similar analysis to what we've done for Assateague with the same goal, to look at how the ecosystem responds -- how the ecosystem will respond to a sea level rise, and also if there is any pumping that may be affected there, as well, because there are some communities out there. But anyway, that was the ecosystem response.

The next one was done by some more colleagues in the Connecticut office. Yale University funded them to look to see how the water table is going to change beneath their buildings. They've got three-story below grade basements that they're worried about the water table. So we did this study here in New Haven, and I think it's really applicable to the Brooklyn and

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Queens story.

I mean, Brooklyn and Queens is actually more interesting because you know that the system -- that was the primary source of water up until the early '40s for this area. The water table was depressed by, in some cases, as much as 50 feet. Think about the infrastructure that went in; the subways, the buildings. Then they stopped pumping, they shifted to the upstate reservoir system, the water table came up, now they're pumping two ways just to keep buildings dry and subway systems dry. If you add another three feet of sea level rise to that, you can think about how much more water they're going to have to contend with.

This is something that could easily be done with a flow model, and you do this with a

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model and you get some engineers involved in this, and they can start to calculate just how much water they're going to have to pump and what the cost would be. So this would be a logical extension of a -- we're going to be developing a detailed model for the island, and this is something that's considered low hanging fruit for a project, the affect of sea level rise on Long Island.

I guess I should have been saying that while I had this slide up here, but that's the question, how is the system going to respond to sea level rise? With this tool that will be developed, there's a lot of application to the sea level rise story once we get that up and running.

So if I had to, without a model, say what I thought was going to happen, I wouldn't think

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of it in terms of a water supply sustainability problem, sea level rise on Long Island. I think the biggest concerns are going to be infrastructure.

I think the Brooklyn/Queens story is basements, subway flooding. Nassau, if you're already sewered, you're not worried about septic systems or cesspools, you're more concerned with basements. Suffolk, septic systems, basements. You get out in the Forks, that may be the one place, because it's similar to Cape Cod, the outer part of the Cape Cod where you've got the freshwater lens, you may have some saltwater concerns there with sea level rise. And again, Fire Island, that's the groundwater dependent ecosystems where I'd see that being the biggest concern.

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Sea level rise questions?

(Applause.)

MR. KOCH: Any questions?

MR. TERRACINO: This is Stephen Terracino.

Differences in the geology along the North Shore of Long Island is different from the Cape, and the response would also be different. Lower permeability settlements, higher water tables, and different response to what we saw in the Cape. Would that not be true?

MR. MASTERSON: You're talking about the sea level response?

MR. TERRACINO: Yeah.

MR. MASTERSON: I'm not sure if -- you're talking about from a water quantity standpoint, or what response are you talking about?

MR. TERRACINO: Water

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table response.

MR. MASTERSON: I'm not sure. I'd have to see that in a model. I'm not sure if you'd expect -- because all you're changing in the model would be the sea level position. So I don't know if the response would be all that different. But --

MR. TERRACINO: Okay.

MR. MASTERSON: But it's something to consider. What I would say for the north shore, if it's a problem for you there, you would be less likely to have concerns about depth of water, more so than you would on the south shore.

MR. KOCH: Thanks, John.

MR. MASTERSON: I'd like to introduce Sandy Eberts. Sandy runs the national modeling team, the national program. We're going to talk about more about the water

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quality story, and Sandy will introduce the program and then she's going to talk specifically about the work that we just got underway here on Long Island.

MS. EBERTS: Thank you, John.

I'm Sandy Eberts. I'm also with the U.S. Geological Survey, and I'm with our National Water Quality Program. I've been with the program for about 13 years, with the USGS for about 30 years.

For the past three years I've been leading our National Team of Groundwater Modelers, who are involved in water quality work, and we have a program that we're marching across the country and we're just coming to the Long Island area. So I thought what I would do is I would provide you with some background on the

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national program, which is the genesis of the work that we're going to be doing here. We actually started here about a year and a half ago, started ramping up. It's about a six-year program and we're investing several hundred thousand dollars a year. So we're going to be developing some tools that will be at your disposal when we're finished with that. I only have about 20 slides, but I did want to come out and let you know where we're headed with this.

With our National Water Quality Program we have the Surface Water Program, and we look at ecology and we look at groundwater. Within our groundwater program, we have what we've referred to as status and trends. We're sampling across the country and looking at the status

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of water quality. And then we have a modelling and mapping team, which Don and John are a part of, where we're mapping water quality as we go.

So the focus of our National Water Quality Program currently is we're trying to assess the water quality, this is the groundwater piece, the water quality at the depth zones that are used for public and domestic supply across the country. We're evaluating eroding of contaminants by groundwater to streams in selected areas, and then in even fewer locations we're assessing and forecasting changes in groundwater quality.

The forecasting of water quality is a new component for our National Water Quality Program, and it's best done at a more local scale, such as Long Island, than

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at the national scale. So we'll be testing, you know, some of these ideas and tools here in Long Island.

For our National Water Quality Program, we've organized everything by principal aquifer. We are assessing water quality, groundwater quality, again at the depth zones used for domestic wells and for public supply in 20 principal aquifers across the country, and those aquifers account for about 90 percent of the pumping for public supply and about 85 percent of the pumping for domestic supply in the country.

Here's what we're sampling for. We're sampling for water quality constituents that are both regulated and unregulated, those that have geologic sources, such as trace elements, arsenic,

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uranium, radium, we're also looking at radium nuclei, we're looking at constituents with human sources such as the nutrients, organics, some microbiological indicators, and new constituents such as iron, manganese, dissolved solids and the like. We also are looking at pharmaceutical, polonium, enterococci, and some other constituents.

The sampling that we're doing is very comprehensive. It's being done in a nationally consistent fashion so that we can look across the country and have a national perspective. Where we find constituents that are important regionally, we also are modelling and mapping those, but at the national scale this is what we're looking at.

So here's a picture of our sampling network. At the top we

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have our land use networks. We put these networks in place over two decades ago. They are primarily monitoring wells. About 20 to 50 feet deep we have 47 networks, about 1,300 wells. The green and the red just represent agricultural and urban land use areas. And the idea for these networks, these land use networks, is to look at the quality of the water near the water table, what kind of water quality do we have under these different types of recharge areas.

We also have networks we call our major aquifer networks. These are networks of wells made up of predominantly domestic wells, and they're about 50 to 100 feet deep. We have 32 networks just shy of a thousand wells, and these have been sampled now several times over.

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In this third decade of our National Water Quality Program, we've added a new network, and it's called our principal aquifer network. These are public supply wells that we're sampling across the country, around 1,500 wells nationwide. They're typically deeper wells. This is the first time that our national quality program has looked deeper into the aquifer systems and trying now to get a full three-dimensional picture of water quality, again, historically looking at shallow groundwater and the affects of land use on water quality near the water table and then at the depths of domestic wells, and now we're going deeper.

These new networks have been designed to be not so clustered as we have in the original networks, but rather

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distributed so we can look at the proportion of our aquifers at the depths of public supply wells that are affected by different constituents.

We also, in addition to marching across the country and sampling wells in each of these networks for these various constituents, we are also trying to evaluate time scales for change and to better be able to put our water quality data into a flow system process. So again, if we sample our networks every decade, if we see a change, is that a decadal change or is that just a change based on a hydrologic condition that might not be persistent; you know, does the water quality vary and we're just sampling at different ends of the spectrum.

So again, we're resampling

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all of our wells to decadally, but to understand that decadal data, we are now collecting continuous water quality data at selected locations so that we can understand the seasonal and yearly fluctuation in water quality so that we can better understand our national data set.

We are also analyzing water from our wells for various traces of groundwater age. So this is something that we've added. We used to look at groundwater ages sporadically, but now we are systematically looking at the age of the groundwater produced by these different wells, and specifically those deeper public supply wells so that we can look across the country and see where we produce our public drinking water from, you know, aquifers with that amount of

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recharge within the last few decades, and where is the water coming from where this recharge maybe hundreds of years ago.

We've had EPA ask us questions such as, we've put into place these various best management practices, but we still see concentrations of, say, nitrate going up in these areas, but over here, we seem to have had more success, why is that? It's very frequently tied to the mix of age of water being produced by those wells. So again, we're trying to systematically lay out the age of the groundwater in various aquifer systems.

In addition to sampling for tracers and interpreting that age information at the wells within our network, we're also building groundwater flow models and extrapolating beyond our

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sample data points, and that's where some of the work that John just talked about will come in. Again, there are benefits from having --

Yes?

MR. WHITE: Just a question because it was difficult to see. Where does Long Island stand within your application of this work and stuff?

MS. EBERTS: Those are my last few slides, so I'm giving you kind of the genesis of where all of this is coming from and where we end up here. Thank you, that's a good point to make right now because people --

MR. WHITE: I mean, we're interested in the rest of the world, but --

MS. EBERTS: Yup.

So the benefit of the strategy of having these nested

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well networks is that we are able to look at the groundwater in the shallower parts of the system and then look at what's happening in the deeper parts of the system. This is just an example from the Central Valley where we can look at nitrate in the San Joaquin Valley and see that the percent of water being produced in the shallower part of the aquifer where concentrations are greater than 10 milligrams per liter is notably more than in the deeper parts of the system, so you can start to anticipate that that's going to move down at some point.

So connecting the dots, this is where the modeling and mapping is coming in. Our National Water Quality Program didn't really apply groundwater models or statistical models of water quality systematically up

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until this point because we didn't
have sufficient data, nor did we
have sufficient tools to be able
to do that. But we are in a
position now that we can do that.

So again, our networks
that we've been sampling, we can
now connect the dots using some
statistical models. We did some
proof of concept of this some
years back published by Tom Nolan
and others where this is nitrate
and this is the shallow
groundwater at the top here across
the country, with the red being
concentrations of nitrate above
10 milligrams per liter, which is
our MPL, and then in the domestic
well depth. And we can see, even
on a national picture, that
shallow groundwater has more areas
of high concentrations than the
domestic well depths, and the same
would be true systematically as we

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look deeper, but we haven't finished that work yet.

So again, we get a better picture of the water quality and aquifer systems and when we're able to use statistical models to connect the dots, and that allows us to provide information to people beyond those locations that have been sampled.

So, for instance, speaking to some of our state quarters in North Carolina at a meeting recently, we were talking about some of the mapping that we can do, and they said, boy, that would have been useful -- for instance, we have an arsenic problem in an area and we had been telling the developers to keep infrastructure costs low, have everybody on well septic. Well, they happened to suggest this and required developers to do that, and the

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people in the community have been drinking high arsenic water. They didn't know that was an area of high arsenic groundwater. So again having a continuous picture of the water quality, even when it comes to just, you know, iron and manganese and sulfate, as well as some of the contaminants, it helps you know how to plan and use your water resources.

So at the national scale, what we're mapping using these statistical modelling tools are the trace elements, arsenic, uranium and boron; nutrients, nitrate and phosphorus; and nuisance constituents. We then are going more detailed work in four of the principal aquifers, the North Atlantic Coastal Plain is one of those, and then additional work up in Long Island, so that's getting to what this

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gentleman was asking about.

We're marching across the country with more refined modelling and more refined sampling in the Central Valley, the Glacial Aquifer System across the northern part of the country, the North Atlantic Coastal Plain, and then the Mississippi Embayment. Each effort is a five- to six-year effort.

We'll be developing maps of water quality at depths, both at domestic and public supply well depths, in these areas that will be more refined with less uncertainty than what we can provide at a national scale.

Why are we in these four aquifer systems? It's because the Groundwater Resource Program that John was just talking about has just finished or is finishing up developing groundwater flow models

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for these areas. They've been looking at water quantity issues, and we are following them, our Water Quality Program is following our Water Availability Program and making use of that knowledge and tools, the modelling tools they develop so that we can complete the story in terms of availability by adding that water quality understanding. We actually are taking information from the output of these flow models and putting them into models of water quality so that we can quantify the effects of groundwater age and such on water quality and do some forecasting.

So before I spend a moment or two to share how we come up with our water quality maps, I just wanted to point out some of the utility of these maps. One is to anticipate water quality in

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unsampled areas or unsampled depth zones, as I mentioned in North Carolina. We don't have a prospective on the water quality across the country, across our principal aquifers, and even in areas that are much more local than that. With that information, one can design monitoring programs and form protection practices, plan for treatment, locate new wells, and evaluated your sustainability in terms of water quality. This information is also useful for public health professionals because there is, you know, regional and local differences in the quality of water used by people who are on domestic wells, and no one else is really looking at them.

So these water quality maps are based on a great deal of understanding. As I mentioned,

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we're just at the cusp of being able to do this type of work. We spent several decades collecting data that we can build our models from, and as statistical tools have evolved, we're able to do that. But we've also developed a great deal of understanding about the water quality and the framework of our principal aquifers over the last decade or so.

We have a fairly recent circular called Factors Affecting Public Supply Well Vulnerability to Contamination. I brought copies, but left it in my hotel room, but you'll be able to contact one of the local USGS people and get copies of that if you'd like. But this circular and this study, which involved about 30 of our scientists and hydrogeologists for about 10

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years, we looked at how contaminants get into public supply wells and what types of information you need to be collecting to understand the water quality in a well and not just to explain your observe water quality, but to forecast future water quality in the scale of a well. We have a lot of tools associated with that.

We really found that if one doesn't take the time to understand what a well's sample really represents, you really can't decide what your next steps are going to be. We found low concentrations of the same constituents in public supply wells in different aquifer systems across the country. But the reasons why we made those observations and why those contaminants showed up in

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different systems were for different reasons, and not knowing the differences, you know, will prevent you from making your next steps appropriately. So we have some comparisons of different situations in the circular that are going to help you think through that.

We also just published a series of nine circulars, each describing the water quality as we know it based on our sampling, not our modeling, in different systems across the country and came up with conceptual understanding of why we see what we see, and we're using this information then to develop these more refined models.

But really kind of a summary of that understanding that was developed, we learned that these five things really are what contribute to the quality of water

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that you observe both in an aquifer and in a well. The contaminant source, the geology, the geochemistry, hydrogeology and climate.

When I talk about factors that affect water quality, I really kind of collapse them into these three categories. You have your sources that contribute or your input of contaminants either from geologic or human sources. You have your conditions in the subsurface that affect whether a contaminant remains mobile and persistent with the groundwater, flows with the groundwater towards a well or towards a surface water feature or whether it degrades or precipitates out. And then we have our information on hydrogeology and climate that together really affect susceptibility. The way we define

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susceptibility is simply the ease of movement of water and contaminant within the subsurface. So again, your source is whether the conditions that affect whether or not something can persist and how susceptible, and that's really, again, ease of movement in the subsurface.

To understand water quality, not just for the purpose of mapping, but for forecasting, for knowing something about how the water quality in the aquifer might affect our estuaries or surface water features or whatnot, you need to have some knowledge of each of these groups of factors. So what we do is we use statistical models as the tool to explain the observe water quality and the results of those models to map.

We have a myriad of

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variables that can represent each of these different categories. So, for instance, for susceptibility, for ease of movement, if we're working on a national scale, we might use soil information to represent susceptibility because you need a national data set, and you can look at course and fine grain soils and identify maybe where recharge would be more pervasive and where it would not be. But if you start looking locally at Long Island, you might want information on groundwater age at the subsurface to characterize susceptibility.

So again we have all types of variables that we can use. Out west, a lot of the recharge occurs near the mountain fronts, so we can look at elevation as a surrogate or proxy for some of

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these variables.

So there are all types of data sets that we can pull together to represent each of these factors. Our statistical models, then, will help us sort through which of the variabilities and data sets we have that best explain that observe water quality, and then we use those handful of data sets and combine them according to those statistics to come up with maps. This is just an example of arsenic in -- groundwater arsenic concentrations in the southwest principal aquifers, but this is how we're going about modelling and mapping.

So I mentioned susceptibility. Groundwater age is the ultimate measure of susceptibility. It really integrates the effect of the recharge rate, the subsurface

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pumping, the geologic materials, everything that really affects ease of water movement is characterized in the age of the water at a point in the aquifer system, you know, at your surface water features or at the wells themselves.

And so because we have flow models now and we're building off of those flow models, we can come up with wall to wall groundwater age information that we can feed directly into those statistical models to help improve our understanding of water quality. It's a very big part of what we're doing. It's the first time we've really brought to bear all of our understanding of flow systems into our water quality effort, and we are generating information on groundwater age for all these aquifer systems, and

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we're actually going to be publishing groundwater age maps and information and rep tools. Just specifically looking at groundwater age gives us an important stepping stone everywhere we go in terms of understanding water quality.

The other thing that we're doing with the susceptibility product, in addition to just mapping horizontally where you might have young or old waters in a watershed, is we're also simulating the depth of what we call the antivergenic water. So the depth of the water that's been chemically affected by human activity, and that's going to be different in different systems. That's really useful to know whether your supply wells are well below that depth of human influence or if they're up within

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that area of human influence, and particularly for the domestic wells, again, because no one's really monitoring or watching out for that.

So how does it fit into Long Island? Well, John showed you the outline of the north Atlantic Coastal Plain model that they built for water availability assessment, and we are coming to Long Island and we're building a nested model, more local scale model within that larger model so that we can further look at water quality issues at Long -- well, let me back up.

We're building our water quality understanding at the aquifer scale, but because it's a fairly large area and because the models, albeit very nice, are still very, you know, somewhat course, we want to know how well

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do we really understand water quality, groundwater ages, and the like at that scale.

So what we're doing in each one of our aquifers is we're looking at some smaller regional area, we're building similar models, and we're comparing the outfit from the more local models to the regional models. How well are we characterizing groundwater age and travel times with these large scale models compared to what we can do if we refine things? Are we capturing the essence of what's important? Can we add some information on uncertainty of what we can say at the regional scale by really exploring local scale. And the team, the USGS team from Long Island and up in Massachusetts were saying, you know, this is an area where there's local interest,

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and if you're going to spend the resources to really drill down and understand water quality by using modelling tools, this is an area to do it, and so that's why we're here.

So again, we're building these local models, one of them here on Long Island. If you look at the top, you can see that there's going to be a lot of refinement in terms of the layering, the grid spacings, 500 by 500 feet as opposed to one mile by one mile. So we're getting a lot more detail. What that gives us is a much better understanding of flow in the shallow part of the system and the relationship between groundwater and surface water. So that, as John mentioned, there are some things that we can do with the regional model and other things we can't

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do, as well. But with the local model that we're building, we ought to be able to address a lot of local issues.

So what are we adding? What kind of information are we adding so that we can improve the model and build something that's more locally relevant? We are characterizing the sediment texture in three dimensions. We have a team that's really pulling together all of the information from journals, logs, and really refining our understanding of the heterogeneity of the sediments and the texture so that we can refine the flow model and get better flow path, better information on travel times, therefore we can forecast water quality much better. We've been updating our recharge estimates with a soil water balance modelling approach, and

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we're procuring some current pumping information to improve our models.

We are also collecting data here on Long Island starting next summer in support of the construction of this flow model that will, again, help inform our regional understanding of water quality and at the same time be relevant for local application. We've gridded out the island, and in each one of these models, or these sampling grids, we are sampling a deep well and looking at age tracers, as well as shallow wells, so that we have an understanding based on chemical data of the ages around the Island, and then we're calibrating or matching those groundwater ages with our new developed flow model so that we're pretty confident in the ages and the particle tracking

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results that we're getting from this new model.

As we march across the Island, we collect data, again, predominantly in support of the development of the flow model. We're also sampling for other water quality constituents. We're looking at nutrients, we're looking at trace elements and several other constituents.

This is an opportunity, if a group like this is interested in additional water quality constituents that we are not interested in, you know, you can piggyback on our field effort and other constituents can be sampled for if that's something you wanted to pursue, wastewater constituents or other contaminants. But we are predominantly sampling for support of development of this model.

MR. WHITE: What was the

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criteria for size and manner of grid?

MS. EBERTS: They're equal area grids, and the size has to do with how much money we have to spend on sampling. So we're going to be collecting samples, 25 samples. Some of the wells that we sampled back in 2012, we'll use that data, and we're filling in, and we'll probably have enough wells left that we can actually do some flow path sampling, as well.

So this is currently being -- the design is being refined, I would say, John. I don't think we have exact wells picked yet. So again, there's opportunity to have some input.

Yes?

AUDIENCE MEMBER: Are these all from USGS wells, or do you coordinate it with the Health Department, and do you save some

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of your sampling?

MR. TERRACINO: In some of the cooperative programs that we have with the Health Department, Water Authority, we are building on the NAWQA sampling and adding additional constituents and also supplementing some of the plant sampling with additional wells.

MS. EBERTS: But the wells aren't necessarily owned by USGS because the deeper wells are all public supply wells.

MR. TERRACINO: As I'm sure she'll show, the principal aquifer assessment, Long Island, including additional samples from the Water Authority, did participate in the principal aquifer study.

MS. EBERTS: Right.

MR. WHITE: I guess my other point was in terms of the shape of those grids, if you have

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a deep well and a surface well, it's going to be a big difference if I look at even that center grid there in the bordering of western Suffolk County whether I'm on Great South Bay or whether I'm in Melville.

MS. EBERTS: Right. So we're using the data to help constrain our flow model to make sure that our porosities, our recharge rates, our heterogeneity, we have them characterized well enough to match observed conditions. But we aren't saying that the wells we're sampling describe the whole system. What they're doing is pinning down the model that will describe the whole system. Does that help?

MR. WHITE: It does.

MS. EBERTS: So the model is what we're using to really characterize groundwater age wall

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to wall, but we're pinning it down with some very unique data sets.

MR. LEVY: You said some of your deeper wells are public supply wells?

MS. EBERTS: Yes.

MR. LEVY: Aren't those blending a lot of different ages of water inherently by the way they operate?

MS. EBERTS: Yes. Here we go; a good segue.

It's interesting, I led this investigation on public supply well vulnerability for ten years. You know, at the outset we felt that the monitoring wells were going to give us the best information sampling from discrete zones and that would help inform what we were seeing at the supply wells. You know, ten years later I think most everyone on our team felt that the public supply wells

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actually provide you the most information. For that very reason, they integrate quite a bit of what's going on in an aquifer system, and if you systematically march through what it is that that data is telling you, you really have a lot more knowledge than just a discrete point in the system.

But let me go through this schematic. This really is speaking to how information on groundwater ages can be used to forecast water quality and why it's important to actually know the age of the water from the wells that you're looking at or from the surface water wells, the age of the groundwater discharging.

So if we back up a few slides, I showed that black-and-white slide where we were looking at groundwater ages

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wall to wall, and that was just average age, you know, beneath each pixel on the map or beneath each point on the landscape, and we can see that we have varying groundwater ages across an aquifer or across a watershed.

But we are really interested if the quality of water at different depths, as well, not just horizontally, and so when we look at a domestic well and we look at a public supply well, those two types of wells sample an aquifer very, very differently. And so if we have high concentrations, say, of nitrate in a domestic well or in domestic wells throughout an area, we need to know is that going to become a problem for the public supply and when will that occur.

So we really have to know how our wells sample our aquifer.

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If we look here, we've got a domestic well, we've got some flow paths going to that, we may be drawing in some water from maybe a single land use or, you know, a small grading of land use, and the water entering that well might be recharged years to decades ago. And in monitoring that well you might be sampling along flow path and it's showing you a discrete picture of what's happening in one localized point in your aquifer system.

But the public supply wells, with their high pumping rates and their long screened intervals, they draw water from a very large volume of aquifer and typically are mixing waters from very different points in time, very different recharge history; in fact, sometimes a very long recharge history. You can have

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water that was recharged years ago simultaneously entering a well as water that was recharged centuries ago and might be predevelopment. In fact, in some other western basin aquifers some of the waters entering the wells recharged thousands of years ago. This proportion of young and old water that is mixing in a well dominates your contaminant trend, and let me tell you why.

So it's the youngest water that enters a well that affects contaminant arrival, first arrival. It's the oldest water that will affect how long it takes to flush a contaminant through, unless it degrades in the subsurface. It is the age span, the range of age from youngest to oldest that affects your maximum concentration, and here's why.

You might have some

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non-point source contaminants coming from from the water table. But if you have a large volume of water coming into your well that's predevelopment, those concentrations will remain diluted for a very, very long time, and, in fact, your concentrations in a well that produces this kind of range of water ages will never be as high a concentration as a well that produces a narrower range of younger water. So it's the age of the water and it's the range of ages of the water that affect arrival and concentration.

This is why we see, as we go across the country, so many public supply wells that have detections of a variety of contaminants, but not usually at very high concentrations. It's the mix of waters that result in what you're observing. You're

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pulling young water in, so you do see some detections, but you're also simultaneously producing a lot of older predevelopment water, so your concentrations are typically very low and they may never reach the concentrations that you see at the water table.

MR. DALE: Question.

MS. EBERTS: Yes.

MR. DALE: What is the methodology, is there some type of test that ascertains how old the water is, whether it's 1,200 years old or 12 years olds?

MS. EBERTS: Yes. So when we sample for age tracers, we are not looking for a single apparent age of water. We sample for age tracers that represent different recharge histories. So tritium and helium and carbon 14 and CFCs and sulfur hexafluoride, we sample for all of those and analyze for

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all of those in a single water sample, and then we use mixing models to tease out what possible mixture water of different age can come up with that combination of tracer concentrations. And so that's what we're using, then, to calibrate our flow models so that we can tease out what that age mixture of water is.

MR. DALE: So as an example, then, what would the constituent component of 1,200-year-old water be compared to 12-year-old water so I can get a better picture of what that --

MS. EBERTS: So carbon 14 would give you kind of a read on some of the older water. The tritium would give you a read on some of the younger water. Then we also use the flow models to kind of come up with what's in between.

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So we run our flow models and we come up with the age mixture of water at the wells, and we back out what the concentrations of each of those tracers would be to those input histories would be and we compare those to major concentrations.

We typically don't calibrate our models to ages, we calibrate to age tracers, and the reason is every groundwater age, even if it's, you know, based just on the CFC, it's still an interpreted age. We don't want to compare, you know, a modelled age to a modelled age. We are actually comparing concentrations and we just use a range of tracers. You know, there are gaps in time that aren't all represented by tracers, but we work with what we have.

My point is this: We are

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using information, wall-to-wall information on groundwater age, and we're mapping that and that helps us map water quality. But when it comes to forecasting water quality, we need a better picture, if we're forecasting locally, of what exactly wells in different parts of the system actually are sampling and what that water represents, because you need that range of groundwater ages to forecast out what your contaminant trends are going to be.

I had some complicated graphs in here that I dropped out thinking maybe it was beyond what people wold be interested in. But I will share that I have developed what we call an educational tool, web tool, and I can give you the URL for that. It's a tool built for people like yourselves where you can go in and you can move a

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well screen around in an aquifer system, you know, a hypothetical aquifer system, and explore how the position of the well screen affects the age of the water produced and how that, in turn, affects concentration profiles.

Again, we found, even with within our National Water Quality Program, we have very sophisticated scientists and engineers, and yet people still weren't grasping how important age mixtures were in terms of contaminant trends. We would say the average age of the water in the shallow part of the aquifers is this and the average age of depth is this, so we might have an offset of 10 or 15 years. But in reality, it's not like the same trend is going to be seen ten years later in a supply well. That trend might be actually drawn

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out over a longer period of time because you're mixing more water. So our circular on public supply wells focuses in on just that, and some of these tools are from that effort, but this web tool really upon his you explore this.

You'll see that by having a Long Island flow model that has a lot of refinement in it that these guys are building, we'll be able to provide you with that information on age mixtures for depth zones use for public supply, for depth zones used for domestic supply, and your relationship between groundwater and your surface water features. So you'll be able to use that tool, then, to do forecasting for each of those types of receptors.

And that really is all I had to share. We don't have the model built yet and so we don't

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have results to share, but that's kind of the genesis of why we're here. We're looking nationally, we're incorporating flow system understanding into our water quality program, we're quantifying groundwater age because it's critical for understanding the susceptibility component that affects water quality. We haven't been able to do that before.

Again, typically we've looked at things like soils to represent susceptibility. But now that our program is not just looking at water table water quality or even shallow depths, we're looking deep in our aquifer systems. It's not really a good representation of susceptibility if you're looking at what's happening just at the soils when you want to know what's happening, you know, several hundred feet

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below land surface. So we're sample for ages and modelling that so we can incorporate that directly into our water quality understanding.

Yes?

AUDIENCE MEMBER: Since you've been doing this for a decade or so, can you give us an example or two of how in real life you help people maybe solve problems locally by giving them a direction?

MS. EBERTS: Yes. So we've just started the mapping of water quality, so we don't have a lot of, you know, those examples, although, as I shared, in North Carolina as we were developing our program we've had people say, well, if we would have known this, we would have developed our aquifers differently, or public health people have said, you know,

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if we would have known that that area had high concentrations of this, we might have been looking for this.

But at the scale of the individual wells, our public supply well effort which is kind of foundational for the understanding we're bringing to bear now, an example, out in Modesto, California, they were taking wells offline because they were having an increasing number of wells that exceeded the uranium MCL. So that was becoming a problem for them, and so they've been taking wells offline.

We had chosen Modesto because we like to take our national program and explore concepts where there are local issues that we can solve at the same time, kind of what we're trying to do here, as well.

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So we started to explore what was going on. As I mentioned, you've got your age mixture, your geochemical conditions and your inputs, start to explore what the water quality from these wells with high uranium, as well as low uranium wells in the area, truly represented.

What we learned was when the wells were cycled off, there was enough of a gradient within the aquifer system that there was a lot of cascading of water and movement of water along those public supply well wellbores. There's high uranium concentration water in the shallow aquifer out there because of agriculture.

So, you know, with irrigated agriculture we've changed the CO_2 concentrations in the water, we've changed

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alkalinity, and that's been mobilizing uranium off the sediment in the shallow aquifer. They knew they had a shallow uranium problem, but all of a sudden we see this in the public supply and we think, well, this uranium starts moving down, now we've got to take these wells offline. All it was is the shallow high uranium water moving down the wellbore when the wells were turned off, moving out into the aquifer surrounding the wellbore, and when the wells were kicked back on you have these spikes of high uranium because now you're drawing in high uranium water from a longer section of wellbore.

Once we understood what their well -- how it was sampling the aquifer, we were able to provide them with information that

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they could change their pumping schedules. Now they pump more frequently and they're putting all their wells back online.

So just understanding where the water from a well is coming from and what that sample actually represents rather than simply looking at a concentration ask reacting. So we had that situation.

Same thing in Albuquerque. They have high arsenic concentrations in some of their public supply wells. Again, we observed spatially where those high arsenic concentrations were, and they were in an area of upward natural gradient. You have naturally high arsenic water at depth, it was moving up wellbores and out into the surrounding aquifer. Again they were able to change pumping schedule and

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improve water quality with really very little effort. So we have these kinds of examples.

MR. HERSHKOWITZ: So just looking toward the future, you think that you will be able to more accurately predict contaminant plume movements on Long Island?

MS. EBERTS: So we'll be able to provide information on age mixtures of water at depths typically used for supply wells, at shallow depths, at surface water features. When it comes to individual contaminant plumes, I don't know how much plume chasing that we'll do, but we'll be providing a tool that other people can continue to make use of in terms of the modelling. Our purpose with our national program isn't really to speak to individual plumes.

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What would you say to that, you USGS folks?

MR. SCHUBERT: I would agree with you. This is an excellent opportunity for technology transfer and building a tool in an area where there's great local interest, and you hand it off to us and then we can address the more site-specific concerns.

MS. EBERTS: Right, I would say that's right. The local office would develop local program based on what the national program can bring to your community and you would develop local project with it. Because that's not something we're doing initially, but we're providing the tools and the data and information and understanding that will allow for that to happen.

Yes?

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AUDIENCE MEMBER: How can you determine the outcome of your formulas when you're including coastal erosion? I have a coastal erosion task force in Suffolk County, and what we're trying to do is encourage the New York DEC to complete the Coastal Erosion Hazard Area Mapping Project. But just in my district in Miller Place, we lost 30 feet of land in one storm.

So how does that relate to how you can determine saltwater intrusion in some of these well areas?

MS. EBERTS: Do you want to take that, John?

MR. MASTERSON: Well, we use a static landform, so we don't take into account how it's changing with time. I'm going to pass it over to Dom because we just did that in Cape Cod with the

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Chatham story with the breach.

MR. WALTER: So we recently completed, we showed a map there, sea level rise in Cape cod, and that was one of the issues we had to deal with, the raised sea level, inundated boundaries in the models. We essentially have a caveat saying you can't really use the groundwater model in those areas, and so we don't even attempt to because, let's face it, it's probably going to be submerged anyway or very much altered. While we're looking at groundwater invasion, rising of the water table, that's going to be the farthest thing from their concerns in those areas, a six-foot sea level rise. So that's something that we --

We did do a few things where we said what if you've

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reached, say, a barrier bar across a freshwater feature and it became from freshwater to saltwater. But again anything near the coast, that is a limitation by the coast, because you can't possibly simulate those kind of changes to the degree you would need to run a regional flow model.

AUDIENCE MEMBER: So how does Suffolk County stand right now with the wells that we have in general?

MR. WALTER: Are you talking about saltwater in --

AUDIENCE MEMBER: Yes.

MR. WALTER: I don't know. You know, essentially, this is on Cape Cod, our supply wells aren't near the coast; they're well inland. So the interface position, no matter what you do to the coast and how you change boundaries locally, they're not

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going to affect supply wells. I don't think Suffolk County has supply wells located right near the shore.

MR. SCHUBERT: On the barrier lines we do. We did see during Irene and to another extent during Sandy that some supply wells, particularly -- not supply wells, but monitoring wells, at lease, did get water flowing down into the wellbore and eventually into the aquifer because they weren't sufficiently elevated to account for increasingly high --

AUDIENCE MEMBER: Our sewers, too, because they weren't high enough we had that issue with sewers. Any suggestions how we can --

MR. WALTER: No. I mean, I don't know.

AUDIENCE MEMBER: Again, I just wanted to also mention to

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LICAP, is there any way you can write a letter to encourage the DEC to expedite the hazard mapping? Because we're waiting on that to determine our priority areas. At least my district on the North Shore, we have severe erosion and we're losing homes. Every storm we're losing homes, you know.

MR. WALTER: The work we've done looks at something that's far less dramatic or far less acute. It's essentially groundwater inundation, rising water tables, erosion of the coast, and we're not able to do anything to those, sort of, acute issues because, let's face it, a six-foot rise --

AUDIENCE MEMBER: So Sara's talking about bluffs on the North Shore and sea level rise. The beaches are disappearing, the

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bluffs are being undercut, and homes that were built close are now even closer, and some are in really bad shape.

AUDIENCE MEMBER: Some have come down. We've got a handful that have --

MR. WALTER: Well, there are coastal erosion experts in the USGS. That's far from me, the geology side of things. I wish I had a better answer for you.

MS. EBERTS: Likewise, I would say I'm not a coastal erosion expert. We're groundwater flow and quality people.

MR. KOCH: I think LICAP's mission also isn't coastal erosion. While it does affect it, I don't think it's a main component.

AUDIENCE MEMBER: It's just that when you lose so much land, you think that change is

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basically the line as far as -- my concern would be saltwater intrusion, and it's going to get in the groundwater, and how does that affect things.

MS. EBERTS: I just wanted to kind of wrap up by saying the local work we're doing here from a national perspective feeds up into our national understanding. But because we work, you know, locally, there are tools and data and information and knowledge that are available, then, to you as a community. If you could have, you know, maybe ongoing dialogue with some of our local people, you can probably imagine the utility of this modelling tool that we're developing.

You know, there are different local issues that could be addressed using the model. It's not for us to imagine what

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those would be, but if you can see where, perhaps -- John was showing the effects of sewering or not sewering, we can really look more closely at those thing with a more refined model. There are a lot of things that we can do with a more refined model that's not part of our National Water Quality Program, but the legacy of the program will be that you'll have this tool and these data sets and this understanding of the age and water turnover times in your aquifer that then you can run with.

The model is being built in fiscal year '16, probably finalized and published in early '17, so it's really not far away. It's been a couple of decades since you've had this kind of a tool.

As I mentioned, it's

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costing us, the national program, several hundred thousand dollars a year to put this tool together, so it's really, you know, a really nice opportunity for you locally to be able, then, to build your understanding and your forecasting and your management of your system with the tool.

MR. SCHNEIDER: This is completely funded by USGS?

MS. EBERTS: It's completely funded by USGS. But there's a lot that you could continue with down the road should you choose, so make some plans.

Any other questions?

MR. MASTERSON: Also permissions for sampling public supplies?

MS. EBERTS: Yes, yes, that was a point I did intend to make.

One of the challenges that

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we've had, since we are sampling public supplies and incorporating that knowledge, someone said, you know, are those really samples that are as useful as monitoring samples? As I mentioned, we're finding they're more useful. They give us a longer history in terms of what's happening in the aquifer. They also speak more directly to the water that we produce that will then be ultimately treated and served to the public. So it's an important piece of the picture.

It's very difficult at times to sample those wells because we have challenges getting permissions. So if there's anything that this group can do to nudge that along, that would be very, very useful to our program, as well as to what you'll get out of it.

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Was there anything else, guys, that you wanted to bring up?

Okay. Thank you for having me.

(Applause.)

MR. WHITE: I just want to say a great thank you to the USGS for making the presentation and for us on Long Island who sometimes complain about what we're not getting or what we're getting. This is a great appreciation for work that's being done, and as was questioned, sponsored by the federal government, and we appreciate that work and the funding. I think the next step for us, in working with your group, is to understand and appreciate the linkages that it's going to mean between the work that you're doing and all the work that people around this table and the counties and state are

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familiar with. So that's what I think we're really hoping for.

MS. EBERTS: Those conversations, you know, will take place right here in the local office, so that would be great. And again, you know, when we look at a principal aquifer and we decide we want to look more closely in several areas within those aquifers to make sure we better understand what it is that we're saying nationally and regionally, we choose to come to locations where there are either water quality issues that we think are worth understanding or engaged communicates that's interested. So those were factors that brought us to Long Island, so we do hope that you stay engaged. It's what attracted us to Long Island.

MR. WHITE: Thank you.

MR. HERSHKOWITZ: How do

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we access this thing?

MS. EBERTS: How do you access this --

MR. HERSHKOWITZ: The presentation materials that you gave today.

MS. EBERTS: They're left on the computer, so I suppose somebody can --

MR. MASTERSON: We can send them some PDFs.

MR. SCHUBERT: I'll work with both LICAP and the DEP, so I hope we can share these things as soon as possible.

MS. EBERTS: And then I'll send you a link to the web tool I mentioned so the people can explore what mixtures of ages actually means for forecasting water quality. There's a couple-of-page the documentation that goes with it. The reality is you can actually just start moving

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things around on the screen and there's really no learning curve at all. It's fun to use and it really drives home how important it is to understand that age of water and the mixture of ages of water at your receptors so that you really can make sense of the water quality.

AUDIENCE MEMBER: So you're going to give us that URL?

MS. EBERTS: I think Chris will send that out. And again, it was developed not necessarily for application by our scientists, but it's really an educational tool for folks like yourselves. I hope that you find it useful.

MR. KOCH: Thanks, Sandy, thanks again, and thanks, John.

The next meeting is going to be held December 9th. That's a full meeting.

Steve, the next

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subcommittee is October 14th, and that's --

MR. COLABUFO: 9:30 it starts. Starts with the Water Quality Working Group, and 10:30 is the joint subcommittee meeting of the water and sewer systems.

MR. KOCH: Any other business?

With that, I think the meeting is adjourned.

(Time noted: 3:51 p.m.)

C E R T I F I C A T I O N

I, KRISTI CRUZ, a Notary Public in and for the State of New York, do hereby certify:

THAT the foregoing is a true and accurate transcript of my stenographic notes.

IN WITNESS WHEREOF, I have hereunto set my hand this 6th day of October 2015.

____

KRISTI CRUZ

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