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STATE OF ILLINOIS
Pollution Control Board

ILLINOIS POLLUTION CONTROL BOARD
February 17, 2009

IN THE MATTER OF:)
)
WATER QUALITY STANDARDS AND) R08-9
EFFLUENT LIMITATIONS FOR THE)
CHICAGO AREA WATERWAY SYSTEM AND) (Rulemaking -
LOWER DES PLAINS RIVER PROPOSED) Water)
AMENDMENTS TO 35 ILL. ADM. CODE)
301, 302, 303, and 304)

TRANSCRIPT OF PROCEEDINGS held in the
above-entitled cause before Hearing Officer Marie
Tipsord, called by the Illinois Pollution Control
Board, pursuant to notice, taken before Rebecca
Graziano, CSR, within and for the County of Cook and
State of Illinois, at the Thompson Center, 100 West
Randolph, Room 2-025, Chicago, Illinois, on the 17th
Day of February, A.D., 2009, commencing at 10:00
a.m.

A P P E A R A N C E S

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ILLINOIS POLLUTION CONTROL BOARD:

Ms. Marie Tipsord, Hearing Officer
Ms. Alisa Liu, P.E., Environmental Scientist
Dr. Tanner Girard, Acting Chairman
Mr. Anand Rao
Mr. Thomas Johnson
Dr. Shundar Lin
Ms. Andrea Moore

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY:

Ms. Stefanie Diers
Ms. Deborah Williams
Mr. Robert Sulski
Mr. Scott Twait
Mr. Roy Smogor

ENVIRONMENTAL LAW AND POLICY CENTER:

Ms. Jessica Dexter

METROPOLITAN WATER RECLAMATION DISTRICT OF
GREATER CHICAGO:

Mr. Fredric Andes
Mr. Marcelo Garcia

1 MS. TIPSORD: Good morning. My name
2 is Marie Tipsord, and I've been appointed by the
3 Board to serve as hearing officer in this procedure
4 entitled Water Quality Standards and Effluent
5 limitations for the Chicago Area Waterway System and
6 Lower Des Plaines River Proposed Amendments to 35
7 Ill. Adm. Code 301, 302, 303, and 304. The docket
8 number is R08-9.

9 With me today to my left is acting
10 chairman, G. Tanner Girard, the presiding Board
11 Member. To his immediate left is Board Member
12 Andrea Johnson -- Andrea Moore, and to her left is
13 Board Member Dr. Shundar Lin. To my far right is
14 Board Member Thomas Johnson. To my immediate right
15 is Anand Rao, and to his right, Alisa Liu from our
16 technical staff. In addition, today we have Brian
17 Lambel, who is our extern this semester from Kent.

18 This is the ninth set of hearings
19 to be held in this proceeding, and I believe we're
20 on days 24 and 25. The purpose of today's hearing
21 is to continue hearing testimony from the
22 participants, other than the proponent, the Illinois
23 Environmental Protection Agency. At the close of
24 hearing on December 3rd, 2009, we had finished with

1 22 witnesses from the Metropolitan Water Reclamation
2 District of Greater Chicago. We will continue with
3 the District starting today with Marcelo Garcia,
4 Adrian Numera (phonetic), Paul Freidman, and Samuel
5 Dennison.

6 Generally, the testimony will be
7 marked as an exhibit and introduced if read. After
8 marking the pre-filed testimony as an exhibit, we
9 will then proceed to the pre-filed questions, and I
10 believe we still have the IEPA and the Environmental
11 Law and Policy Center that are the only two that
12 pre-filed questions for these four witnesses.

13 Anyone may ask a followup
14 question, and you need not wait until your turn to
15 ask questions. I do ask that you raise your hand,
16 wait for me to acknowledge you. After I've
17 acknowledged you, please state your name and whom
18 you represent before you begin your question.
19 Please speak one at a time. If you are speaking
20 over each other, the court reporter will not be able
21 to get your questions on the record. Please note
22 that any questions asked by a Board member or staff
23 are intended to help build a complete record for the
24 Board's decision, and do not express any

1 preconceived notion or bias. We will go until
2 around 5:00 p.m. today with a lunch break, and then
3 we'll start again tomorrow morning at 9:00 a.m.

4 Also, I have heard from some of
5 you about future dates, and at this time, I plan to
6 continue this hearing on the record. The plan was
7 to go for March 3rd and 4th. I have rooms in the
8 building across the street and here, and I'd like to
9 finish the witnesses from the District at that time.
10 Mr. Andes, you indicated before we went on the
11 record that those days might not work for the
12 District?

13 MR. ANDES: I believe that's right,
14 but I will get back to you later today to nail that
15 down.

16 MS. TIPSORD: All right. Because my
17 intent, frankly, at this point is if the District is
18 not available, then I would be inclined to, since we
19 have rooms for those days, move ahead and come back
20 to the District when they are available. Because of
21 the difficulty of the scheduling that I've already
22 seen from the IEPA and others, that would, sort of
23 -- I would, kind of, like to try to do that. So if
24 you could get back to me later in the day, that

1 would be very helpful.

2 MR. ANDES: I will.

3 MS. TIPSORD: So I can give notice to
4 whoever else can be available on those days. Thank
5 you.

6 I also received a motion from Corn
7 Products seeking to withdraw their testimony of both
8 James Huff and Alan Gerick (phonetic). I think
9 they're going to withdraw and then re-file. I
10 didn't, frankly, read the motion. I just saw it and
11 I spoke briefly with Katherine Huff. Citgo also, in
12 conversations with Jeff Ford, would also like to,
13 perhaps, amend their testimony with some additional
14 information.

15 Given this -- these, sort of,
16 developments, and given that it has been awhile
17 since we've talked about the schedule, as far as who
18 would be testifying next and where we're going, I
19 would like to schedule a pre-hearing conference for
20 -- I picked February 27th, which is a week from
21 Friday. If people can't be available that day, we
22 can do it the afternoon of the 26th. But check your
23 calendars and get back with me, and I will put a
24 hearing officer order out on Thursday reflecting the

1 additional hearings and the pre-hearing conference,
2 which would talk about where we're going, who we're
3 proceeding with, and based on an email I got from
4 Ms. Dexter, too, I also understand that the
5 environmental groups might want to decide what order
6 their witnesses are presented as well.

7 So that will be what we'll talk
8 about. We'll talk about who's going next, where
9 we're going, after we're finished with the District.

10 MS. DEXTER: Did you say, Marie, that
11 those would be in the afternoon on either of those
12 dates, or at any time?

13 MS. TIPSORD: It could be at any time
14 during the day on the 27th and the afternoon of the
15 26th. It would have to be the afternoon of the 26th
16 because we have a closed session in the morning.

17 MS. DEXTER: All right. Thanks.

18 MS. TIPSORD: So I won't be available
19 until afternoon until the 26th. And with that, Dr.
20 Girard.

21 DR. GIRARD: Thank you. Good morning.
22 On behalf of the Board, I welcome everyone to
23 another set of hearings in this rulemaking. The
24 Board is very grateful for the amount of time and

1 effort that everyone is putting into both preparing
2 testimony and also preparing questions and
3 continuing the questions in the cross examination of
4 the hearings. It helps us immensely in putting
5 together a record, especially in these days of, you
6 know, lean governmental budgets and lean staffing.
7 We really do need the help, so we appreciate
8 everything you're doing. We realize this is a very
9 extensive rulemaking, but this, you know, is a very
10 complicated topic. So we look forward to the
11 testimony and questions today. Thank you.

12 MS. TIPSORD: And with that, Mr.
13 Andes, I think we're ready to swear in your witness.

14 (Witness sworn.)

15 MR. ANDES: This is a copy of
16 Dr. Garcia's testimony.

17 MS. TIPSORD: And it is Dr. Garcia?

18 DR. GARCIA: Yes.

19 MS. TIPSORD: Just wanted to check.

20 DR. GARCIA: Yes, yes.

21 MS. TIPSORD: And you're going to have
22 to speak up. I can tell already. They're not going
23 to be able to hear you in the back of the room.

24 DR. GARCIA: Don't worry about that.

1 MS. TIPSORD: If there's no objection,
2 we will mark the pre-filed testimony of Dr. Garcia
3 as Exhibit 139. Seeing none, the testimony and
4 attachments are marked as Exhibit 193. Thank you.
5 And I believe the Agency had pre-filed some
6 questions.

7 MS. DIERS: Yes. Good morning, Dr.
8 Garcia. My name is Stephanie Diers, and I'll be
9 asking questions on behalf of Illinois EPA, and I'll
10 begin with our pre-filed question one. How might
11 density occurrence affect water quality and
12 transport little oxygen, sediment laden water, and
13 contaminants for long distance? And I think this
14 refers to on Page 3 of your pre-filed testimony.

15 DR. GARCIA: Right. Okay. Let me
16 first explain what is a density current. A density
17 flow is a name given to a flow that happens when you
18 have differences in density between two fluids. So
19 the best and simplest way to imagine this, imagine a
20 lake, and imagine that you go through the winter,
21 and all of a sudden spring comes along, and there's
22 no -- and all the water -- all the runoff finds its
23 way into the river, and eventually the water in the
24 river flows into the lake.

1 If the temperature of both the
2 water in the lake and the temperature of the water
3 in the river -- or if you want to do it more
4 generally, the density is different between one and
5 the other, and the density coming down the river,
6 because it's cold water, is larger than the one in
7 the lake, still the flow, just entering the lake
8 nicely, at some point, it's going to plunge. It's
9 going to go underneath, and it's going to generate
10 what we call a density current.

11 In the case of the Chicago River,
12 the question is: How might a density current affect
13 water quality and transport oxygen sediment laden
14 into someplace. Well, these flows have the ability
15 to transport whatever it is that they are carrying,
16 be it salt, something you put on the streets, and
17 find its way through the runoff into a river, be it
18 the difference in temperature, or because of
19 suspended particles or solids, they can travel for
20 very, very long distances, you know, up to several
21 miles, several kilometers.

22 So what you are doing is basically
23 taking water that could have really low dissolved
24 oxygen, and it could have other contaminants in it.

1 You are distributing it through a mechanism that
2 allows these flows to reach places that otherwise a
3 regular flowing river would not get to, and I'll
4 give you an example of that.

5 For instance, the many leaps that
6 we have in close proximity between the junction
7 between Bubbly Creek and the south branch, there are
8 a number of entrances on the river, the center face
9 leap and so forth. The way these flows work, let's
10 assume that you have a density flow in the area
11 generated because -- by water coming out of Bubbly
12 Creek. Well, it has the ability to actually go not
13 just downstream along the south branch, but also to
14 try to go upstream, depending on the conditions of
15 the river, and take whatever comes with it and
16 deposit it there.

17 So the answer -- it's a long
18 answer, but it's -- but the important thing here is
19 to understand what -- how do these flows happen,
20 because they go -- since we don't see them, because
21 it's like having a river under a river in this case,
22 we tend to think that there isn't much going on
23 there.

24 MS. DIERS: So with respect to

1 question two, what distances are you referring to or
2 suggesting, and you're saying seven miles?

3 DR. GARCIA: Several miles.

4 MS. DIERS: Several?

5 DR. GARCIA: Several miles.

6 MS. DIERS: Okay.

7 DR. GARCIA: Not seven, several. They
8 can travel several miles, depending on what the
9 river flow conditions are.

10 MS. DIERS: And have you done modeling
11 in the Bubbly Creek or in the Chicago Area Waterway
12 System throughout the whole system to show that the
13 impact is several miles?

14 DR. GARCIA: Yes.

15 MS. DIERS: And can you explain what
16 you've done?

17 DR. GARCIA: We have been modeling.
18 We started to model this about a year and a half
19 ago, and we can model the possibility that when the
20 Racine Avenue pumping station goes into action due
21 to a rainfall event, the water that comes out of the
22 pumping station into Bubbly Creek will -- has a
23 possibility of being dense enough -- I mean, not
24 dense, I mean heavy enough -- to generate a density

1 current once it reaches the basin in the south
2 branch.

3 We have modeled that. We have a
4 paper that is going to be presented at a conference
5 in May in Kansas City. We will be happy to share
6 copies with you with my students, and what we see is
7 that, indeed --

8 MR. ANDES: Actually, should we -- do
9 you want to use the chart?

10 DR. GARCIA: Yeah, sure.

11 MR. ANDES: Okay. Well, I think you
12 have one here. I can pass them out.

13 DR. GARCIA: Yeah. We -- I had made a
14 poster, which was -- the idea was to be able to show
15 it to you, but last night I was trying to catch a
16 train and the poster --

17 MR. ANDES: Well, let me take those.

18 DR. GARCIA: Sure.

19 MR. ANDES: We have two reports and a
20 chart that we can introduce that are relevant to
21 this issue.

22 DR. GARCIA: This is the one you --

23 MR. ANDES: That's the one you want to
24 use right now?

1 DR. GARCIA: The density current one.

2 MR. ANDES: Okay. Just a moment.

3 DR. GARCIA: Essentially, what we have
4 done with the model, to answer your question, is to
5 try to explore different scenarios that have the
6 potential to generate density current in the south
7 branch of the Chicago River.

8 MR. ANDES: Let me stop you there.
9 We'll introduce the reports, and then we can go on.
10 We have a report entitled Upstream Intrusion Effect
11 of CSO Events in Bubbly Creek, Illinois.

12 MS. TIPSORD: If there's no objection,
13 we'll mark this report, Upstream Intrusion Effect of
14 CSO Events in Bubbly Creek, Illinois, as
15 Exhibit 194. Seeing none, it's Exhibit 194.

16 MS. DIERS: Can I ask just a quick
17 clarifying question on this? IS this the paper that
18 you're referring to that you'll present in Kansas
19 City?

20 DR. GARCIA: Yes.

21 MS. DIERS: Okay. Thank you.

22 MR. ANDES: And then we have a chart
23 with the title Upstream Intrusion Induced by CSO
24 Events.

1 MS. TIPSORD: If there's no objection,
2 we will mark that chart as described as Upstream
3 Intrusion Induced by CSO Events as Exhibit 195.
4 Seeing none, it's Exhibit 195.

5 DR. GARCIA: If I can explain what the
6 chart shows, because it's a lot easier to do that
7 than try to go over the paper. But the idea here is
8 we use a three dimension dynamic model. It's a
9 model that we refer to in the testimony through the
10 dynamics code. And what we do, as I was explaining,
11 we use the model to explore different scenarios in
12 which the Racine Avenue pumping station is
13 discharging water into Bubbly Creek and, say, into a
14 CSO event.

15 We keep the flow constant, about
16 55 cubic meters per second, based on what we know
17 about the Racine Avenue pumping station, and then we
18 see how it's going to function. The water moves
19 into Bubbly Creek, and you can see that there is a
20 changing color -- unfortunately, as I said, I had a
21 larger poster with these same images, but this is
22 the time when you find out that your glasses might
23 not work that well -- but you go from times zero,
24 let's say, the very first image here, and then you

1 move over to the right, and as you go by, time
2 passes, goes on, and the changing color implies that
3 there is a front, this density current front is
4 moving, basically, along Bubbly Creek, until it
5 reaches a turning basin.

6 The one below, the one image that
7 sits down below, it'S simply to show you -- you see
8 where it's, kind of, reddish orange there, that's
9 when the flow first reaches the turning basin and
10 what it shows is that -- it's a concentration of
11 sediment at milligrams per meter. So what you can
12 see is that the reddish color is the largest
13 concentration, and then the blue would be the lowest
14 concentration, and that's the same for all the
15 graphs, okay?

16 So this gives you an idea of the
17 grading and the concentrations that happen because
18 of this flow, and then what it shows is the
19 complexity of the flow at the junction and the
20 basin. Because you see all these lines that look
21 like a whirlpool? They are basically showing that
22 there is a lot of rotation on the flow. There is a
23 substantial amount of mixing.

24 If you go in the paper, if you

1 would be kind enough to look into the paper, if you
2 go to figure -- the paper explains how we do this.
3 But if you go to Figure 6, okay, it gives you a lot
4 more detail here to what happens with what we call
5 the stream lines. The stream lines basically show
6 you if you release a particle there, what is it
7 going to do? Is it going to go straight into the
8 south branch, or is it going to spin around for a
9 while, is it going to get mixed up with other
10 particles.

11 And what you can see here, as part
12 of what I was telling you before, the structural --
13 the flow there is complicated. You can see that on
14 the one -- on Image D, you can see some particles
15 going all the way across the south branch into this
16 river that is there. And what we found with this
17 paper, which was the main intent of the paper, it
18 wasn't necessarily to try to characterize anything
19 in particular, but it was based on the data that we
20 have from the Racine Avenue pumping station with a
21 recent CSO event, could it be possible for density
22 current to take place, and we found numerically yes,
23 indeed, that can happen.

24 But what we do in the paper, we go

1 one step further -- and this is getting to the
2 question, which is that -- one of the questions --
3 depending on how much water is coming down the south
4 branch -- and there is a table here. If you go to
5 table two, okay, which is about the fourth page in
6 the paper, these are the cases that we have tested.
7 So we say the flow coming down the main channel of
8 the south branch, it can range, let's say, anywhere
9 from not moving at all, but let's just put a low
10 flow, a kilometer per second -- that's about
11 1,000 liters. That's about 250 gallons per
12 second -- all the way to 30 kilometers per second,
13 and we see the amount of water, with sediments,
14 coming out of Bubbly Creek.

15 And then what we see is that when
16 the water gets to the junction, it actually takes
17 off as a density current, and it tries to actually
18 go upstream into the south branch. So it's almost
19 like the river has lost its memory. You know, it
20 remembers that 100 years ago it used to flow that
21 way, and the water of the river is still sloped in
22 that way. The water surface may slope the other way
23 depending on what we do to the river.

24 So what it does is it tries to go

1 upstream, and that's what we call in the paper
2 intrusion, upstream intrusion. That's why we have
3 this term in the paper. So what is happening is
4 this water is trying to go up, and in the process of
5 going up, it's also finding its way into some of
6 these lakes, and it deposits in there the sediment
7 that was bringing.

8 So what we need to visualize this,
9 if you look at the Mississippi River and then you
10 have the salty water and you go to Mexico, and that
11 salty water, because it's denser, is trying to form
12 something very similar to a density current. It
13 tries to move upstream, but the Mississippi's
14 pushing it the other way, and that's what we call an
15 arrested wedge. This is similar of what is
16 happening in the south branch.

17 So in the case of the Mississippi,
18 of course you don't want that to happen during those
19 conditions, because if you get salt water --- this
20 goes back to your question, how long can this go.
21 In the case of the Mississippi, it can go 100 miles
22 upstream intrusion. Of course, it's not the same in
23 the Chicago River, you know, because we have the
24 ocean pushing salty water upstream, but just to give

1 you the idea of how far this phenomenon can go.

2 So if you have a water intake
3 there, it's not very good for New Orleans because
4 you're going to be pumping in salty water. In our
5 case, we want to understand what is the role played
6 in this phenomenon. Because wherever it goes, it's
7 going to deposit materials there, and it's also
8 going to bring in the BOD that was in there, in the
9 CSO, not just the sediments.

10 So anybody who -- or anything that
11 is transported in low oxygen water is going to come
12 with it as part of the flow itself. So it's going
13 to take it to different places. As you go to the
14 other side -- and I know this is long.

15 MS. DIERS: That's fine.

16 DR. GARCIA: But upstream is trying to
17 intrude, but it's facing the flow coming down the
18 south branch, but then it's also going to try to go
19 with the flow, and what we find out is that it mixes
20 up more with the flow that is going down the south
21 branch.

22 So what we have been trying to do
23 is model -- in particular we have concentrated a lot
24 on Bubbly Creek because early on, as part of a phase

1 one study, between Grand Avenue, Lake Michigan and
2 Cicero Avenue, we said, "Okay. Let's do a 3-D model
3 of all these," and then it became quite apparent
4 that the role played by Bubbly Creek was not only
5 unique, but it has a large impact on the system
6 depending on flow conditions.

7 So that's what steps have been
8 taken as to try to model this type of phenomenon.
9 And I have to say that -- I'm not sure if we have it
10 in the testimony, but also the city, the water
11 department for the city, they're known as two
12 outlookers, which are sensors that basically send
13 acoustic waves and they measure how much water is
14 moving on the south branch. So we can put one in
15 correlation with a geological survey. There is one
16 upstream of the junction between Bubbly Creek and
17 the south branch and there is one downstream.

18 And what we're trying to see if we
19 can catch these events in the acts, basically, not
20 just model them. You know, modeling is just a tool.
21 But to see actually, you know, when they happen, how
22 often they happen, you know, what is the frequently,
23 you know, how much water you're actually getting
24 into it.

1 MS. DIERS: When did you start doing
2 that?

3 DR. GARCIA: This we started about a
4 year and a half ago, yes.

5 MS. DIERS: And is it currently
6 ongoing?

7 DR. GARCIA: We are going full force,
8 yes.

9 MS. DIERS: And I think you said that
10 you have three scenarios that you looked at. How
11 did you decide the scenarios?

12 DR. GARCIA: Basically we decided it
13 was based on what the range of flows is from the
14 Racine Avenue pumping station, and also the range of
15 flows that we know can come down the south branch.

16 MS. DIERS: And on Exhibit 194,
17 Figure 5, you have CSO particle concentration equals
18 1,000 milligrams per liter. Is that measured or
19 assumed?

20 DR. GARCIA: That's -- it's an assumed
21 value, but based on records taken by the history.
22 You're talking -- can you clarify which one is the
23 one you're looking at?

24 MS. DIERS: I have a report. It's

1 Exhibit 194.

2 DR. GARCIA: Yes.

3 MS. DIERS: And I'm looking at
4 Figure 5. I'm not sure what page.

5 DR. GARCIA: Yes. This is --

6 MS. DIERS: I think it's the sixth
7 page.

8 DR. GARCIA: This is an assumed value
9 for the purpose of the modeling exercise. It
10 doesn't mean -- therefore, it doesn't mean that all
11 the CSOs that come out of a scene are going to come
12 out are going to have 35 millimeters per second and
13 are going to have a concentration of 1,000. But
14 that's a value that we estimated to be a reasonable
15 value for the purpose of modeling.

16 MS. DIERS: And I know you mentioned
17 the Mississippi River. So have you measured density
18 current in other places? Outside of the Chicago
19 River area, have you measured in the Mississippi
20 River?

21 DR. GARCIA: No.

22 MS. DIERS: Have you measured anywhere
23 else?

24 DR. GARCIA: I, myself, cannot

1 measure, but I did my PSE on density currents a long
2 time ago at the University of Minnesota. And the
3 motivation for that was actually a problem in Lake
4 Superior, and it had to do with mining and disposal
5 of mine tailings. And that's according to this
6 topic, because the tailings were going into Lake
7 Superior. This was near Duluth, and people thought,
8 "Well, we'll dump it into the lake, and this goes
9 and takes the tailings all the way to the deep end
10 of Lake Superior."

11 And at the time, I calculated that
12 they could travel for 80 kilometers, these flows.
13 But there was -- there was an issue, and the issue
14 was that depending on the time of the year, Lake
15 Superior would stratify, and that would mean that
16 the density of the water column, particularly in the
17 summer, it wouldn't be the same. So what these
18 flows were doing, they were coming down, and when
19 they found a layer of water that had the same
20 density, they made an intrusion there.

21 But, see, the lake was
22 circulating. It was taking the water all the way to
23 the water intake of Superior, Wisconsin, and the
24 People in superior, Wisconsin, they didn't like

1 that, because they found bad substances on the
2 tailings. And that, basically, shutdown the mining
3 operation to the point that when the mining
4 operation resumed a few years ago, they no longer
5 can dump into Lake Superior. They got, basically,
6 tailing basins, you know, in the ground.

7 I have also worked -- because you
8 asked me in the field where I had worked. Last year
9 I worked at a project in Canada where there is
10 another mining operation, and there is a mine, and
11 the residue, fortunately it doesn't contain any
12 contaminants, but it has a -- because it has a very
13 material -- it has very fine particles that come --
14 remain in suspension for a long time.

15 So they use the lake as a settling
16 tank. They pump the tailings with the idea that you
17 form a current, and that way you take the sediments
18 far away and deposit them in the water. That
19 doesn't work that way all the time. So in Canada,
20 in the mine operation, you have to make sure that
21 the sediment doesn't cross this imaginary line from
22 here to here. Otherwise, you know we'll find you.

23 So we had to do a study with one
24 of my colleagues, Professor Parker, and then with

1 another professor, Jack Lucat (phonetic), who is a
2 geotechnical engineer, to try to figure out a way to
3 move the pipes that put the tailings into the lake
4 so that, first of all, the particles circulate, they
5 are not on the surface, because it's a lake used for
6 recreational purposes, and then the particles don't
7 go sideways.

8 MS. DIERS: And do you know what the
9 impact of the density currents are on aquatic life?

10 DR. GARCIA: The impact -- we don't
11 know much about what the impact is, but I can
12 imagine a situation in which you could have these
13 density flows reaching out to places on a hot summer
14 day where fish might seek refuge, you know, what
15 people call thermal refuge, you know. You go there
16 because it's cold, the water is colder than the
17 surface of anywhere else. And since these flows are
18 always trying to reach a point of lowest elevation,
19 they might reach that, and that might not be good
20 for the fish.

21 MS. DIERS: But you don't know for
22 sure, correct?

23 DR. GARCIA: I don't know for sure,
24 but I have seen this happen when somebody makes a

1 mistake at a nuclear power plant, and all of a
2 sudden they release very cold water into a lake that
3 is using for cooling purposes, you get a density
4 flow, and it goes all the way under the water and
5 you get fish kill. So the answer is I don't know
6 for sure, but you are going to get water of poor
7 quality to a place where it might affect it.

8 MR. ANDES: If I can follow up on that
9 for a moment, I think it might help to -- this is
10 Exhibit 1 to Dr. Garcia's testimony. I just thought
11 this map might be helpful for people to visualize in
12 addition to the color maps, just to make sure people
13 have that.

14 So Doctor, I see -- is your point,
15 looking at the map of Bubbly Creek, that the density
16 current leads to potential impacts during wet
17 weather events up in the south fork?

18 DR. GARCIA: No -- yeah. Part of my
19 conclusion is that, that you have the potential to
20 have density flows and that they are going to
21 impact --

22 MR. ANDES: Beyond Bubbly Creek?

23 DR. GARCIA: They are going to impact
24 Bubbly Creek, and they could impact beyond Bubbly

1 Creek, too, depending on the impact in the south
2 branch.

3 So, for instance, if you have no
4 flow down the south branch -- let's assume that we
5 call that the freshwater flow, which comes down the
6 south branch -- the chances of having an intrusion
7 going upstream are going to be larger, of course,
8 and the extension of it is going to be larger. But
9 also, you could have a flow going downstream on the
10 south branch.

11 Now, one thing I want to clarify
12 is that it doesn't mean that all the flows emanating
13 from the scene are going to lead -- all the CSOs are
14 going to lead to density currents, okay? But the
15 potential is there, and that's why we are doing the
16 modeling, that's why we are studying, and that's why
17 we're trying to measure this.

18 MS. DIERS: Do you know if it'll
19 affect any other segments besides the south branch?

20 DR. GARCIA: Well, nobody's coming out
21 of here. I think what is coming out of here has the
22 potential to affect the south branch itself. Now,
23 one question that someone may ask is whether -- how
24 far down the south branch is this going to go, and I

1 imagine that it could go pretty far.

2 However, having said that, when
3 these flows happen, at the interface, what we call
4 the ambient water and the water that makes it flow,
5 this is constantly mixing too. So the flow keeps
6 diluting as it travels. So the further away you go
7 from the source of the flow or where the flow plans
8 and it went underneath, the turning basin -- after
9 the turning basin, the impact is going to diminish
10 with distance.

11 One thing I want to clarify is
12 that -- which I mentioned before, is that if you
13 look at this exhibit, this figure, you see all these
14 leaps across. So what that means is if you have a
15 flow going up the south branch, okay, the minute it
16 finds an open door there on this leap, it's going to
17 try to go in there, and it's probably going to it
18 there, and it's going to deposit whatever the hazard
19 is. Then the river has no other mechanism to
20 actually get this out of there, whatever it is that
21 the density flow put on the bottom of those leaps,
22 and that obviously brings other questions probably
23 into your mind too.

24 MS. DIERS: I'm going to go back to

1 our pre-filed question three.

2 DR. GARCIA: Yes.

3 MS. DIERS: And on Page 3 of your
4 pre-filed testimony, you're talking about -- you say
5 your recommendations have been implemented. Are you
6 referring to MWRDGC accepting those recommendations?

7 DR. GARCIA: You mean accepting,
8 right?

9 MS. DIERS: Mm-hmm.

10 DR. GARCIA: Because the question says
11 accepting. But which one is at -- I need some
12 clarification on that.

13 MS. DIERS: I'm sorry. On Page 3 of
14 your pre-filed testimony, "Our recommendations have
15 been implemented." And question -- the pre-filed
16 question three is asking who -- what recommendations
17 are you referring to, and who did you make them to?

18 MR. ANDES: So you're referring --

19 DR. GARCIA: Oh, yeah.

20 MR. ANDES: So you're referring to
21 recommendations about the SEPA stations.

22 DR. GARCIA: Yes.

23 MS. DIERS: I think -- yeah. I think
24 that's what it's trying to ask.

1 DR. GARCIA: Yes.

2 MS. DIERS: "Our recommendations have
3 been implemented." I was just trying to get
4 clarification on that.

5 DR. GARCIA: Yeah. That was -- that
6 was a study that was done for the District. The
7 SEPA stations, as you know, are used to increase the
8 amount of dissolved oxygen. Some of them were
9 experiencing sedimentation problems, and we did a
10 study -- I think it was around 2000, I believe -- to
11 try to see how we could solve the problem. The
12 problem was that there was a lot of fine sediments
13 in suspension the Cal Sag where the SEPA stations
14 are, and I know that that gets quite a bit of
15 organic material in it.

16 So it was going into the SEPA
17 station, and it would settle down in there, and
18 cause a sedimentation problem. So we started the
19 problem both with measurements, and we looked at how
20 to solve it, how it could be solved. We modeled --
21 we did a 3-D model of the flow intake to try to make
22 the operation standards of the District, and then we
23 model the SEPA stations themselves, which was a very
24 complicated exercise, because of the shape that they

1 have.

2 And, in particular, we
3 concentrated on SEPA number three, and we made a
4 series of recommendations, and they were -- last
5 October I took a litigation from Argentina to Buenos
6 Aires that came to visit -- to see how water quality
7 is managed in the Chicago waterways, and -- because
8 they've got very similar problems, and actually a
9 lot worse than the problems that we have here with a
10 particular lake in Buenos Aires, and we went to see
11 all the SEPA stations, and when we were there, SEPA
12 three was out of commission. They turned them off
13 in October, depending on how the weather has been,
14 and then water came down, basically, modifying the
15 volume of the rivers to meet the recommendations.
16 They tried to solve the problem.

17 MS. DIERS: Okay. With question four,
18 what recommendations did you provide?

19 DR. GARCIA: The recommendations that
20 we provided were that the District and its
21 consultant, which was the company that designed it,
22 the pools -- this was -- by the way, I think it's
23 one of the greatest innovations I have seen
24 worldwide, the SEPA stations. You know, Illinois

1 state water surveys through Tom Butts was involved
2 in this early on in the study of the pools, and the
3 District built the pools as an alternative to -- at
4 the time of tertiary treatment, and they had water
5 failure.

6 However, when they built the
7 pools, one of the decisions that was made was to put
8 columns on the bottom of the pools with the idea of,
9 I think, trying to prevent young people from
10 entering and getting hurt or drowning or having an
11 accident. And that was fine for that purpose, but
12 when you have these columns on the bottom and you
13 have the water going above and the water has a lot
14 of fine materials, somehow these fine materials find
15 its way through the space between the columns and
16 started to fill up the current.

17 So that became, like, a breeding
18 ground for the plants, basically, after the sediment
19 was captured. That became a problem, because the
20 District, every summer, had to go in, stop the
21 operation, clean up. Cleanup is not easy. These
22 roots go really deep, so it's not just easy to get
23 them out through mechanical means. Sometimes you
24 have to use other products to do these. So there

1 was a lot of interest in doing this.

2 So the first recommendation we
3 made was you have to get rid of the columns. You
4 have to put a bottom that, first of all, is flat,
5 but it has a certain amount of slope so that once in
6 awhile you can also flush the system through a
7 series of pipes, without having to stop the
8 operation of the SEPAs.

9 And that was the main
10 recommendation that we made. We also recommended to
11 redistrict the flows as they went on to the wheels,
12 particularly the first set of wheels on SEPA three,
13 and we also looked at other things, the possibility
14 that maybe some of the positions between the water
15 intake -- I don't know if you're familiar with SEPA
16 three, but there is a canal that goes underneath the
17 sidewalk, basically, in this park-like area.

18 So we looked at the deportation
19 for sedimentation there, should we worry about
20 cleaning that too, should that become a source of
21 sediment for the future. So those are some of the
22 recommendations that we made.

23 MS. DIERS: I think we've already
24 talked about question five, and I did want to ask,

1 specifically with respect to number six, when did
2 your research begin with the density currents you
3 were looking at in the system?

4 DR. GARCIA: In the system? A long
5 time ago. You mean the Chicago River System?

6 MS. DIERS: Mm-hmm.

7 DR. GARCIA: Almost ten years ago,
8 nine years ago.

9 MS. DIERS: Okay. And then with
10 respect to Bubbly Creek?

11 DR. GARCIA: Bubbly Creek a year and a
12 half ago, as I stated before.

13 MS. DIERS: And when will your study
14 be completed?

15 DR. GARCIA: I think in about a year.

16 MS. TIPSORD: For clarification, the
17 study on Bubbly Creek.

18 DR. GARCIA: On Bubbly Creek, yes.
19 This I have to -- I think it's in the testimony.

20 MR. ANDES: This is the study to
21 develop the 3-D model. Am I correct?

22 DR. GARCIA: Yes. We -- this -- what
23 we're doing now is part of a larger project with the
24 idea of being able to model the Chicago waterways

1 and develop a 3-D model of the waterways, and what
2 we're doing right now is what we call phase one, and
3 it entails the Chicago River from Grand Avenue in
4 the north branch all the way to the dock by the lake
5 in the main stem, and then all the way down the
6 south branch to Cicero Avenue just upstream of
7 Stickney.

8 And the reason why we broke this
9 down in phases is because originally, I wanted to do
10 the whole 80 miles in one shot, and something called
11 me to my senses, and I said, "Well, isn't that a
12 little bit too much?" And as it turns out, yes. If
13 you try to do everything at once, it's a lot.

14 So what we are doing now -- this
15 is phase one, like I explained -- and inside phase
16 one is Bubbly Creek. This project, phase one, is a
17 36-month project, and I think that we started to
18 work on it somewhere in June of 2007. We finally
19 got everything going in 2007.

20 MS. DIERS: Okay. And phase one is
21 not completed?

22 DR. GARCIA: Phase one is the one that
23 we are working on, and you can say we are halfway --
24 a little bit more than halfway.

1 MS. DIERS: Okay. And what would
2 phase two be?

3 DR. GARCIA: Phase two is going to
4 build the north branch. It's going to include --
5 excuse me a second, because I don't want to --

6 MR. ANDES: I believe we're referring
7 to a progress report that was attached to the
8 testimony. That would be attachment three to the
9 testimony.

10 DR. GARCIA: No. Actually, this is --

11 MR. ANDES: That's a progress report
12 on phase one.

13 DR. GARCIA: Just a second.

14 MR. ANDES: Let me clarify. The
15 document that Dr. Garcia is referring to is not
16 attachment three. The progress report is a separate
17 document, which is the research proposal, and we can
18 provide copies. So this would be a new exhibit.

19 It's titled Research Proposal, the Chicago Waterway
20 System, Environmental Modeling, Phase One, Chicago
21 River Main Stem, South Branch, South Fork (Bubbly
22 Creek) and Sanitary and Ship Canal.

23 MS. TIPSORD: If there's no objection,
24 we will mark this research proposal as Exhibit

1 No. 196. Seeing none, it's Exhibit 196.

2 DR. GARCIA: So this -- this proposal,
3 just for clarification, because I think it's a lot
4 easier to read the document, this was the original
5 proposal we prepared for the District to develop
6 this 3-D model of the waterways, okay? The proposal
7 was written in mid-2006, but because of different
8 circumstances, things didn't start until mid-2007.

9 If you go to -- this explains what
10 we are doing and what we were doing. It talks about
11 density currents, what we knew about density
12 currents at the time, which was the main stem of the
13 Chicago River, the motivation for doing the 3-D
14 modeling. And then if you go to Page 12 of the
15 proposal, it tells you what are the different phases
16 of this project. So you have the phase one, which
17 is the one that we are on right now, and it says
18 this proposal is one I was trying to explain, that
19 goes from the main stem of the Chicago River, and
20 then the north branch, and then the south branch of
21 the Chicago River, the Sanitary and Ship Canal, and
22 the south fork of the south branch of the Chicago
23 River -- that would be Bubbly Creek -- and if you
24 can see there in parenthesis, we said Bubbly Creek

1 will be initially modeled with -- it's a model
2 that -- a 2-D model.

3 We decided that there was no point
4 in trying to throw the kitchen sink initially at --
5 in terms of modeling Bubbly Creek, because we knew
6 very little about it. So we said why don't we --
7 you know, people got one model of it, that was a
8 Marquette University model of it. We said, "Why
9 don't we go 2-D and try to see what happens on a
10 plane before we try to see what happens on the
11 column," which we have already done, but we started
12 with a 2-D model. That's another paper that will be
13 presenting in Kansas that we can also enter.

14 But let's continue with this right
15 now. So you can see here, the proposal called for
16 that 36-month study, and that's what we have done, a
17 little bit more than halfway into it, and then we
18 have a phase two, which is 24 months, and then we
19 have a phase three.

20 One thing that is important to
21 mention is that together, with this proposal, they
22 use a logical survey, and also submitted a proposal
23 to do synoptic measurements, that is measurements of
24 flow and water quality at different locations,

1 including the symmetry of the water elevation in the
2 river so that we can put that into the mathematical
3 model to run it, basically, to do the model
4 predictions. And those are still ongoing, and
5 they're going to -- they're going to continue.

6 So that, in a way -- if we go back
7 to your question, when did the research begin, it
8 began mid-2007. Who is involved in this research?
9 Well, the University of Illinois, our group, and
10 also the geological survey is involved with a few
11 measurements, along with the District as well.
12 They're monitoring at the research branch. They are
13 also working with us on the mission. We need to run
14 them all.

15 MS. DIERS: After the 3-D model
16 results become available, how will these results be
17 used to determine the aquatic life potential for the
18 south fork, south branch of the Chicago River?

19 DR. GARCIA: What is that question?

20 MS. DIERS: It's a followup based on
21 what we've been talking about.

22 DR. GARCIA: Oh, okay.

23 MR. ANDES: Can you repeat the
24 question?

1 DR. GARCIA: It didn't sound familiar.
2 So the question is?

3 MS. DIERS: After the 3-D model
4 results become available, how will these results be
5 used to determine the aquatic life potential in the
6 south fork, south branch of the Chicago River?

7 DR. GARCIA: Okay. The aquatic life
8 potential. When I wrote this proposal, the main
9 motivation, if you read the proposal, is to try to
10 understand what is the structure -- how the river
11 behaves, okay. Because we knew, from what they have
12 done before in the late '90s and early 2000, that
13 the conditions in the river are not homogeneous.
14 And what I mean by that, is that the velocity of the
15 water is not the same at the surface as it is at the
16 bottom, but also the temperature of the water is not
17 the same near the surface as it is near the bottom.
18 The sediment you're going to find is not being the
19 same. In other words, there are variations in the
20 system.

21 So the motivation for having the
22 3-D model and using it as a tool is to see how the
23 rivers actually behaves as a whole. When you have a
24 CSO event during dry weather events, I mean, what

1 happens when you don't -- just normal operations of
2 the river, what goes on in the river, that's what
3 makes Bubbly Creek kind of unique, because it's in
4 two completely different stages. You know, one were
5 there's practically no flow, and one were there's
6 flow.

7 So the answer to -- your question
8 is how are we going to use a model. I think the
9 model is going to help people that want to figure
10 out or want to assess water quality in the Chicago
11 waterways determine -- how do you say -- if not with
12 more precision, in a more educated fashion, I would
13 say, what are the true conditions in the river.

14 MS. DIERS: I'll go to pre-filed
15 question eight. What other options were there
16 besides the environmental fluid dynamics code? I
17 guess I should also ask first what is the
18 environmental fluid dynamics code?

19 DR. GARCIA: Yeah. The environmental
20 dynamics code -- yeah. We have a -- if you want, we
21 can give you the --

22 MR. ANDES: We have an exhibit, which
23 is titled Environmental Fluid Dynamics Code, EFDC.

24 MS. TIPSORD: If there's no objection,

1 we will mark Environmental Fluid Dynamics Code,
2 EFDC, as Exhibit 197. Seeing none, it's
3 Exhibit 197.

4 DR. GARCIA: The environmental fluid
5 dynamics code, as the name indicates, is a
6 three-dimensional code that can be used to model
7 dynamic sediment transport, and it also has
8 nitrification components, for example, and it was
9 available by Dr. Joe Hambrick (phonetic) when he was
10 a professor at the Virginia Institute of Marine
11 Science in the early '90s, and it was there
12 originally for rivers going into estuaries. But
13 it's a model that has received wide application --

14 MR. ANDES: If I can stop you there,
15 Marcelo, we have another exhibit, which is a list of
16 known EFDC applications as of January 2004.

17 MS. TIPSORD: If there's no objection,
18 we will mark the list of known EFDC applications as
19 Exhibit 198. Seeing none, it's Exhibit 198.

20 MR. SULSKI: Two from 200.

21 DR. GARCIA: So what you can see from
22 this second -- if we were in class I would say a
23 handout -- exhibit, is because it's been widely used
24 in places like the Everglades, and it's a code that

1 is used these days for -- to establish total maximum
2 daily loads, for example, of TMDLs into streams and
3 lakes.

4 Could we have used another code?

5 Yes. There are a lot of codes out there now that
6 people use. Why are we using EFDC? Well, I thought
7 that the characteristics of the waterways, in a way,
8 they behave a lot like an estuary more than a
9 typical river, just because of the large degree of
10 mining control that we have here in this particular
11 case. I also wanted to use EFDC because it's a
12 public domain code that we could -- what that means
13 is that we could get access to the source code, and
14 we could try to adapt it to the Chicago waterways.
15 We would have to pay for the license and so forth,
16 and then be set for life on the particular type, and
17 so forth.

18 So we can modify it, and the other
19 thing is it's a code that's supported by U.S. EPA.
20 U.S. EPA teaches courses with this code to many of
21 the people, you know, state agencies, federal
22 agencies, consultants. They use the code for TMDL
23 studies. So those were some of the considerations
24 that went into -- into play.

1 I also had the opportunity to have
2 been exposed to this code as part of a five-year
3 review panel, and this was a case between General
4 Electric and U.S. EPA, and I was part of the review
5 planning of the modeling, and one of the models that
6 they use is a river model, and a fish dynamics
7 model, and a risk of human exposure to model, and
8 the model that they had used at the time was the
9 EFDC. And in that particular case, the model
10 struggled a little bit, because it was a natural
11 river, very different from what they have in this
12 particular case.

13 But that's how you begin to
14 intimate with the EFDC. And so when the time came
15 to choose a tool, I thought the learning curve, if
16 we go with this model, is going to be a lot shorter
17 than if we try to start to work with another model,
18 commercial or public, or if we try to develop it on
19 our own.

20 MS. DIERS: Okay. Pre-filed question
21 number nine, which I think we might have talked
22 about, but I'll go ahead and ask it, what conditions
23 might cause the south branch of the Chicago River to
24 act as a barrier to the flow coming out of the south

1 fork of the south branch of the Chicago River?

2 DR. GARCIA: Right. Yes. What I --
3 what I tried to -- when I referred to that on the
4 testimony, the way to visualize this is that
5 depending on what the water levels are in the south
6 branch of the Chicago River, you know that the
7 models of the waterways is that when there is a
8 storm on the way, at Rockport they open up the
9 gates, and they say, "Okay. We need to lower the
10 water surface elevation in the waterways in
11 anticipation of the rain that we are going to get."
12 So the idea is that you remain some storage capacity
13 by doing that.

14 Now, there are other instances in
15 which you do that, but still it starts to rain, the
16 water level in the river starts to go up. So
17 depending on what the water elevation is compared to
18 the water coming out of Bubbly Creek, you are going
19 to have what we call a backwater effect.
20 Essentially, the south branch is going to back up
21 the water coming out of Bubbly Creek.

22 Now, that is going to depend on
23 how much Racine Avenue is pumping, and how much is
24 coming out of the storm outfalls, the ones that you

1 can see in Exhibit 1 right here. So all of those
2 are going to contribute water, particularly during a
3 storm event, and depending on what the south branch
4 is doing in terms of water surface elevation, this
5 is going to backup, more or less, water into Bubbly
6 Creek, and that's what I meant by that.

7 It's a dynamic situation, and the
8 way this works -- because Bubbly Creek has an
9 inoperative flow -- all it does is get all the
10 kinetic energy, or the water coming out of the
11 pumps, transforms that kinetic energy to potential
12 energy, essentially, and raises the water level,
13 into then Racine, you know, the pumping station,
14 until the water starts to flow towards the south
15 branch. Now, if the water in the south branch is
16 too high, well, it's going to flow less.

17 And the effect of that, if I could
18 elaborate more, is that at times, you're going to
19 have Bubbly Creek moving with a certain regime of
20 flow velocity. The flow discharge is going to be
21 the same, but depending on what the south branch is
22 doing, the water is going to move faster, more
23 slowly, in Bubbly Creek, and it could work.
24 Depending on the effects, sometimes it could work as

1 a settling tank, and sometimes it could actually
2 transport -- you could be swift enough to resuspend,
3 and move whatever came in, plus whatever it can pick
4 up from the bottom of the creek.

5 So what the south branch does,
6 it's important to the dynamics of the CSOs in Bubbly
7 Creek. And therefore, that's the need to have a 3-D
8 model, because the only thing you can do is -- I can
9 come here and try to explain this, but the only way
10 you can do this is through direct observation, doing
11 as many measurements as you can.

12 MR. ANDES: If I can follow up on
13 that. So if you have these wet weather events where
14 the flow may be coming out of Bubbly Creek and going
15 into the south branch, if one, then, were to add
16 flow augmentation, supplemental aeration to address
17 issues, what effect could that have, in terms of
18 changing the phenomenon? What impacts would that
19 have outside of Bubbly Creek?

20 DR. GARCIA: You're asking me now?

21 MR. ANDES: Yes, yes.

22 DR. GARCIA: Well, you know, there is
23 consideration of, as Fred is saying, increasing the
24 amount of flow, particularly in dry weather

1 conditions, so that the water moves, injecting air
2 and so forth. We have more than that as well with
3 our 2-D model, and what we have found is we need to
4 know more about the sediments along the bottom of
5 Bubbly Creek.

6 And the reason why we need to know
7 more is because, as you know, there is a legacy
8 there of material that was -- that found its way
9 into Bubbly Creek for many, many years from the
10 stockyards and the packing -- the meatpacking
11 houses, and there is always buildup, and then on top
12 of that buildup there is a contemporary -- and I
13 call it contemporary for lack of a better word --
14 the contemporary sediments have found their way
15 there from the outfalls and the water coming out of
16 the pumping station.

17 MR. ANDES: Should we use your report
18 on that issue?

19 DR. GARCIA: Yes. Yeah, we can use
20 that.

21 MR. ANDES: We have an exhibit on this
22 issue. It's titled Two Dimensional BOD and D.O.
23 Water Quality Model for Engineering Applications,
24 the Case of Bubbly Creek in Chicago, Illinois.

1 MS. TIPSORD: If there's no objection,
2 I will mark the report as described as Exhibit 199.
3 Seeing none, it's Exhibit 199. There are extra
4 copies of these last four exhibits, too, that are
5 still up here on the front table if somebody needs
6 one.

7 DR. GARCIA: So if you -- this is also
8 another word with my graduate students -- here what
9 we tried to do was model the water quality in Bubbly
10 Creek, and to try to understand what was going on.
11 And the main -- the main thing coming out of it, if
12 you look at figure -- don't look at the equations,
13 because you're not going to like the equations. But
14 if you look at Figure 4, there we have the symmetry
15 of Bubbly Creek, and then we look at the flow
16 velocity field in different colors.

17 So what we were trying to do here
18 is figure out how fast does the water move in Bubbly
19 Creek when the Racine Avenue pumping station is
20 discharging water at a certain rate. So if you look
21 at this figure, it corresponds to a rate of about
22 69 cubic meters per second. And then what we try to
23 do is, besides modeling the flow velocity, you can
24 see that near the pumping station the flow moves

1 very fast, and then it starts to slow down. And
2 then on the lower two graphs, there we show
3 biochemical oxygen is in demand. You can see that
4 is the largest closer to the turning basin, or as we
5 approach the Chicago River itself, and then we have
6 dissolved oxygen.

7 So when we were going through all
8 these exercises -- and you can see that when the
9 water comes from the Racine Avenue pumping station,
10 you know, it has been tumbling and going through
11 drops and things. So it's fair to assume that it's
12 fairly well oxygenated, but it also has a very large
13 BOD, a large demand for oxygen in it. Some of it is
14 settled, some of it may settle as the flow goes on,
15 some of it might just stay with the flow.

16 So when we were doing these
17 exercises, we were trying to understand what happens
18 in Bubbly Creek, in terms of water quality, due to a
19 CSO event. And then the question came, "What is a
20 role played by the sediments," and then that's when
21 we started to see that the sediments played a role
22 that was a lot more important than we originally
23 thought, and it was difficult to correct it.

24 And what do I mean by that? Well,

1 as you know, the sediments have a certain appetite
2 for oxygen. So there is a certain amount of
3 sediment oxygen in demand that takes place, and that
4 sediment oxygen in demand is a function we know from
5 previous studies, research at the University of
6 Minnesota, for example, by Professor Highstef
7 (phonetic) and the design of aerators and lakes to
8 prevent fish kills in, you know, winter conditions
9 where you have ice on top of a lake. We know that
10 the amount of sediment oxygen in demand depends on
11 the flow velocity near the interface between the
12 water and the sediments.

13 So when we started to play with
14 that parameter, we said "Wait a minute." You know,
15 anything that we try to do here, we have to be
16 careful, because we might try to do this flow
17 augmentation, but then depending on how fast we move
18 the water, we actually may be hitting this process
19 of sediment oxygen in demand, and actually, even
20 though we may be injecting more oxygen, the oxygen
21 might end up in the sediments, and not necessarily
22 in the water column, which is where we want it say,
23 for fish, and other life forms.

24 So as part of this study, we also

1 look at what we call privilege indication scenarios.
2 The person that wrote this paper is Italian, and he
3 likes the word purification. So we tried to say
4 "Okay. Why don't we look at the different
5 alternatives of -- that can be considered by the
6 District and as part of the user and the analysis
7 studies," and this going back to the flow
8 augmentation, the aeration that Fred was referring
9 to, and we started to look at those with the help of
10 our model, okay? And we started to play with
11 different parameters, and that has led us now to
12 believe that what we have done, we think is right.

13 You know, we -- look at Figure 6,
14 for example. We look at the radiation coefficient,
15 and the idea is whether you move the water faster,
16 you get more aeration because you produce more
17 material. Well, that material also affects the
18 sediment oxygen in demand, but also, if the flow
19 becomes too turbulent and swift and fast, then the
20 chances of the suspended sediment increase. And
21 once you suspended it, now you're sending a new
22 source of oxygen demand into the water column. And
23 of course, if you're doing a model, you need to
24 account for that.

1 But also, if you're trying to do
2 any type of -- or you're considering any type of
3 remediation alternative to try to keep dissolved
4 oxygen levels at the certain value, then you have to
5 take that into account, the possibility that, "Okay.
6 We could recirculate the water, which is one of the
7 things that we can look at. Besides pumping water
8 from the south branch, besides adding oxygen to that
9 water, we also have to look at what if we just
10 recirculate and we increase, we pump in air." Well,
11 this seems to work on the surface, but we still have
12 this question of all the solids, the sediments in
13 the water. So there's that.

14 MR. ANDES: So to follow up, does that
15 mean that if you apply these methods, the aeration,
16 recirculation, but you don't do it correctly, you
17 could actually worsen the problem?

18 DR. GARCIA: That would be correct,
19 yes.

20 MR. ANDES: And you would need to do
21 these additional 3-D modeling and further studies in
22 order to determine what to do and what levels you
23 could get to. Am I correct?

24 DR. GARCIA: Yes. Besides the 3-D

1 modeling, what we are in the process of doing now is
2 basically turning Bubbly Creek into a lab, an
3 experimental lab, in the sense that we are trying to
4 add more sensors to the ones that the District
5 already has, the water quality sensors that we have.
6 We are going to have flow sensors as well, but also
7 we just build a gizmo, which is just half a pipe --
8 and I saw it yesterday. It's not done yet, but we
9 follow the experience of the Illinois state water
10 survey with Tom Butts. He did a lot of measurements
11 of sediment oxygen in demand on the waterways of
12 Illinois. This is a report that people can download
13 from the web.

14 But basically, they use what is
15 called a ventichamber that you lower it, you put it
16 on the bottom of a stream or lake, and then you run
17 water through it, and you do a test, and you can
18 figure out how the sediment oxygen demand changes.
19 We can modify that, and now we are building -- in
20 our shop, in the department, we are building a new
21 flow with the idea that was used before of this
22 ventichamber, but it's a little bit optimized from a
23 highly dynamic point of view.

24 So we are going to lower it in the

1 water of Bubbly Creek in different locations,
2 because there is a lot of spacial variability on the
3 quality of the sediments, we think, and then we are
4 going to do a test where we are going to run with a
5 pump from a pontoon. We are going to recirculate --
6 and this is in collaboration with a geological
7 survey with the District -- we are going to
8 recirculate the water, and we are going to get water
9 that is in sediment oxygen demand at different
10 locations in Bubbly Creek for different flow
11 conditions.

12 So you may say, "Well, that's
13 fine. What is going to come out of it?" Well, what
14 is going to come out of it is going to allow us to
15 obtain, experimentally, laws that is basically in
16 equation, that then we are going to be able to put
17 into our 1-D model, like the Marquette Model, or
18 you're going to be able to put this in a 3-D model
19 that gives you all the -- what could be potentially
20 the resuspension at different locations, and what is
21 going to be the sediment oxygen demand as a function
22 of flow velocity at different locations in Bubbly
23 Creek.

24 MS. TIPSORD: Dr. Garcia, you referred

1 to a report that could be download from the web.
2 Could you please tell us the website where that's
3 available?

4 DR. GARCIA: Yes. I can give you a
5 copy of the report, but I only have one copy.

6 MS. TIPSORD: If it's --

7 DR. GARCIA: If you do -- yes.

8 MS. TIPSORD: If it's available on the
9 web, I think if you could just give us a citation of
10 what --

11 DR. GARCIA: It's the Illinois State
12 Water Survey.

13 MR. ANDES: We can provide a link
14 later.

15 MS. TIPSORD: Okay. That would be
16 great.

17 DR. GARCIA: I can't tell you what it
18 is now, because all the surveys have just been
19 transferred to the University.

20 MS. TIPSORD: Yes. That's all right.
21 If we can get it later that's fine.

22 DR. GARCIA: But if you do Illinois
23 State Water Survey and you type Butts, B-u-t-t-s,
24 Thomas Butts was the author of the report.

1 MS. TIPSORD: Thank you.

2 DR. GARCIA: And this is ISWS,
3 Illinois State Water Survey dash 74-R -- like in
4 Robert -- I -- like in Irwin -- no pun intended --
5 dash 76. So ISWS-74-RI76. And there are other
6 reports of interest by this same person,
7 coworkers --

8 MS. TIPSORD: Thank you.

9 DR. GARCIA: -- on the subject.

10 MS. DIERS: With respect to
11 Exhibit 199 -- and I'm going to ask a question about
12 Figure 4 in your report.

13 DR. GARCIA: 199 is -- did --

14 MS. TIPSORD: The two dimensional BOD.

15 MS. DIERS: The two dimensional BOD.

16 DR. GARCIA: Yes.

17 MS. DIERS: The numbers that you have
18 in your Figure 4, are they measured or modeled?

19 DR. GARCIA: Figure 4, these are
20 modeled. But we have to put it under the condition
21 at the Racine Avenue pumping station.

22 MS. DIERS: So based on this modeling,
23 is it -- are you assuming D.O. won't go below 8.1?

24 DR. GARCIA: Well, what this shows is

1 that for this particular exercise, you're going to
2 be in that range of values. If you go -- if I may,
3 if you go to Figure 5, we tried to see if we can --
4 we are comparing -- in that figure, we are comparing
5 the measurements taken by the District with the
6 results of our modeling in that figure, Figure 5.
7 So where you see the nice, smooth curves, this is
8 the modeling, and it's because it's in that
9 particular one. And then when you see the points
10 fluctuating going up and down, those are
11 observations.

12 So what we learned from this
13 particular modeling exercise is that you see the
14 blue ones -- which is the upper one -- are the
15 measurements at I-55. That's where the District has
16 a water quality monitoring station, and what happens
17 after that CSO event is that the dissolved oxygen,
18 which is what we have plotted in there on the
19 vertical axis, versus time in the lower axis, it
20 seems to recover. You know, it first drops when the
21 CSO event takes place, but then after a number of
22 hours, it recovers, and we think this is influenced,
23 to some extent, by diffusion, basically, coming from
24 the south branch. Diffusion of oxygen, it would be

1 in this case.

2 While if you go to the other
3 monitoring station, the one on 36th Street, which is
4 a lower set of curves than the red one, then you see
5 that the oxygen goes down, and it has a hard time
6 coming back and making it up above two milligrams
7 per liter, even after 72 hours. So after --
8 72 hours after this CSO event happened, according to
9 our model and according to the measurements taken by
10 the District, you can see that it takes awhile to go
11 back.

12 So what this is telling us is that
13 even though Bubbly Creek is relatively short
14 compared to the rest of the waterways, it doesn't
15 behave the same. You know, in its first half, if
16 you want to call it, in the first portion that it
17 does -- as you get closer to the south branch.
18 Therefore, we go back to what we said before, the
19 dynamics of what happens both aerodynamically and
20 intensive water quality in the creek is influenced
21 by what the south branch is doing.

22 MS. DIERS: I have nothing further.

23 Thank you.

24 MS. TIPSORD: Miss Dexter?

1 MS. DEXTER: Jessica Dexter with the
2 Environmental Law and Policy Center.

3 MR. JOHNSON: Before you get started,
4 Jessica, just a quick question.

5 Dr. Garcia, our environmental
6 engineering students at U of I are lucky, because
7 clearly you enjoy teaching and have done a great job
8 today.

9 DR. GARCIA: Thank you.

10 MS. TIPSORD: You say in your
11 conclusions here that you think additional study is
12 essential prior to us setting water quality
13 standards. Do you think the District and the Agency
14 and us, ultimately, will have enough information to
15 do that by the end of phase one, or do you think
16 each of the proposed additional phase two and phase
17 three would be --

18 DR. GARCIA: Well, with regards to
19 Bubbly Creek, I would hope that yes, we are going to
20 have enough --

21 MR. JOHNSON: Okay.

22 DR. GARCIA: -- at the end of phase
23 one.

24 MR. JOHNSON: Which is a little over a

1 year down the line?

2 DR. GARCIA: About, yes.

3 MR. JOHNSON: Thank you.

4 MS. DEXTER: One second. All right.

5 Most of my pre-filed questions have been answered
6 during IEPA's questions, but I do have a few
7 followups about the density currents. The density
8 currents that your model is predicting, just so it's
9 clear to me, are those due to increased sediment
10 density, or is there a temperature density factor
11 also?

12 DR. GARCIA: It could be a combination
13 of all of them.

14 MS. DEXTER: Okay.

15 DR. GARCIA: And we have found, after
16 awhile, when we look at the density currents that we
17 started in the -- around 2000, we found out that the
18 north branch at times, particularly in the winter,
19 it could be denser in the main stem, and this had to
20 do with the diversion from Lake Michigan. We
21 submitted that, you know, this would be the wind
22 blowing, but it could also be a stratified flow. At
23 the beginning, we thought the temperature was the
24 main cause of this, because it was in winter so we

1 were thinking, "Well, maybe it's cold water." And
2 then after doing a lot of measurements in the field
3 and some more modeling, we had reached the
4 conclusion that the salt that is poured on the
5 streets of Chicago to melt down the ice and the snow
6 in the winter months, once that snow, that ice, that
7 water, you know, it melts down, it goes into runoff
8 and it reaches the waterways, we think that that's
9 one of the major sources of density differences that
10 causes density currents. That's in the north
11 branch, main stem, south branch.

12 Going back to Bubbly Creek, we
13 believe that here, in particular, suspended solids
14 are going to take the lead in causing the
15 development of potential density currents. And when
16 you model these, you treat it -- you have what is
17 called an equation of state that simply says, "Well,
18 if I have -- I got in the water, what can make it
19 heavier?" Well, it depends on the temperature of
20 the water. It may be a little bit heavier if it's
21 40 degrees centigrade than if it's at 20 degrees
22 centigrade. What if I start putting particles on
23 it? I'm going to make it heavier. If I put salt in
24 it, I'm going to make it heavier. So all these can

1 contribute.

2 But for clarification, for Bubbly
3 Creek, from what we know so far, now we are going to
4 do more measurements, and this creek is going to
5 measure exactly -- you're going to see what's coming
6 out of the pumps.

7 MS. DEXTER: Okay. Does the
8 temperature of the flow coming out of Bubbly Creek
9 tend to be warmer or cooler than that in the south
10 branch?

11 DR. GARCIA: That's a good question.
12 If I had to guess, I think it's going to be cooler
13 than what is there on a hot summer day. You know,
14 things are sizzling pretty good. That's why it's
15 called Bubbly Creek in the summer. So I come and
16 look at it -- we have bodies of temperature, and now
17 we're going to measure more, but I think if we look,
18 we're probably going to find out that it's going to
19 be cooler.

20 Now, having said that, if you look
21 at a diagram -- and if I could just take a moment
22 here -- if you plot temperature versus density, it
23 looks like -- something like that.

24 MS. TIPSORD: I'm sorry. Dr. Garcia,

1 you're going to have to explain that for the record.

2 DR. GARCIA: Oh, okay.

3 MS. TIPSORD: Remember, people will be
4 reading the transcript and they won't know what --

5 DR. GARCIA: Well, let me just say,
6 then, in simple words: To create -- to create the
7 density current, just based on temperature
8 differences, you need to have very large temperature
9 differences.

10 MS. DEXTER: Okay. And you don't
11 think that those temperature differences
12 currently --

13 DR. GARCIA: I don't.

14 MS. DEXTER: There's not a great
15 difference that you know of?

16 DR. GARCIA: Not in the summer.

17 MS. DEXTER: Okay.

18 DR. GARCIA: But if you probably have
19 a CSO today, it would probably float in Bubbly
20 Creek.

21 MS. DEXTER: All right.

22 DR. GARCIA: It will be lighter. So
23 you will have, like, an overflow instead of an
24 underflow.

1 MS. DEXTER: Okay.

2 DR. GARCIA: I'm trying to exaggerate
3 a little bit there --

4 MS. DEXTER: That's helpful, though.

5 DR. GARCIA: -- so you can visualize.
6 But it would be lighter in terms of temperature.

7 MR. GIRARD: Dr. Garcia, when you say
8 a large difference, are you talking five degrees
9 centigrade, 20 degrees centigrade? What do you
10 consider large?

11 DR. GARCIA: Well, that's why I was
12 trying to draw the diagram. The maximum density
13 awarded is four degrees centigrade, okay? That's
14 when it peaks, and that's what makes things
15 complicated in the Chicago waterways, because
16 depending on which side of the 40 degrees you are,
17 you could go lower than that. Centigrades could be
18 over 30 to 40, just to give you an idea.

19 So depending on where you are, you
20 could have water that under the bottom is colder and
21 on the surface is warmer. You would need to have at
22 least ten degrees centigrade of temperature
23 difference to have a size of -- a difference in
24 density. Because otherwise, this flow is

1 undeveloped. If you don't have enough density
2 difference, just the motion or the water itself will
3 disrupt the formation of the density current, and
4 you'll just have a regular river flow, or what we
5 call an open channel flow or a free surface flow. I
6 don't know if this clarifies it.

7 MR. GIRARD: Yes, it did. Thank you.

8 DR. GARCIA: The difference would have
9 to be large.

10 MS. DEXTER: Okay. And if that -- if
11 there was such a large difference and there -- let's
12 see. Let me back up one step.

13 How often throughout the year
14 would you expect a density current to occur? Do you
15 know that from your model?

16 DR. GARCIA: You mean in Bubbly Creek?

17 MS. DEXTER: Yes. In Bubbly Creek,
18 how -- is this a constant problem?

19 DR. GARCIA: We haven't done a long
20 term analysis of it because we're still working on
21 the model, but depending on the conditions of the
22 CSO, there's a sediment. You're going to have --
23 you could have a density current when -- amidst
24 Bubbly Creek, but you could also have -- you know,

1 Bubbly Creek is going to mix up pretty good, too,
2 but it's small compared to the amount of water that
3 comes in.

4 But at the junction with the south
5 branch, depending what is below the sediment, the
6 flow might get there and just say, "I'm going to
7 continue as a regular flow," but the conditions
8 could be such -- that's why we're showing one of the
9 exhibits -- that it made plans and may become a
10 density flow.

11 So the answer to your question is
12 I don't know, because it's going to depend on the
13 frequency of CSO events and the characteristics of
14 CSO events, and that's why now we're going back with
15 the District, and we are going to measure exactly --
16 not just the flow, how much is coming out, but what
17 are the characteristics of what is coming out of
18 there in terms of suspended solids, BOD, D.O., and
19 so forth, and other parameters.

20 MS. DEXTER: Okay.

21 DR. GARCIA: So the answer is going to
22 vary. It's going to depend on -- and the whole
23 purpose is, you know, things are optimized, and TARP
24 gets bigger. The frequency of this flow is going to

1 go down, and the characteristics of the flows are
2 going to be bigger. But as long as you pump, the
3 possibility of having the phenomenon are going to be
4 there.

5 MS. DEXTER: Would you characterize it
6 as being a rare occurrence or a common occurrence
7 that -- from -- can you tell right now if this is
8 something that you think happens quite frequently,
9 or is this something that happens more or less --

10 DR. GARCIA: I don't know how
11 frequently it happens, but I think the potential is
12 there for this to happen each time you have a CSO
13 event.

14 MS. DEXTER: Okay.

15 DR. GARCIA: The potential is there.
16 It doesn't mean that it's going to happen each time,
17 but it's there.

18 MS. DEXTER: Okay. I think that
19 covers my followup questions, and now I'll just ask
20 my pre-filed questions four and five. Do you know
21 if the District or the University of Illinois,
22 Urbana-Champaign, or anyone else to your knowledge
23 has studied fish passage through the CAWS?

24 DR. GARCIA: Fish passage?

1 MS. DEXTER: Fish passage. You
2 mentioned something about fish passage standards in
3 your testimony.

4 DR. GARCIA: Right. I can tell you
5 what U of I is doing right now. We haven't studied
6 fish passage in Bubbly Creek, okay? That's number
7 one. What we are doing right now is we are looking
8 at a small dam located in the north branch of the
9 Chicago River just before the junction with the
10 north shore channel, and the Friends of the Chicago
11 River wanted to look at the possibility of modifying
12 the dam and put in a fish way there, something they
13 call a fish way, a fish passage.

14 At that time, we were contacted by
15 the District. U of I was contacted by the District
16 to see, you know, if we had any experience with
17 these, and we had done work in the mid-90s. We did
18 a substantial amount of work for the state,
19 actually. First from IDOT, and then when the
20 division of water resources went from IDOT to the
21 Illinois Department of National Resources -- I think
22 that was with Governor Jim Edgar.

23 We were asked to look at a way to
24 prevent drowning accidents at low hit dams, and the

1 drowning accidents were taking place because people
2 would get too close to speedways with a canoe, or
3 they were swimming and then they would go over
4 the -- the speedway, and they would get caught. And
5 there was a particular side, which was on the Fox
6 River. They came down with the Speaker of the House
7 awhile back, and there had been at that time, like,
8 30 drowning accidents.

9 So we went there. We started to
10 look at what we could do, and we came up with a
11 modification of the speedway that was built -- they
12 put steps to dissipate the energy. The last
13 drowning accident there was about two years ago, I
14 believe, a person that was on a cell phone and was
15 with his daughter on a Girl Scouts camp and he told
16 his daughter "I'm going to go." They stayed, he
17 went, he got too close to the dam, went over. Two
18 brothers that were there -- one of them was a
19 priest -- they went in to get him out, they drowned,
20 too, to give you an idea how bad this is.

21 So we designed this test, and
22 finally the state got the money to build them. And
23 also, as part of this, people said, you know, "The
24 river is used a lot. Can you do also something for

1 the canoes?" So we designed a canoe chute that may
2 get built. I don't know. We're not sure, because
3 it's going to go through the side. And then we
4 said, "Well, the canoe chute could also be used as a
5 fish passage if we decide."

6 So I saw Marjorie Casey, from
7 Bloomington, Illinois, and she was a canoe person,
8 so they wanted to do something with canoes, and I
9 said, "Well, why don't we do the canoes." So we did
10 a review. We looked at what we knew about fishes in
11 Illinois, you know, how fast they move. We found
12 out they didn't move very fast. And the reason why
13 they have to do that was when you design a fish
14 passage and a canoe chute, you need to figure out
15 what flow velocities you're going to have, because
16 you are going down the canoe chute. The fish
17 passage is easy, but going up is a challenge
18 depending on the species, you know, that you have.

19 So we did that. It was a good
20 experience. Then there was a drowning accident a
21 few years ago. Four women get a canoe at Kickapoo
22 State Park, they rent a canoe, they go out, they
23 were celebrating because one of them was coming to
24 Chicago to study, and they missed the exit because

1 it had been raining a lot, and they didn't see the
2 exit, and they just -- the river was running too
3 fast. So they made it to the river, and it's not
4 easy to get out if you get in there because they
5 have these steep walls, so they said, "Well, you
6 know, it doesn't look too bad. Why don't we go
7 over?" They go over and flip.

8 So again, we go back there -- when
9 we go by there, we are asked by Illinois, you know,
10 what we can do, and you get, you know, the people
11 that want to remove the dam and the folks that want
12 to keep the dam because they live by the river,
13 and then the modifications to the dam.

14 So right there I saw the little
15 fish way, which is the one that, you know, the
16 Friends wanted to have in the north branch dam. But
17 these, by and large, this type of structure is not
18 very efficient. In fact, I challenge my students,
19 if you see a fish -- I'll give you an A if you see
20 going up these fish passages, and you can take a
21 picture of it.

22 MR. ANDES: We do have copies of
23 several reports prepared by Dr. Garcia and others on
24 this issue, but I'm not sure that's necessary.

1 DR. GARCIA: So what we did then --
2 this is how we get into the fish passage analysis.
3 So now what we are trying to do in the lab, we build
4 a model. We have to remove the model that we have
5 of the Chicago River. We have a model there, and if
6 you go to Wilkie and you say density currents in the
7 Chicago River, you're going to find it, because it's
8 going to take you there to a picture of the model.
9 We had to take it out because we have no more room,
10 and now we built a model of a little bit of the
11 north shore branch, the north shore channel, and
12 whatever space we have for the north branch.

13 And that -- we have this very old
14 structure, and as you know in September there was a
15 lot of flooding there, so all of a sudden the model
16 became very important, and what we are trying to do
17 is see if we can modify -- you can't remove it,
18 because it's a great control structure, meaning that
19 it controls the grading of the bottom of the river.
20 So if you take that out, the river is going to try
21 to level itself again, and all these buildings that
22 you have encroaching on the river, they're -- you're
23 going to have structural problems.

24 But what we're trying to do is

1 say, "Okay. Can we put a canoe chute there with a
2 fish passage," and we're going to decide that
3 numerically with a 3-D model, and also we have a
4 physical model on a scale of 1 to 20, and we are
5 going to try to design the same design for the canoe
6 chute that we design for these folks, but we have a
7 lot less to play with and a lot less difference, and
8 we are going to put what is called a Dutch fish
9 passage, which is something that we've been trying
10 for small streams that seems to work well when you
11 have very small differences in water level. That's
12 how much we have -- what we are doing on fish
13 passages.

14 MS. DEXTER: Okay. I think that's all
15 I have.

16 MS. TIPSORD: Dr. Garcia, thank you
17 very much. We've enjoyed your testimony. It's
18 about quarter to 12:00. I think -- why don't we go
19 ahead and take an early lunch and try to get back
20 about quarter to 1:00, towards 1:00 o'clock, and
21 we'll pick up then.

22 (Whereupon, a break was taken,
23 after which the following
24 proceedings were had.)

1 STATE OF ILLINOIS)
) SS
2 COUNTY OF COOK)

3
4

5 REBECCA A. GRAZIANO, being first
6 duly sworn on oath says that she is a court reporter
7 doing business in the City of Chicago; that she
8 reported in shorthand the proceedings given at the
9 taking of said hearing and that the foregoing is a
10 true and correct transcript of her shorthand notes
11 so taken as aforesaid and contains all the
12 proceedings given at said hearing.

13
14

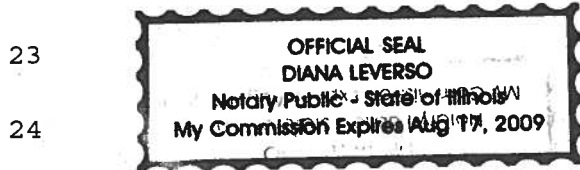
15 *Rebecca Graziano*
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18

19 SUBSCRIBED AND SWORN TO
before me this 17th day
20 of February, A.D., 2009.

21 *[Signature]*
Notary Public

22



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