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In the Matter

- of the -

Meeting of the Scientific and Technical Committee

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1 p.m.

PRESENT:

DAN ABRAMOWICZ
DONALD AULENBACH
JIM BONNER
RICHARD BOPP
BRIAN BUSH
KEN DARMER
DONALD DAVIS
ALBERT DiBERNARDO
ROGER FLOOD
EDWARD GARVEY
JOHN HAGGARD
NANCY KIM
TYLER MADDRY
BOB MONTIONE
GEORGE PUTMAN
GABRIEL RAGGIO
GYULL RHEE
NEIL SHIFRIN
DOUG TOMCHUCK

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MR. DiBERNARDO: But I think everybody knows where they would want to go from here or what the next thing is.

I think I would like to move on, if we can. For those that forgot, this is Dr. Flood. He is going to talk about the side-scan sonar work that we did and the side-scan sonar work that we propose to do; so Roger Flood.

DR. FLOOD: As stated, I guess the first -- or a first objective of this Phase 2-A sampling program is to conduct some geophysical surveys of the river bottom, and there are a couple of reasons why we see this as an important thing to do.

The first thing -- well, I guess with geophysical surveys or remote sensing, what we're doing is using sound in different modes to show us what's on the bottom, and we want to use this in general to extrapolate measurements which are made at one point through core samples over a larger area which can be more easily sampled using sound or acoustic techniques, so there are a number of objectives that I have listed here.

The first is to show -- give us the present status of the river bottom, to make the site map, if you will, which shows where things are at the present time, so if nothing else, in five years we can see to what extent things have changed through natural processes. This is something we can't say now, how fast the bottom changes through natural processes. This would give us something that we could comment on that.

Se:ond, we can get some information on what the sedimentation patterns are or maybe more broadly the structural patterns where different kinds of features are on the bottom. In conjunction with sampling, we can tell where different kinds of sediment types are or different kinds of sediments, and through relation to the sampled PCB distribution patterns, both as part of this project and those especially that are well navigated from previous surveys, we can sort of tie these issues together, again in a spatial distribution pattern.

The third thing we can start getting at are sedimentation processes, what kinds of mechanics actually go towards moving the sedimentss on the bottom, controlling where they are actually deposited. We are looking at an artificially created channel mostly. It's monitored, its flows regulated, and all of this has an implication for transporting sediments, and we are especially interested in the potential for resuspension both by sort of the yearly events that we have talked about and the more unusual or rare event that's going to happen at some time in the future.

A fourth item is that only certain parts of this entire sort of hot spot area, as it were, has been actually sampled to give us information on sediment type and also PCB distributions. We want to be able to use remote sensing data, which is much, much more quickly acquired, in order to understand what the sediment distribution patterns, and perhaps as we -- well, as we go through the process, we'll understand more about the PCB distribution patterns, but what these are in unsampled areas, and then we will as one of the tasks take samples in these areas in order to expand our understanding of the geophysical records.

And the next item that I have listed here are what are some of the possible considerations for -- maybe dredging isn't the way to say it but certain kinds of remedial actions -- in all of this is there that we need to know?

For instance, a sediment thickness, if there's rock right at the surface, we have to consider that. If there's an area of high concentration which is a thick sediment layer, then there is a different kind of interpretation or recommendation.

As Al pointed out, in May we did a one-day demonstration project through EPA that showed us what the bottom of the river is like with scales that we could manage sort of on one day, and in order to put some of these kind of comments more in context, I want to show that, some of the results of that, briefly.

One of the problems is pretty

well known, I think, in terms of sediment variability. This is a stretch of the river just down from Ford Edward, I think. It's about here someplace [indicating]. This is a summary that Ed prepared, I think --

MR. GARVEY: Actually from the New York --

MR. ABRAMOWICZ: It's backwards.

DR. FLOOD: North is on this side.

MR. GARVEY: It's actually based on the DEC survey of core top classifications.

DR. FLOOD: I will back up one step. The section on that chart is right here [indicating], and in our one-day project we went down two times with the sonar and collected a little more high-resolution data sort of in that corner.

The general problem is that there is a lot of sediment variability, as we can see here. We have a lot of areas characterized by gravels, fine sand, fine sand with wood chips, clays, little -- we've got a little spot there; coarse sands, gravel with wood chips, coarse sand -- anyway, all within a very small area we can see all different kinds of sediment types and even a few that didn't fall into this classification, but there's very little reason for understanding either how to connect these samples into patterns or what has created the patterns, and that's, I think, a critical lack of understanding for being able to assess what's going on because there's n -- in a statistical sense maybe we see something, but there's not very much understood past that.

MR. ABRAMOWICZ: Perhaps I missed something. Is that based upon using your side-scan sonar technique?

DR. FLOOD: No, no.

MR. ABRAMOWICZ: That was just the historical data.

DR. FLOOD: This is historical. This is presenting some of the problem, and a similar kind of thing that -- PCB distributions. It's not the best reproduction but we get very high values and low values sort of right next to each other.

Right here, that's characteristic of the whole region, and sort of what to make of that, how do you take one sample or a bunch of samples and extrapolate it to a larger area? How do you know what kind of approach to take to analyze -- to understand resuspension? These are places where we think the geophysical framework will help.

To do this, the primary tool is the side-scan sonar. This is an acoustic device that I show here sort of in a cartoon form. It's operated by a survey vessel, or there's a tow-fish pulled by a survey vessel. The tow-fish transmits sound off to the side. The very narrow band along the track of the fish sends sound out to the side.

The sound -- it will make one ping that would go out to the side. The sound reflects off the sediment, reflects off obstacles and comes back towards the tow-fish, and for any given scan, we get areas of higher reflectivity and areas of lower reflectivity or shadows, so as the survey vessel moves along, the fish moves forward, pings again, sends out a sound beam to the side. As the fish moves along, you end up covering the whole area with sound, and you get returns from much of the area in a picture like this.

MR. ABRAMOWICZ: Question.

DR. FLOOD: Yes.

MR. ABRAMOWICZ: My understanding is that this is an easy way to differentiate, you know, gravel, larger particles from finer particles, but that it's significantly more challenging to try to differentiate, say, fine sands from silts or something like that, particles of similar sizes but very different compositions.

DR. FLOOD: As you can see, what we've got back here is a map of sound reflectivity, and we have to consider what goes into reflectivity in order to get sort of to the end product.

Just to address that, a typical sonar works at 100 kilohertz. The sound pulse -- the sound wavelength is about one and a half centimeters on a 100-kilohertz unit, but the pulse -- I'm not sure exactly how long it is but it is a number of cycles, so it would be a -- there is a pulse maybe about this long made up of wavelengths about this long [indicating] that's sent out and bounces back.

We can do this at more than one frequency. There is a unit that operates at 500 kilohertz -- actually that operates both at 100 and 500. 500 kilohertz would have a wavelength of just three millimeters now, and its pulse length presumably is also shorter, but the basic character of the sound can be shifted depending on the kind of unit that's available.

The actual reflectivity, the strength of the echo that comes back, can vary with a lot of things, as you pointed out. Sediment type is one thing that will affect just how much sound is reflected back at a given angle. Sediment type here could not just mean

HRP 001 1426

sand, silt and clay, but also if we have wood chips, you might expect a different characteristic, return, so there might be some other things that come in here.

Grain size is an important control, especially the relationship between -- or one way of approaching it is the relationship between grain size and the wavelength, so you're right when you're talking about finer-grain sediments, we have -- the particles are smaller than the wavelength, so it does become -- it can be a more difficult process, but if you can count on more than one frequency, you can start to see relationships. Something that's one millimeter here would still be pretty big at 500 kilohertz, although it would look pretty small at 100 kilohertz.

MR. ABRAMOWICZ: Yes, but the success -- you know, the 100-micron type range --

DR. FLOOD: Right. It's difficult but then I haven't heard anyone yet say exactly which part of the sediment is the critical one to map for the PCB problem.

MR. ABRAMOWICZ: We've done a lot of analyses like that actually where we've broken the sediment into a variety of different size fractions using traditional screening techniques and things like that, have mapped total organic content, the PCB distribution, et cetera. These are fairly standard measurements, and as you might not be surprised, it's those finest particles that seem to be enriched in the organic material that show a disproportionately high level of PCB, and we are talking, you know, the less-than-sixty-micron type fraction.

DR. FLOOD: Okay. Well, as you see, and as you say, one cannot -- this is a topic of active research among people who use sonar. It's very difficult to uniquely classify sediments on the sound alone. You have to use some other criteria, but as data sets develop, as we have sediment samples within a sonar grid, we can develop an understanding that seems to work. If we have gassy sediments -- fine-grain sediments especially in fresh water often have methane bubbles. If they're near the surface, that's going to affect the reflectivity.

If we have thin layers of fine sediments over more reflective sediments, that also can affect reflectivity; so there are a number of things that go on. What seems to work out in many instances is that fine-grain sediments, say, tend to accumulate in certain kind of environments, and one can identify those environments based on the setting; so this is all sort of an iterative process that goes on, and one needs to look at some of the data to start to understand how well t actually works.

Also very important is the slope of the bottom. If the sound -- if the bottom is pointing at the fish, you will get a stronger echo. If it's pointing away, you can actually have a shadow effect. Slope is very important, and the topography sort of between grain size and -- in the vicinity of the wavelength can be important; so there are a number of things that go on, and it would be nice if we had a specific property of the sound return that was based on PCBs but that's not -- I would not expect that to happen.

MR. MADDRY: Is there a way to separate some of those variables out? It looks like you get the same reflectivity from different combinations of those, in other words, like looking at patterns of the data or something.

DR. FLOOD: Well, there are patterns. Having two frequencies helps quite a bit, and also working in a region where we have a number of -- a lot of sediment samples. We don't expect to do this in an area and then not sample. We suggested when we take a sonar image, then go and sample just specific things, make sure we know what they are. Some of the exploratory coring is based on that with PCBs in mind, but we can also do a more rapid sediments analysis.

Also, at least the one time we were on the river, the visibility looked good enough for underwater television cameras to be able to show us some of the small-scale textures, and that would help to bridge some of this kind of problem.

MR. MADDRY: So this technique

is used sort of as an additional package of information.

DR. FLOOD: Yeah, it won't stand on its own.

DR. BUSH: Isn't the intensity of the reflection a third dimension you use?

DR. FLOOD: Well, this is the -- the reflectivity is sort of the ratio between the sound that came in and the sound that went back.

DR. BUSH: Right. That is the type --

DR. FLOOD: Right, and these are the sediment characteristics.

MR. ABRAMOWICZ: What about depth?

DR. FLOOD: Well, depth --

MR. ABRAMOWICZ: I mean, say that you -- I mean, in many of the cores we have taken, the sediment characteristic is by no means uniform throughout the core.

DR. FLOOD: Well, this would be the surficial sediments. The rule of thumb is one wavelength or so, maybe two into the sediments.

MR. ABRAMOWICZ: Oh, so this is just -- I didn't realize that.

DR. FLOOD: This is surficial segments.

MR. ABRAMOWICZ: This is just going to give us a bit of that very top layer, perhaps a centimeter.

DR. FLOOD: Right, depending what that material is.

MR. ABRAMOWICZ: Oh, okay.

DR. FLOOD: And the information that would come out would be information especially on patterns. You would see where different kinds of reflectivity were. We would see how these pieces went together, and I'll show you some illustrations that I think will make this kind of clear; where there are rock outcrops.

There's a lot of very fissile shale, I guess, that underlies the river and much of the gravel is really these sort of rock outcrops that seem to break. From patterns and

HRP 001 1432

sediment types we can start talking about the processes, what appears to have been important in moving sediments, and the sediment -- as we build this database to take advantage of what's been collected in the past, we can worry about patterns -- distribution patterns of things related to the sediments, and this is an iterative procedure, this kind of thing, that we put forward models, acoustic models. We sample. We look --

MR. DiBERNARDO: Did you want to elaborate on the subbottom profile?

DR. FLOOD: Well, that's -- the third -- the vertical dimension would come from the subbottom profile and there are -- at least in this part of the river, the main Thompson Island Pool, as we know, many of the sediments are really quite coarse, and we are interested in distribution patterns near the surface, so we have been looking at some of the profiling techniques that, one, could give us the resolution we needed in core sediments, and there are some on the market, especially a swept-pulse system, that should give us the high resolution that we are considering using.

The other thing, especially in terms of -- let's see, I have this written out in one place.

This was just what I said. In terms of especially mud, especially in estuary situations, one can use an echo sounder that works at two different frequencies, say 200 kilohertz and 50 kilohertz, with the idea that the 200-kilohertz sound bounces off the very top of the sediments and the 50 kilohertz might -- will go through the mud and bounce off the stronger layers underneath, and so this gives us the potential for seeing where there is mud, especially near the edges; but this would be the third dimension where the sonar is sideways. I didn't want to get too much into the details.

density?

MR. ABRAMOWICZ: I missed the third dimension somehow.

DR. FLOOD: The third dimension is depth.

MR. ABRAMOWICZ: Yeah, thank you. Is it a different technique you are using to try to get that vertical profile?

DR. FLOOD: Yes. The side profile -- that's a different sheet, but the sonar looks out to the side. What you do is you take the profiles. You essentially point --

MR. ABRAMOWICZ: It's a sonar technique but you aim it straight down.

DR. FLOOD: You aim it straight down. The frequencies that are used to map the surface frequencies are rapidly attenuated in the sediment, so they do not go very far.

MR. ABRAMOWICZ: Yeah, that was obviously then my next question. What kind of depth do you predict?

DR. FLOOD: This -- well, it depends very much on the sediment type, and --

MR. ABRAMOWICZ: What are the typical ranges of depth that you get for different sediment types?

DR. FLOOD: For fine grain you should be able to see thirty or forty meters.

MR. ABRAMOWICZ: Thirty or forty meters?

DR. FLOOD: With a continental margin fine-grain sediment. Now, we don't have thirty or forty meters of fine-grain sediment but that's a typical kind of penetration that can be expected with the systems, so when we talk about the exact kind of sediment here, I think we have to say when the sediments are very coarse, I think we might get a meter penetration with the right kind of system, and that's the area that's of interest.

MR. ABRAMOWICZ: You just -- why don't you go ahead.

MR. RHEE: What is the resolution of particle sizes when you go through that depth?

DR. FLOOD: This particular system, which is new to the -- newly developed, should give a resolution of ten centimeters between layers.

MR. RHEE: No, particle size.

DR. FLOOD: No, you wouldn't determine particle size.

MR. ABRAMOWICZ: No particle

size information.

DR. FLOOD: Well, the particle size information comes from actual sampling. What we are interested in here is in the actual thickness of the material that's present, where there is only this much material or there's this much material.

MR. ABRAMOWICZ: Okay. So this is a probe just to kind of estimate how much sediment there is in a general area but not to characterize it in any real detail.

DR. FLOOD: The characterization would come through an analysis -- from the bottom profiling what we would see are a series of reflecting horizons, so if we had a river bottom, say, like this, what one might expect is that there would be -- one possible thing one might see are reflecting horizons that look like this, and in most instances -- well, most of the time these kinds of -- reflections like this is a time line that is a whole discipline of interpreting subbottom profiles, but just as an example, if we saw a characteristic like this, we would say that the sediments have been building out from the side, but perhaps here there's been a scour event and rather older sediments are quite close to the surface.

One might also see something that looked like this as a kind of layering, and in this case one would interpret that sediments -- that this area has been building up but not going -- so if one sampled here, one might sample into older layers, so these are tools to help to understand the sedimentary environment more than -- they will never replace the specific analysis, I believe.

However, they are very important for giving us a way of extrapolating one measurement to an area that's larger.

MR. ABRAMOWICZ: But that assumes that that one representative sample was representative of that larger area.

DR. FLOOD: But the information that says that, I would -- from my perspective one should be able to determine on these kinds of scales whether it is.

MR. MONTIONE: Clarification. What you're saying is that the subbottom profiling in lieu of frequency, you can determine the total depth to sediment as well as major changes in the sediment in there.

DR. FLOOD: Yes.

MR. PUTMAN: What's the limit of resolution on determining stratigraphy, let's say? Obviously if the particle sizes are quite different, you're not going to see a reflector horizon.

DR. FLOOD: The reflection comes because there's a change in what's called acoustic impedance in the sediment, and that's the -- it's the product of the density and the velocity, so when there is a change in acoustic impedance, then sound is reflected. If all the sediments are identical, then you won't get a reflection.

So this was a tool for allowing us to think about how much sediment is actually present as well as to learn something about the sedimentation patterns.

MR. PUTMAN: But what's the limit of resolution? How different do the reflective layers have to be in terms of the density contrast or whatever?

DR. FLOOD: A tenth of a meter.

MR. PUTMAN: A tenth of a meter.

DR. FLOOD: If they're much closer than that, it's unclear that individual horizons will be resolved.

MR. MADDRY: Have you been able to relate the acoustical impedance to the type of sediment that contain PCBs? Have you used this to determine volume --

DR. FLOOD: Well, the velocity -- there's sort of a -- finer-grain sediments tend to have lower velocities than coarse-grain sediments. Coarse-grain sediments, I believe, have -- coarse-grain sediments have a higher density than, generally speaking, fine-grain sediments, so one would expect to see impedance contrast between coarse- and fine-grain sediments.

MR. MADDRY: It just seems like it would be a very valuable tool. If you have, you know, some of the data on what kind of sediment has PCBs and we're able to relate that to acoustic impedance, then you can get real quick math of what the volume is of all those PCB-invested sediments somehow. Does that make any sense?

DR. FLOOD: I would say that's a use that one would put this towards, yes, and also to the extent where the sediment horizons might show layers coming close to the surface, a sample that's analyzed here might have different amount of material than the one that's analyzed off to the side just because it samples actually a different set of layers, and if, for instance, one could identify a horizon which was, say, related to the '76 flooding or the '73 flooding and understand where those horizons went, then you would go, I think, a long way towards eliminating some of the questions there are.

MR. ABRAMOWICZ: Just a

general question. This seems like an interesting technique, but at least just hearing about it for the first time, it sounds to me like it's more in the research stage at this point, that there are so many potential variables that it is challenging to yield quantitative data.

DR. FLOOD: Well, it gives us -- any drill hole that's drilled for the oil industry is based on this kind of data. The oil industry at the present day would never drill a hole without a seismological profile.

MR. ABRAMOWICZ: But what are they looking for? They're looking for a big batch -- they're looking for a huge hole, right?

DR. FLOOD: That was the old way. Thinks have progressed, and what they happen to be looking for are sediment characteristics, structural characteristics, that make it likely that they will find what they want, but just to say that this is only a research tool, there are many applications where it's taken as a necessary -- a necessary step in a study. Engineers -- a lot of engineering studies on the continental margin where they build -- put up oil rigs are based on seismic profiling supplemented with borings.

MR. BONNER: But in every one of those cases it is basically dramatically different. I mean, you're talking miles there and you are talking centimeters here.

DR. FLOOD: Right, but the --

MR. BONNER: Concept is the same.

DR. FLOOD: The concept is the same, right. Now, the actual -- whether or not -- and the degree to which one will actually see layers depends on the precise equipment which is used, which is -- what we recommended is scale to find the layers that we need to find here.

MR. BONNER: In terms of reliability, is there a scenario where I could come up with Sediment A that has some mixture of fines and coarse fraction and Sediment B that has a different ratio of fines/coarse fraction but in some way that they would generate the same signal? Is that possible to do?

DR. FLOOD: What's seen here is a change from one to the other.

MR. BONNER: What I'm saying is it's an indirect measure, that you could be fooled.

DR. FLOOD: Well, one -- with all of these techniques, one does not believe them -- well, that's probably the wrong word, but it's part of a process. We're not -- I don't think the suggestion is to do this in lieu of anything else. The suggestion is sort of along the lines of how much new insight into the problem will come from another thousand PCB measurements versus what other pieces of information should -- should or could be added to that sediment analysis program that would allow measurements that are made to be understood over a wider area.

Part of the question sort of is at the moment one has to do statistical arguments along these lines to say where different kinds of materials are. Are there approaches that should be used that can allow these kind of boundaries to be drawn much better and also allow the sediment distributions to be understood better in terms of processes, because if that's true, then the association of gravel with some fine sand in certain places and a few wood chips and some coarse sands might be a very logical kind of thing to find in a certain area, and depending on which meter you actually happen to touch with your sample, which is only this big [indicating] you would get a different number.

MR. BONNER: Could your device, your traveling through that little bend in the river there, generate that map as well?

DR. FLOOD: This map -- it could. It could generate something similar to that through an analysis of the reflected sonar records.

MR. MONTIONE: Do you have pilot results to answer a lot of these questions?

DR. FLOOD: Yes.

DR. SHIFRIN: Maybe if you got into some data, it would answer some of these questions here.

MR. DiBERNARDO: I think that

diagram showed if you looked at the various items there's really only three or four major categories. It looks like a lot of different materials but there's fine sand and then there's fine sand with wood chips. I mean, it's fine sand but it's got wood chips, and there's coarse sand and there's coarse sand with wood chips, but --

DR. FLOOD: But there is a sample right here which says clay, this one, and that's right next to gravel and --

MR. DiBERNARDO: I guess my only point --

DR. FLOOD: And according to the Brown results this had no PCB contamination in it, the clay, in this area, so I think that's -- when we talk about these kinds of results, it's towards helping to solve those problems that we're directed to.

MR. ABRAMOWICZ: You just brought up another point I hadn't considered, which is the wood chips. At least in many of the samples we've looked at, wood chips are a nontrivial part of the equation. What would the

HRP 001 1446

system do with a wood chip?

DR. FLOOD: Wood chips would have a low velocity. Anything -- wood is a lower velocity than sediment or rock material.

MR. ABRAMOWICZ: But do you think it has a chance to tell the difference between fine sands and fine sands and wood chips and fine silts and fine silts and wood chips?

DR. FLOOD: I think this could. The potential is there. The reflectivity depends on, as I said, many things. Some of it will be directly related to the sediment particles. I think we can see -- there's a suggestion that we can see the gravels pretty well where they're present. When these charts show a lot of gravel, we get a certain kind of return. When they show fine sand in the channel access, we get a different kind of return, so there is, I think, the potential of that, and wood chips is something that would show up.

In order to do the kind of interpretation that I think is required, this has to be put together with the available sample information. To the extent that we can use these that are well navigated, we will use those, realizing that things may have changed, but that's part of the advantage of it and the samples that are collected during this study.

Let me show you a couple of illustrations.

MR. ABRAMOWICZ: Sure.

DR. FLOOD: Because right now I think this is all more esoteric than it needs to be. That's not exactly what I meant, but I think seeing some results would help focus some of the questions.

So as I said, we did -- I'm going to show a record from this area first just to get us a little more familiar with what a sonar record looks like. This is in the vicinity of Lock 7 where the Hudson River comes in south of Rogers Island and then continues down.

Then there are three records in this area that go across -- some examples from the eastern side down into the channel, and then we have some others down here if we get that far.