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CHINO BASIN WATERMASTER

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MANAGEMENT ZONE 1)
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SPECIAL REFEREE WORKSHOP)
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REPORTER'S TRANSCRIPT OF ORAL PROCEEDINGS

DATE AND TIME: Wednesday, May 25, 2005
10:38 a.m. to 3:10 p.m.

PLACE: CHINO BASIN WATERMASTER
9641 San Bernardino Road
Rancho Cucamonga, CA 91730

REPORTED BY: WINIFRED S. KRALL, C.S.R. #5123

OUR JOB NO.: WK-052505

APPEARANCES

SPECIAL REFEREE:

Anne J. Schneider, Attorney at Law

TECHNICAL ADVISER:

Joe Scalmanini

CHINO BASIN WATERMASTER:

Kenneth R. (Ken) Manning, Chief Executive Officer
Sheri M. Rojo, Finance Manager
Michael Fife, General Counsel
Sherri Lynne Molino, Executive Assistant

WILDERMUTH ENVIRONMENTAL:

Mark Wildermuth, Engineer
Francis Riley, Hydrologist
Andy Malone, Engineer

ALSO PRESENT:

Raul Garibay, Pomona
Dennis Williams, Geoscience/Chino Hills
Kyle Snay, Southern California Water Company
Jim Erickson, City of Chino
Dave Crosley, City of Chino
Mike Maestas, City of Chino Hills
Robert Tolk, Monte Vista Water Company
Rick Hansen, TVMWD
Craig Stewart, Geomatrix/State of California
Mark Kinsey, Monte Vista Water Company
Boyd Hill, Monte Vista Water Company
Eric Fordham, GeoPentech, City of Chino
Ray Wellington, San Antonio Water Company
Tom Bunn, City of Pomona
Mark Hensley, City of Chino Hills

RANCHO CUCAMONGA, CALIFORNIA

WEDNESDAY, MAY 25, 2005, 10:38 A.M.

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MR. FIFE: Good morning, everyone. We're going to get started. We're here for the second MZ1 subsidence workshop. I am Michael Fife from Chino Basin legal counsel. And with us today is Anne Schneider, the Court's Special Referee, and Joe Scalmanini, the Court's technical advisor.

We have a lot to do today. It's quite a lengthy presentation so I think we're going to get into it as quickly as possible. I'm going to say a few words just a couple minutes to give background on the presentation and to lay out the procedure of what we're going to do today. I think Anne had a couple words she wanted to say about that also. And then we'll move directly into Andy's presentation.

But first for the benefit of the court reporter and the record, why don't we go around the room and everybody introduce yourself and state the entity that you're here on behalf of.

So again I'm Michael Fife. I am general counsel for Chino Basin Watermaster.

KEN MANNING: Ken Manning, Chino Basin Watermaster CEO.

SHERI ROJO: Sheri Rojo, Chino Basin Watermaster Finance Manager.

SPECIAL REFEREE SCHNEIDER: Anne Schneider, Special Referee to the Court.

MR. SCALMANINI: Joe Scalmanini.

MR. MALONE: Andy Malone, Wildermuth Environmental.

MR. RILEY: Francis Riley, Wildermuth Environmental.

MR. WILDERMUTH: Mark Wildermuth from Wildermuth Environmental.

MR. MAESTAS: Mike Maestas, City of Chino Hills.

MR. WILLIAMS: Dennis Williams, Geoscience for Chino Hills.

MARK HENSLEY: Mark Hensley, City Attorney, Chino Hills.

WADE HILL: Wade Hill, attorney for Monte Vista Water District. And Mark Kinsey will be joining us shortly from Monte Vista Water District.

KYLE SNAY: Kyle Snay with Southern California Water Company.

ROBERT TOLK: Robert Tolk with Monte Vista Water District.

RAY WELLINGTON: Ray Wellington, San Antonio Water Company.

RAUL GARIBAY: Raul Garibay, City of Pomona.

DAVID CROSLEY: David Crosley, City of Chino,

ERIC FORDHAM: Eric Fordham with GeoPentech, representing the City of Chino.

JIM ERICKSON: Jim Erickson, attorney for the City of Chino.

CRAIG STEWART: Craig Stewart, Geomatrix Consultants representing the State of California.

RICK HANSEN: Rick Hansen, Three Valleys.

TOM BUNN: Tom Bunn, attorney for City of Pomona.

MARK KINSEY: Mark Kinsey, Monte Vista Water District.

MR. FIFE: I think we've got everybody. So please, as a matter of procedure throughout the day, if you ask questions, we're going to ask that you come up to the microphone and please state your name again for the court reporter when you speak. And remember to speak loudly so that she can hear you, especially if you're speaking without a microphone.

Again, this is the second workshop regarding subsidence in MZ1. The first workshop was held on August 29th, 2002. That workshop was followed by a Special Referee's report and a court hearing and court order. Copy of that court order is on the back table just for everybody's review, just to remind everybody where we last left off with the Court on these issues.

The purpose of that workshop was to introduce the interim plan to the Court. At the time, if you recall, we weren't even complete with the interim plan. We were still negotiating it. The monitoring plan still had yet to get going. We were still talking about signing up for the forbearance program, et cetera. And so the issues that were discussed at that workshop were how participation in the plan would work, whether monitoring would work, and what was going to happen over the next three years.

The Court in its order ordered a follow-up workshop in order to monitor all of those issues and what kind of progress we were making under those issues. In the order that's on the back table, the Court set a date for that workshop of July 2003.

Over the last couple years as the monitoring has progressed, at every step we decided that it would be helpful to have a little bit more information before a workshop and a little bit more and a little bit more. And I think finally the MZ1 technical committee got to the point where they felt they had enough to present it to the Court. And that's why we're here today, is to have the workshop that the Court asked us to have back in July of 2003.

The purpose of today's workshop, then, unlike that first workshop where we were doing primarily a legal introduction of the interim plan, the purpose of today's workshop is primarily technical in nature to inform the Referee and the court's technical advisor about the progress of the monitoring, the things we've learned, and what we see for the future.

Because of that, we are hoping that this discussion will be technical in nature primarily. This is a workshop. It's not a hearing. There's no decision that the Court is going to make as an outcome of this process today.

We will take a break at lunch, so about noon. So we'll go for about an hour. Then we'll take breaks periodically throughout the day after that. And I think the Referee wanted to make some comments now, and then after that, we'll go directly into the presentation.

SPECIAL REFEREE SCHNEIDER: Thank you. As Michael indicated, the active order of the Court is the October 17th, 2002, order that's on the back table.

That order directed Watermaster to implement the interim plan that was before it, to continue the MZ1 technical committee work, and schedule a follow-up workshop, that was, as Michael said, in July 2003. The workshop today is that workshop.

To file reports on a quarterly basis, which pretty much the Watermaster has done, advising the Court of the activities going on under the interim plan.

And finally, the order requires that a long-term plan be developed by fiscal year 2004-2005, which would mean by July 1. That clearly is not going to happen. I anticipate that Watermaster will go back to the Court to have an amended order that would provide a new date for a long-term management plan.

The purpose of this workshop is to describe the substantial amount of work and study that has been done since the interim plan began, if any conclusions have been reached, what those conclusions are, describe the activities that are being undertaken now, and describe remaining work to be done, if any. And it is finished -- to our understanding, that a long-term management plan is the goal for this process.

As Michael said, this is a workshop and not a hearing. Andy Malone will make the main presentation, as I understand it. Questions are welcome so long as we don't bog down Mr. Malone's presentation. This is a technical workshop in my view and not a legal one. So if there are comments or questions, I would hope that they would stay on technical issues. There also will be no cross-examination of anyone. So the questions have to be not in the nature of cross-examination or we'll just cut them off, if necessary.

So I appreciate your being here. Due to our flight schedule, I'd like to stop, wherever we are, if possible, by 3:30 at the very latest. And with that, I'd like to have you start. Thank you.

MR. FIFE: So again, please, if you have questions come up to the microphone that's here for that purpose and state your name clearly for the reporter. Thank you.

MR. MALONE: I would encourage a lot of us here from the MZ1 technical committee are familiar with this material, and if I happen to skip over a point that someone else in the audience feels is an important point to illustrate at this point in time, please speak up and say so.

With that we'll start right in. This is the outline of discussion for today. We'll start with some brief topics on the basic concepts of aquifer mechanics. We will talk a little bit about the background, the hydrogeology of the Chino Basin, and the history of subsidence and fissuring in the Chino Basin just to get everyone up to speed. And then the bulk of the presentation will be on our monitoring program.

We'll update you on the hypothesis that we started with that was written in the OBMP and our methods that we chose to test that hypothesis and then discussion of some of our results and some of our conclusions that we've come to today. And then a discussion on our ongoing and recommended work for the future.

So we start out here with some of our basic concepts. Before we get into those, though, I'd like to mention that a lot of these concepts that we're talking about are not new, that they've been documented and studied. This process of aquitard drainage due to groundwater withdrawal and associated land subsidence that goes along with that aquitard drainage, it's been documented in many places across this country.

What this map here shows in these areas here that are highlighted or shaded are unconsolidated aquifers. And each one of these lines here that indicate a certain groundwater basin in these areas are areas where groundwater withdrawal has been studied as the cause of land subsidence, aquifer system compaction and land subsidence.

In some of these areas like the San Joaquin Valley, we have seen subsidence that's approached 30 feet in magnitude. We're not seeing that same sort of magnitude of subsidence here in Chino Basin, but we have ground fissuring associated with our land subsidence which makes it an issue. And in many of these places we have ground fissuring that's associated with the land subsidence as well.

This here is an InSAR image of the Las Vegas area. And in these areas here we're seeing land subsidence that's been attributed to groundwater withdrawal, and these white lines here represent faults. This one right here which is acting as a groundwater barrier and is causing some differential subsidence to occur across that fault. And there's ground fissuring that has been documented to be associated with that subsidence. So in areas like Las Vegas, very similar hydrogeology and a similar history of subsidence and fissuring that we're seeing in Chino.

This here is a photograph of a ground fissure. It's fairly large. The ground fissures -- you're going to see some photographs of our ground fissures that occurred in the early '90s in Chino. Ours are not quite of this magnitude here. But this is a ground fissure in Arizona that was associated with land subsidence due to groundwater withdrawal.

Again, something to point out here, these ground fissures, the way they form, at the ground surface here, you see it's an erosional feature. The fissure forms that depth, and it's not quite this wide. But erosion, rainfall events and erosion, which wash the sediment, the surficial sediments down into that ground fissure at depth manifest themselves as these large cracks that appear in the ground surface.

So some of our basics of aquifer mechanics that can lead to land subsidence in ground fissuring. I'm going to go through these concepts one by one. The first one is this concept of effective stress. And the way this works is that at any point in a saturated aquifer system, the overburden load, the sediments and the saturated -- the saturated sediments that compose the overburden load are supported by, in part, the pore fluid pressure in those saturated sediments and in part by the skeletal stress which is the grain-to-grain contacts in the aquifer system.

So pore pressure, as we know, can change. When the well turns on, the pore pressures decrease. And when that happens, these skeletal stresses, those grain-to-grain contacts, they increase. And the sediment package will deform to become more stiff and support that increased effective load. So that's why we call it effective stress.

When pore pressures increase, the skeletal stress can decrease, and the sediments can expand to their original geometry. This can happen in an elastic process. So that's the concept of effective stress.

MR. SCALMANINI: Andy, I'm flashing back about 40 years. Is there going to be a quiz on this at the end of the day?

MR. MALONE: That is your textbook here.

So this skeletal stress in this deformation, that brings us to this concept of compressibility of sediments. All sediments are compressible, but it's a material property, and it can vary from different types of sediments. Aquifers are not as compressible. They're composed of sand and gravel. They are not as compressible as aquitards, which are composed of silt and clay. They compress more.

And to give you an idea, the magnitude, the compressibility of these aquitards can be anywhere from 4 to 8 times more compressible -- 8 to 4 -- 4 to 8 times more compressible than aquifers. When the sediments compress, they can yield water. So aquitards, when they compress, yield more water than when the aquifers compress.

Now, this sort of compression, like we mentioned up here, can be an elastic process where they compress and expand, or it can be an inelastic process where they permanently compact. They compress and permanently compact and will never achieve their original geometry, no matter how high the water levels get back up or pore pressures get back up.

Because of that, this inelastic process can yield a lot more water than the elastic process to the aquifer system. As Francis quotes, in some cases this inelastic process can yield a hundred times more water than the same amount of compression in an elastic process. And this represents a one-time mining of the water from the aquitards.

Did I state that correctly, Francis? You shook your head.

MR. RILEY: You said the same amount of compression. What you really mean is compression in response to the same change in head or the same reduction in pore pressure.

MR. MALONE: Yes. So what controls the difference between the elastic and the inelastic processes that can occur in these aquitards, what controls the transition between those, that's this concept of preconsolidation stress. What the preconsolidation stress is is the maximum past skeletal stress that the aquifer system has encountered in the past since those sediments were deposited. And again that skeletal stress can change due to pore fluid pressure changes. So as pore fluid pressures decline and skeletal stress increases, if it increases past the maximum past skeletal stress, then we have a new preconsolidation stress. And that preconsolidation stress is the threshold between the elastic and the inelastic deformation that occurred in these sediments -- that can occur in these sediments.

And the last concept, this is the concept of time lag of aquitard drainage and deformation. As you're probably aware, aquitards fine-grained sediments are not very permeable sediments. It takes time for them to drain and become equilibrated with lower heads in the aquifers. This process can take weeks to months for the elastic processes to come to completion, or they could take decades or centuries for inelastic processes to come to completion.

When we talk about coming to completion, that is the time required for 93 percent of the ultimate potential drainage to occur in these aquitards. And this can be quantified if we know a little bit about the materials that are being compressed and mathematically what those terms are are the compressibility of the sediments, the vertical hydraulic conductivity of the sediments, and the thickness of the sediments. You can see that the thickness is especially sensitive to the time lag. It's to the power of 2.

So we have some graphics to illustrate this process and some of these concepts. If these represent our aquitards, our fine-grained silts and clays, and these white areas represent our saturated aquifer sediments, our sands and gravels, when a well turns on -- if this is where it's perforated, when a well turns on, it's drawing water from the permeable coarse-grained sediments, and lower heads are a result of this process in the aquifers.

What occurs then is that these aquitards begin to drain. They have higher heads in here than in the aquifers, and water begins to drain out of these aquitards. And so if you look at a point inside one of these aquitards, your overburden pressure being partly supported by the pore fluid pressure and the intergranular stress here, when we have this aquitard drainage, that pore fluid pressure will decline and the grain-to-grain contact stress will increase. And then when the well shuts off, we can have the pore fluid pressures increase as water migrates back into these aquitards.

We have this maximum past effective stress that is one of these aquitards here. And we actually pump the aquifer and decline heads in the aquifer so much that water is draining out of these aquitards and the pore fluid pressure in the aquitards exceeds the maximum past effective stress, then this is when we can have the permanent compaction in the aquitards which translates to land subsidence at the surface.

Are there any questions on those concepts, those basic concepts.

MR. SCALMANINI: Go ahead.

SPECIAL REFEREE SCHNEIDER: No.

MR. MALONE: Well, if we start talking now about the background of subsidence and fissuring and some of the hydrogeology of the Chino Basin here, we can go back to virgin conditions near the turn of the century.

Basically what was happening in the Chino Basin at that point in time is we have our four bay regions where a lot of the recharge to the groundwater basin is occurring, and we have groundwater flow from these four bay regions down towards areas of discharge in the southern part of Chino Basin.

And Mendenhall mapped an area right here, swampy conditions, flowing artesian wells, in this general area here in the southwest part of Chino Basin. Now, what this indicates, these swampy flowing well regions, is that we have fine-grained sediments that are acting to confine the groundwater system. And that's what it indicates.

So what we've also put on here is our area of subsidence, our primary area of subsidence that we've identified through our studies here. You can see that there is some overlap here between these areas of subsidence and the old flowing artesian zones.

What this also indicates, not only the existence of fine-grained sediments in this area, but that water levels were historically at or above the ground surface. So we had a completely saturated column of sediments in this area.

What occurred over the course of the Twentieth Century is that a lot of wells were drilled in Chino Basin and we pumped a lot of water out and we drew water levels down significantly in some of these areas, especially over here on the west side of Chino Basin. So what this map here represents is that we had as much as 150 feet of drawdown in some of these parts of the western side of Chino Basin. And it coincides with our area here that we've indicated subsidence to have occurred.

Now, this figure only shows the end result, 1933 to 2000. We look at a water level time history of some wells over on the west side of Chino Basin, the ground surface was about 690 for these wells. So you can see that water levels in 19- -- in the late 1930s were really close to the land surface in this area. This right here is elevation of water level.

This gray line here represents the cumulative departure from mean precipitation. And so this is a wet period, and this represents dry period, a wet period, dry period, and so forth.

So you can see that during this dry period we also had a lot of wells come into the Chino Basin, and we had a considerable amount of drawdown on the order of about, let's say 650 to 550, so maybe 150 feet of drawdown in this area here.

In the late 1970s, we had the adjudication of the Basin and control of production. And we also had a relatively wet period here. And so we have water levels recovering about 50 feet in this area over that time period.

When we look at the history of subsidence in Chino Basin, we don't have much of a time history that goes back past about the 1980s. But we do have good data that starts in about the mid 1980s and goes forward to the present.

What this graphic here is showing is two types of data that we can use to monitor ground surface deformation. The ground level survey data as outlined by this green polygon. And this is an area where the City of Chino has done repeat ground level surveys from about 1987 forward and has documented a maximum of about

2 1/2 feet of subsidence in this area.

The shaded area all right in here is InSAR data. It's our remote sensing data. It's a relatively new technology that came about in the early 1990's. And what this is showing is this orange area right here is showing about a maximum of 11 inches of subsidence over the 1993 to 1995 time period.

So you can see that both of these two methods of measuring subsidence, these two independent methods, are showing the subsidence has occurred over here on the west side of Chino Basin. They're both documenting that.

One thing to note here is that in the southern part of Chino Basin, this gray area represents areas where the InSAR is not coherent and we don't have good data down here. Agricultural areas don't normally return very good data to the satellites that are collecting this data. So we don't have very much good InSAR data here in the southern part of the Chino basin, but we have very good data where the landscape is composed of municipal and industrial land uses.

If we zoom into this area right here, we have a little time series of events that occurred since about 1987. So what we're looking at here is Central Avenue, north-south alignment of Central Avenue here. This is the southern part of the City of Chino proper. We have

Eucalyptus Avenue here, Edison, Schaefer, Chino, and Riverside.

In the late '80s, early part of the 1990s, a number of wells were drilled in this area that tapped the deep confined aquifer system. After those wells were drilled in the early 1990s starting in about 1991 and going for a couple of years, some ground fissures began to open up here on the city's -- I mean in the City of Chino and on the property of CIM, the property of the State. These fissures formed in this area first and propagated to the north and to the south somewhat over this couple-year period.

And here's some photographs of what some of those ground fissures look like. This is on CIM property. And this is just north of CIM property just near Edison Avenue.

So when these fissures began to develop, the City of Chino went out and performed again these repeat ground level surveys from about 1987 to about 1999. And these contours here are land subsidence contours in feet that occurred over this time period. The data behind these contours are those ground level surveys. And as you can see, we have a north-south trending trough of subsidence, a little over 2 feet of subsidence, that occurred over this time period along Central Avenue here.

And another thing to note here is this very steep eastern limb of the subsiding trough that coincides with the fissuring zone which has led multiple authors in investigations to associate this fissuring with this land subsidence that's been documented.

Right here what we're doing is we're overlaying that InSAR data on top of this and showing that these areas -- again we're just looking at a short time period from April to September 1993. A little over a half a foot of subsidence occurred in this area, the maximum of about .65 feet of subsidence occurred in this area.

Really the point of this slide is to show you that these two methods of measuring subsidence, they're turning out to be pretty comparable methods. Completely independent of each other, but the distribution and the magnitude of the subsidence that is being measured by both these two methods are very similar.

And again in the InSAR data you can see here we have some incoherence. These blank areas are where we have incoherent data. You can see this steep grading of subsidence along the same lineament as the ground fissures. We will talk about that much more later.

So the OBMP -- when we constructed the Optimum Basin Management Program, it addressed this phenomenon of subsidence and fissuring in Chino Basin. What was said in the OBMP is that we'll do these things. We will attempt to minimize the subsidence and fissuring in the short term. What we've done there is, that's the forbearance agreement where we've agreed to reduce production on an annual basis in this part of Chino Basin by about 3,000 acrefeet a year. And then to initiate a study to collect the information necessary to understand the mechanisms, the extent, and the rate of subsidence and fissuring in Chino basin. And that's our interim monitoring program that we're going to be talking about. And then to use that data that we collected there to formulate a long-term management plan to minimize or abate subsidence and fissuring in the future.

Another reason why this process is very important to understand the best we can is that we have other management programs in the Chino Basin where there may be head declines associated with these management plans. And especially in areas that are adjacent to our areas of subsidence and fissuring where we may have head declines, we want to really understand this process so that we don't -- that we don't cause additional subsidence and fissuring to occur.

One of those programs is, of course, the hydraulic control monitoring program where these high capacity desalter wells are reducing water levels in these regions.

So to go into the monitoring program update. We're going to take you through the scientific process here where we first develop a hypothesis based on existing data that we had back in about 1999, 2000. Then we developed the methods, as the MZ1 technical group, to test that hypothesis. And then we will review some of the results and conclusions.

MR. SCALMANINI: Just before you launch into that, Andy, it probably would be awkward to do it, but whether you page back or not is academic. The hydrograph of what I call the collection of wells as against the cumulative departure curve. All shallow wells; right?

MR. MALONE: Yes.

MR. SCALMANINI: So from 1930-ish -- I don't remember exactly, but does that sound right?

MR. MALONE: 1935.

MR. SCALMANINI: Forward, there's this pretty massive decline in shallow groundwater levels. Before we get to those dots, but while that's of interest, we're not really going to talk today anymore about that and subsidence. Is that fair to say?

MR. MALONE: We're not going to be focusing so much on this, yeah, on this time period here.

MR. SCALMANINI: Right.

MR. MALONE: Is that what you're saying?

MR. SCALMANINI: As you look at the collection of slides from about there to where we are now, you know, it's like we -- this is of interest. We had this massive decline of, let's say, at its peak prior to the judgment, if you just kind of integrate the hydrographs, of water levels that went from 670 plus or minus feet in elevation to 520, -30, -40 somewhere in there. So there's a 150 foot decline, plus or minus. Okay?

MR. MALONE: Yes.

MR. SCALMANINI: Let's just call that of interest. And then we put yellow dots and deep wells on the map in the late '80s, early '90s, and then fissuring and then surveying, InSAR, subsets of the survey period that are pretty short in duration that consistently support the cumulative subsidence in the area. But there's no tie between that water level decline and the onset of subsidence or anything like that. Is that as far as we're going to go from here forward in this discussion?

MR. MALONE: We obviously know a lot more before the 1990's than we do about this time period here in terms of water levels, the production, and the subsidence that occurred. So a lot of our focus is on what we know most about. But this cannot be ignored. And in our modeling efforts that we'll talk about later on in the discussion, we do not ignore this.

MR. SCALMANINI: All right. So we will talk some more about that.

MR. MALONE: Yeah.

MR. SCALMANINI: Okay. I'll ask this now just so I don't forget later, and that is, can we ultimately get like a more readable color set of these?

MR. MALONE: Yeah. That's no problem. We gave you those so you can make notes, but we can provide you with --

MR. SCALMANINI: Obviously some of these appear in other places in a little more readable form than they are right here. So that's fine.

The contours -- maybe you could page back just about two or three -- the contours of equal subsidence, so to speak, with that. Okay. Well, all the contours up to the 2.2 feet in the center --

MR. MALONE: Yeah.

MR. SCALMANINI: -- are all derived over some time period or from some time period?

MR. MALONE: Yes. It's the 1987 to about 1999.

MR. SCALMANINI: Okay. Thanks

MR. MALONE: So that's one of the issues. The InSAR data, it's constrained in time.

MR. SCALMANINI: Yeah. It's chunks of time.

Right?

MR. MALONE: The survey data is constrained in time when you took the surveys. In the past we don't have a really good match between those time periods. But qualitatively we can look at it and say, look, it looks like the InSAR data looks like it's showing us the exact same pattern of subsidence, and the magnitudes are comparable.

MR. SCALMANINI: Yeah. Clear.

MR. WILDERMUTH: When Andy said they don't match up on time periods, you understood what he meant?

MR. SCALMANINI: I think so.

MR. WILDERMUTH: Maybe you should explain just to be sure. On the survey days, they weren't always in the same point in the year.

MR. MALONE: The survey data goes from one year to the next year, and the InSAR data might be offset from that. It's the same concept. InSAR is the same concept, data collection at certain time intervals and you compare the two data collection periods.

MR. SCALMANINI: The data that allows the development of the contours, that started in '87?

MR. MALONE: In '87.

MR. SCALMANINI: Did it just happen to have been available, or was there surveying going on because of any kind of subsidence-related concerns at that point in time, '87.

MR. MALONE: The City of Chino might chime in on this, but my understanding is that was data they went back into the archives and pulled out after this phenomenon appeared. They started doing surveys in about 1993. So the first time period goes -- is 1987 to 1993, and we'll see some profiles that show that. So they went back into the archives to find a ground level survey that could compare to more recent data.

MR. SCALMANINI: There was, quote, some form of baseline, which happened to be '87, against which they could compare the 1993 survey --

MR. MALONE: Yes.

MR. SCALMANINI: -- that was done because of concerns about subsidence.

MR. MALONE: Yes.

MR. SCALMANINI: Thanks. Sorry for the interruption.

MR. MALONE: Is that generally your understanding too, Dave?

DAVID CROSLEY: Yes.

SPECIAL REFEREE SCHNEIDER: Would you describe for me why that gray shaded area has no data. That's the state land.

MR. MALONE: Down in here?

SPECIAL REFEREE SCHNEIDER: Yeah.

MR. MALONE: The InSAR data is collected from a radar satellite, and so it emits a signal at an angle to the ground surface. And then what they need is a signal to bounce back toward them. So they need some sort of reflection that bounces back toward them, and then they record that return.

In agricultural areas it's not as good of a reflector as roofs would be where it's rough and hard and it's consistent from year to year. When they take another image, they have the same exact surface features that come back to them. So the reflection is better in these hardscape area than in these agricultural areas where you can have cows walking on the field or they plow the field or something like that.

SPECIAL REFEREE SCHNEIDER: When Chino collected its data from 1987 on, it wasn't relying on InSAR exclusively?

MR. MALONE: No. Yeah, these contours here are from the ground level surveys that they were doing, the conventional leveling surveys.

SPECIAL REFEREE SCHNEIDER: So whether from InSAR incapability or just unavailable data, there are no data that would complete this picture into that state agricultural area?

MR. MALONE: The State did some of their own investigations, and they did some surveying over this time period too. But this data right here is showing us only the data from the city of Chino surveys.

SPECIAL REFEREE SCHNEIDER: Were you given the data that the State collected?

MR. MALONE: The State -- Craig, you may recollect what the process that we went through here, but I'm not sure that this data was completely comparable to the state data.

MR. WILDERMUTH: They're not tied into the same datum and things of that sort.

CRAIG STEWART: Craig Stewart. We have shared data. They have the results of our work, and they know what we did. But as you said, the surveys weren't tied to the same reference elevations at that time. However, I think I'm comfortable anyway that the data that the State obtained and also interpreted for the areas beyond the State's boundaries were generally consistent with what Andy was showing.

MR. MALONE: And now our monitoring program, we have monuments that we have brought into the state property, and we're collecting that data.

SPECIAL REFEREE SCHNEIDER: That's what I was getting at. So going forward, you'll be able to complete more of that picture?

MR. MALONE: Yeah. In the past there is data down here that, like Craig says, looks consistent with the data that's been collected by the City of Chino. But we're not showing it on the map.

MR. SCALMANINI: Andy, I don't want to put you on the spot. Maybe I ought to ask Francis. In the Las Vegas Valley, it looks like in what I'd generally tend to classify as a not very urbanized area, they seem to get pretty good InSAR response in some open-area country out there. Is there some thought as to why that was successful or more successful maybe? If you don't know, let's not even waste time on it. It's just a curiosity question.

MR. MALONE: I don't know exactly. In the areas where you're plowing up the land, say, for instance, then that can have an adverse effect on ability to compare radar images.

MR. RILEY: Joe, in general the desert areas are good radar reflectors. This is true in Las Vegas Valley and Arizona and a number of places.

MR. SCALMANINI: Okay.

MR. MALONE: So when we go back to the OBMP and look at our hypothesis that we started with, what we did was reviewed the potential causes of subsidence, all the laundry list of them, which included subsurface withdrawal of fluids, hydrocompaction, oxidation of organic soils, collapse of underground caverns, tectonic causes, shrinkage of expansive soils, et cetera, here.

We reviewed all these, but what we zeroed in on was this subsurface fluid withdrawal as our hypothesis. That's what we identified as the most likely cause of the subsidence that we had observed in the City of Chino.

MR. SCALMANINI: And more specifically, water as contrasted to hydrocarbon fluids and things like that.

MR. MALONE: Right. So our hypothesis was that the groundwater production caused land subsidence and fissuring in Chino Basin. That was our hypothesis. And the line of reasoning has that groundwater production caused drawdown in our aquifers which caused the aquitards to start to drain into the aquifers and deform so we have compaction, aquifer system compaction; that this aquifer system compaction resulted in differential land subsidence across this zone of fissuring which caused the fissuring.

So that was the hypothesis that we started with. We also noted that it was likely, or that we were hypothesizing that the production from the confined aquifer system was the main cause of this recent episode of subsidence and fissuring that was measured in the early 1990s. So this is what we designed our monitoring program to test, whether or not this hypothesis was correct.

So we developed the internal monitoring program, and this is a two-pronged effort. One is to monitor the ground surface deformation itself. And again the way we were going to do that is through conventional benchmark surveying and this remote sensing method, this InSAR.

Then we were also going to do some fissure monitoring with the conventional benchmark surveying where we were going to do some horizontal distance measuring between benchmarks to cross our zone of fissuring to see if we could see any horizontal movement that might be occurring.

Then along with that, we were going to monitor the possible subsidence mechanisms, which would be the aquifer system monitoring -- or the mechanisms would be the aquifer system deformation. So we're going to monitor the aquifer system, we're going to look at groundwater production very closely. We're going to look at piezometric levels, what the water levels are doing in the area very closely. And then we're going to monitor the aquifer system compaction or expansion that might be occurring as a result of these piezometric levels fluctuating.

If we look at each one of these methods individually, the ground level surveying, again it monitors the ground surface deformation. And what we did there is we compiled all the historical data that we could. Looking at City of Chino's data from 1987 to 2001. And the pre-1987 data, we made some attempts to collect that, but actually we're having Associated Engineers, a contractor that we have, do our ground level surveying. We're having them go back and just try to glean any information that they can from pre-1987 to give us some idea of what happened subsidence-wise in the Basin prior to 1987. That's in progress.

We then installed permanent benchmark monuments. What we did is we took the City of Chino's existing network and we augmented it. We filled in some spaces with new monuments and we expanded the network.

And then what we've been doing is performing annual survey events across this entire network. And then we are also doing the semi-annual survey events in the fall and then in the spring across the fissure zone down here where these fissures appeared in the early 1990s.

So we have annual events across the entire network and then these semi-annual events across the fissure zone to see, if during the course of a pumping season, we can see any sort of horizontal movement across the fissure zone.

SPECIAL REFEREE SCHNEIDER: Do you have a slide that shows what your whole network --

MR. MALONE: Yes. What you'll see, the way this presentation is structured, Anne, I tell you in text first of all what I'm going to show you with figures or photographs or graphics. So I'll review it here, and then we'll explain it again.

MR. SCALMANINI: Andy, on the pre-'87, it's for the whole subsidence area?

MR. MALONE: Yeah.

MR. SCALMANINI: Or is it for the focused study area?

MR. MALONE: We're trying to get, actually, across the entire Chino Basin.

MR. SCALMANINI: Okay.

MR. MALONE: So this is your figure, Anne.

Again, this is our area of concern. And these red lines represent the ground level survey network that we're dealing with right now. If you recall, it was a smaller area up here that the City of Chino was monitoring.

So these are what some of our monuments look like.

This is the so-called Class V monument. It's a brass disc that's glued to a curb. But then we've also installed a number of very stable benchmark monuments where we auger out a hole and then drive a steel rod to refusal in that hole. And then put a grease-filled PVC casing around it. So what we're doing is we're isolating that monument from any shallow surface deformation that might be going on due to wetting or drying of the soil. So it's a very stable form of monument. And so we put a number of these and spread them out amongst the network.

And here is Associated Engineers, a couple of photographs showing them out in the field performing their surveys. By the way, we're getting excellent data from them. We're very pleased with their work.

For InSAR, again what InSAR stands for, the "In" stands for Interferometry, and the "SAR" stands for Synthetic Aperture Radar. Basically what you're doing is you're collecting your radar image and then you're comparing it to another radar image that was collected at a second period of time. You're interfering those. The difference between then is interpreted as a difference in the ground surface elevation.

So what this is is remote sensing of ground surface deformation. The key advantage of this compared to the ground level surveys, as you can see by some of those figures, is it's really an areally continuous representation of the ground surface deformation. Where surveys give us what's going on at certain points, but the InSAR gives us a more or less continuous surface, surficial representation of the land surface deformation.

We're constrained a little bit in time. We only have data from 1992 to 2003. The satellites that were collecting this data began to deteriorate. And they put up some new satellites that have just begun to collect additional data, so we're going to have a little bit of a gap from about 2003 to 2005 where we're not going to have very much usable InSAR data. But these new satellites are up there now and collecting data. And we're actually going to be using that data on an ongoing basis.

What we did was we created some time series, some very detailed time series of ground surface deformation, even more detailed than our ground level survey data over the 1992 to 1995 period, and then another time series from '96 to 2000. The data from 2000 forward is proving to be a little bit problematic because satellites were beginning to deteriorate. It's still a question whether or not we're going to be able to have any post 2000 to 2005 data that we can use from InSAR. But our subcontractor is looking into that right now. And then again, the new satellites are collecting current data.

And this is just a graphic that shows the process. The first pass of the radar satellite takes a radar image. And then the second pass at some later date takes another radar image, and the difference between the time it takes for that radar wave to reflect off the ground surface and come back to the satellite is interpreted as the difference in the vertical deformation of the land surface. So it's that measurement right there that the interferogram is giving us.

So those were the two. Ground level surveys and InSAR are two methods of measuring ground surface deformation. Our aquifer system monitoring is trying to explore the mechanisms behind the ground surface deformation.

The key thing that we're trying to do here is establish the relationships between the water level changes that are happening in the aquifer and the aquifer system deformation. Those are the relationships that we're trying to establish. We think we've done a pretty good job of it.

Again, the aquifer system monitoring is looking at the production and its effect on piezometric levels and piezometric level changes, their effects on the aquifer system deformation.

And the centerpiece of our monitoring program is the Ayala Park extensometer facility, which was constructed in the summer of 2003. It consists of multiple piezometers that are completed at different depths within the aquifer system, and then the dual extensometer which is measuring the aquifer system compaction or expansion.

So this is our monitoring network. What we did was we constructed the Ayala extensometer in this location here. These yellow lines here again are ground fissures. This is Central Avenue. As you recall, this is our main area of subsidence here. So here's where we constructed the extensometer. It consists of the multi-piezometers and dual extensometer.

And then all these wells in red, the little red dots here, we installed a water level transducer. We collect water level data at these wells once every 15 minutes at all these red dots here. The green dots represent a pumping well, and the beige dots represent a non-pumping well. Either it's been abandoned or it's a monitoring well.

So you can see that we've got a number of pumping centers in this area, and we have water level transducers in some of the pumping wells and in some of the monitoring wells. And then we're monitoring water levels pretty intensely here too.

Our extensometer -- this a graphic that shows what our extensometer looks like. I think you've seen this before, Anne, but just basically what it is is it's a 1400-foot bore hole here. And we pour a cement pad here at the bottom of the bore hole, and then we case the bore hole here and insert a 2-inch steel pipe that comes down and rests on the bottom of the cement pad. This pipe comes up and sticks out of the ground here at the ground surface.

The next thing that we do is we install a very stable ground surface datum here, these three piers that go about 30 feet down into the ground surface and are decoupled from the shallow soil by a PVC pipe. And they support this bridge here in our extensometer facility that represents the ground surface.

So as we have any sort of compaction that may occur within this aquifer system, the ground surface will come down and it will drag this datum down along with it. But this pipe, being referenced at 1400 feet, it will stay relatively stable. And we measure the displacement between the ground surface datum and this pipe here. So we have some monitoring equipment that measures that displacement. We measure that displacement once every 15 minutes. And that's a very highly sensitive piece of equipment where we can measure changes in the ground surface on the order of one-thousandth of an inch. It's highly sensitive. And again we're measuring displacement once every 15 minutes, the same rate that we're measuring water level changes out in the aquifer system.

Again we're trying to establish these relationships between water level changes and then what's happening mechanically here in the aquifer system.

So this deep extensometer, we call it, is measuring the deformation that's occurring throughout the entire thickness of the aquifer system.

We also have a shallow extensometer that comes down to about 550 feet so it's doing the same thing here in the shallow part of the system. We can subtract these two records to get an idea of the deformation that's occurring within the deep part of the system.

This is our extensometer in mid-construction. Here's our piers and our ground surface datum, this bridge that rests across the top of the triangle here. And here's the extensometer. And it's hard to see, but this steel pipe is coming up out of the extensometer.

The next figure I'm going to show you, we have extended the steel pipe up and we've extended some monitoring equipment down from this bridge here and we measured the displacement between this bridge here, which represents the ground surface, and this pipe, which represents 1400 feet below ground surface.

This is what it looks like today. The pipe, extensometer pipe, here. This is the bridge, our monitoring equipment here. This is the linear potentiometer which again is measuring displacement between that bridge and that pipe once every 15 minutes. And we are recording that at data loggers inside this building.

What this lever arm does is that it's attached to the pipe, and it's not pulling the pipe up off the bottom but it's pulling about 80 -- 70 to 80 percent of the weight of pipe off of itself. This is a steel pipe, 1400 feet of it. It's a lot of weight, and that weight will cause it to bend under its own weight and rub up against the side of the casing here, and that causes friction. So what we're trying to do here is pull some of the friction off and straighten out the pipe so it would reduce the friction in this monitoring facility.

So as the ground surface goes up and down, this pipe will seemingly come up and down out of the ground. But really it's the ground surface coming up and down. This lever arm will tilt up and tilt down over the course of a pumping season. It's pretty impressive to go in after a couple months and see the difference in the lever arm. Sometimes we have to make adjustments to this lever arm because it's going too far in either direction.

And this is what one of our piezometers looks like here. Again, it's hard to see. We have a conductor casing here and five different piezometers that are completed at different depths within the aquifer system. We have transducers in each one of these wells that are linked to this data logger here, again measuring water levels once every 15 minutes.

What we also propose to do is to run control pumping tests -- to run control pumping tests to stress the shallow part of the system separately from the deep part of the system. And our objectives here to run these tests were to determine the hydraulic and mechanical parameters of both the deep and the shallow aquifer system. If there were any groundwater barriers in the area, we'd be able to characterize those groundwater barriers by running these control pump tests. And the main point here, we were attempting to transition the aquifer system from elastic compression into inelastic compaction. We're actually going to try to cause some inelastic compaction to occur.

So what we would be doing there is identifying that threshold where the deformation process transitions from elastic to inelastic. By doing that, we'd be defining the usable volume of the storage reservoir, under what range of water levels can we operate where we're not causing inelastic compaction. And that would be a very key finding to any long-term management plan that might develop out of this study.

So to go into some of the results. One of the first results that came out of this is that we've identified two very distinct aquifer systems, one shallow system, which is unconfined to semi-confined that goes from about 100 feet down to 300 feet below ground surface. Water levels in this area are generally at about 100 feet in the shallow system. So that's where the shallow system exists.

We have a confining layer, a very tight confining layer, from about 300 to 400 feet below ground surface. And then below 400 feet we have a deep confined aquifer system. And so we have some graphics to demonstrate that.

MR. SCALMANINI: So you do. You have some lithologic or cross-sectional type diagrams? Or --

MR. MALONE: We have that data, but we're not showing it here in this presentation. But the lithologic data supports the hydraulic data that we're going to be showing here.

MR. SCALMANINI: At the site or spatially, or both?

MR. MALONE: Spatially.

MR. SCALMANINI: Okay.

MR. MALONE: This is a hydrograph showing time down here on the X axis and depth to water here on the Y axis. We go from about 80 feet down to 280 feet here. And this time period is going from, looks like, July of '03 to about July of '04. So over the course of one year. And this time history that you're seeing here of water levels is from one of our piezometers that's completed in the deep part of the aquifer system. We call it PA-7. It's completed at about 438 to 448. So it's in that deep part of the system, the very upper part of that deep part of the system.

And what this water level is showing you here is that we have some pretty substantial drawdowns and recoveries that occur in this deep part of the system. Up here at fully recovered water levels, we're near 100 feet below ground surface. But you can see during the course of a pumping season, we can get down to about 250 or more feet below ground surface.

This is in response to wells -- some of those wells that we showed you in some of the very first slides that are completed in this deep part of the system. One or two wells turn on and cause these water level declines. When they turn off, they cause these water level recoveries.

This represents a typical hydrograph for the deep part of the aquifer system.

If we look at one of our piezometers that's completed in the shallow part of the aquifer system -- this is our PA-10 piezometer which is completed at about 220 feet below ground surface. You can see that it also fluctuates in water levels but not at the same magnitude as the water levels fluctuate in the deep part of the system. In fact, we have more groundwater production in this area from the shallow part of the system than we do from the deep part of the system, but not the same magnitude of water level change.

One area to focus in on here to really show you the distinction between the two systems. This was part of our shallow system test back in the spring of '04. And what we were doing was not pumping the deep part of the system and allowing water levels to recover here, but we were pumping starting here, the shallow part of the system and we were getting some water level declines. But it's not really showing up here in the deep part of the system at all. We're seeing water level declines in the shallow part of the system while the deep part of the system is still recovering, illustrating the separation between the shallow and the deep part of the system.

In addition to these two distinct aquifer systems, we also identified a previously unknown groundwater barrier in this area that is coincident with the historic fissure zone. This groundwater barrier, it is turning out, is a groundwater barrier in the deep part of the system, but it doesn't seem to be a groundwater barrier in the shallow part of the system. We have some graphics to illustrate how we discovered this groundwater barrier.

We performed two deep system tests where we were trying to hold water levels constant in the shallow part of the system while turning on wells in the deep part of the system and causing water level declines in the deep part of the system. We did that here at Chino Hills Well 19, which is perforated from about 340 down to about a thousand.

What I'm going to show you is the water level time history in the pumping well. Then I'm going to show you the water level time histories at three wells that are also perforated in the deep part of the system. Then I'll finish by showing you a water level time history of this well that's also perforated in the deep part of the system but is on the opposite side of the historic fissure zone where we think our groundwater barrier occurs.

So again, this is a hydrograph showing depth to water on the Y axis and time on the X axis. And this black line represents the water levels in the pumping well. So the well is on here, turns off, turns on, turns off, turns on, and so forth. And you can see our deep piezometer here, PA-7 at Ayala Park, you can see it react to the pumping that's going on at Chino Hills 19. And you can see that it's reacting with significant magnitude and almost immediately to the pumping episodes.

This next well here is Chino Well 7, and it's showing you a similar water level response that we're seeing at PA-7 that's being driven by the pumping at Chino 19 -- Chino Hills 19.

And then this well here is quite a distance away, Chino Hills 7-C, and it's also showing a similar water level response. Not quite the same magnitude of water level fluctuation, but it's a greater distance away. This is the water level response that we see on the opposite side of the ground -- the ground fissuring zone. So this is why we think that we have a groundwater barrier between Chino Hills 19 and Chino Hills 18.

MR. SCALMANINI: Andy, do you care to say anything about the perforation interval in Chino Well No. 7?

MR. MALONE: Yeah. This is sort of a hybrid well, but it actually, when we compare it to shallow -- other shallow wells, it looks more like it's responding to the deep system than the shallow system. But it is a hybrid between the two systems.

Some other results here that, currently at the extensometer, we are mainly measuring elastic deformation within the aquifer system. We've got some charts to show you that, that over the course of the pumping season, any sort of aquifer system compaction that occurs, it rebounds during the course of the recovery. So that's an observation that we can demonstrate pretty clearly.

We're also establishing those relationships between the aquifer head changes and the aquifer system deformation. And we're being able to determine some aquifer system parameters that are going to be used in some of our numerical groundwater flow and subsidence models that we're going to be developing over the course of the next year. So through these pumping tests we've collected a lot of very valuable data.

This is the graphic that you just saw here with a deep piezometer responding to pumping in the deep system and a shallow piezometer responding to pumping in the shallow system.

This occurs over our entire -- almost our entire time history since we installed the extensometer. It goes from July of '03 to about April of '05. But not only are we going to be charting here the water level time histories, but over on this axis here, we're going to be charting the extensometer time histories and comparing them to the aquifer head time histories.

What we see here with this purple line is the deep extensometer record, deformation that occurred throughout the entire thickness of the aquifer system. The deep extensometer again goes from the ground surface down to about 1400 feet below ground surface. So you can see here that it's tracking pretty closely the deformation -- the water level time history of the PA-7 piezometer in the deep part of the system, that when we have drawdowns in the deep part of the system, we have the compaction that occurs, and when we have recovery in the deep part of the system, we have expansion that occurs.

And again, you can see that a lot of this is elastic in nature, that we have a great deal of subsidence that occurs over this period of time, but as the water levels begin to recover, a lot of that is recovered, a lot of that compaction is recovered as rebound.

I think you can even see in here little episodes where the water level of a nearby pumping well is turned back on and then turned off, and you can see this extensometer responding even to those short-period changes in water levels.

This here is the time history of the shallow extensometer. And the shallow extensometer is completed from about the ground surface down to about 550 feet so it spans not only the shallow aquifer system -- again, remember the shallow aquifer system goes down to about 300 feet -- it goes down into the upper part of the deep part of the system too. So it's recording deformation that's occurring in the shallow system and in the upper part of the deep system. But again it's a lesser amount of compaction that occurs there because it's simply measuring a lesser amount of -- a lesser thickness of the aquifer system. But it generally follows the same patterns as the deep extensometer.

A notable exception is up in this area right here where we're not -- this is the area again where the shallow system is being stressed while the deep system is recovering. And so what we're having here is the shallow system is compacting while the deep system is staying about -- just about the same -- I mean the deep extensometer is not really recording anything. When we subtract these two from each other, we get what's going on in the deep system. So this blue line represents the deformation that's occurring from about 550 feet down to 1400 feet.

You can see here that we're having the deep part of the system continue to expand -- that blue line, continuing to expand -- while the shallow part of the system is compacting. So very interesting part of the curve there where water levels in the deep system are recovering and the deep part of the system is expanding, water levels in the shallow system are drawing down and the shallow part of the system is compacting. So again, a very good illustration of the separation between the two aquifer systems.

When we take this deep extensometer data, which is the strain, the deformation that's occurring in the aquifer system, and we plot it against the water level data, which is the stress that's being a part of this system, we come up with what's called a stress-strain diagram.

So the stress, the water level changes are being -- are on the Y axis, and actually drawdown is in this direction so stress increases in this direction here. The compaction being recorded by the deep extensometer is increasing in this direction so the strain in the system increases this way. So when we plot these two things against each other, this is the relationship that we're trying to achieve, the relationship between water level changes and aquifer system compaction.

Our period of record starts right here in July of '03, and again during the summertime, we have pumpage in the aquifer system and so we have drawdown that occurs in this direction. But we also have compaction that occurs in this direction. So we trend -- this is the trend line that is the stress-strain diagram. This trend is an elastic trend. What we've done is shown a little line here, a little black line here, which represents the elastic storativity of the aquifer system. If this line, if this trend begins to bend over and become more horizontal, this represents a transition into the inelastic processes.

So as long as our line is trending along this slope, we're in the elastic range. We can be fairly confident we're in the elastic range of deformation.

SPECIAL REFEREE SCHNEIDER: Could you describe where you would see inelastic, then. What would it look like?

MR. MALONE: I'll get there.

This was the first pumping season, and then this here in the red line is the continuation of that curve. But this is the recovery season.

MR. SCALMANINI: Can you go back one slide just for a second because I can't read the time scale on the handout.

MR. MALONE: It's our entire record from about --

MR. SCALMANINI: That's from July of '03 through --

MR. MALONE: -- through April.

MR. SCALMANINI: That's this spring.

MR. MALONE: Yes.

MR. MANNING: July 28, '03, to -- that one's March 19th, '05.

MR. SCALMANINI: It goes beyond March 19th, though, so that's all right.

MR. MALONE: I've updated this slide here to represent the current, most current data.

MR. SCALMANINI: That's this, right?

MR. MALONE: Yes. This one here, I have not updated this graph. But we're pretty close. I mean, what's happening, we're still having water levels recover up towards their area right here, their level right here. But I haven't updated this. This is April data. We're missing about a month's worth of data here.

MR. SCALMANINI: If you put that, mentally transpose this to the stress-strain diagram, then what might be called the residual strain as of about January of '05 -- I'm now picking on the blue curve right there.

MR. MALONE: Right here.

MR. SCALMANINI: We could go into here. Andy, MR. SCALMANINI: Starting and stopping, yeah.

MR. MALONE: What this large difference between this trend here and -- not the large difference but the offset between this trend here during the drawdown season and this trend here during the recovery season, what's happening here is the wells turn off at this point in time at the end of the pumping season, and we have -- we immediately have recovery in the PA-7 piezometer. But it takes a little bit of time for that water to start migrating back into the aquitards and start to expand those aquitards which would be recorded in the extensometer data. So this represents the time lag that's involved between -- the time lag that is involved in the migration of water back into the aquitards.

If we look at the drawdown trend here for our first year, it's trending at that slope. And then we have the same sort of trend in the recovery limb of the stress-strain diagram for the recovery in 2004. And then in 2004 for the pumping season, we again have this drawdown and compaction.

But at about 250 feet of drawdown, we start to see this curve become more horizontal and deviate from the elastic trend as represented by this black line here. And if you compare the elastic trend at this water level of about 280 feet to where it ended up here at the end of that would be somewhere up in here (indicating)?

MR. MALONE: What happens --

MR. SCALMANINI: There's four-tenths of an inch or something like that at that point.

MR. MALONE: So what that represents is this area right here where this blue line --

MR. SCALMANINI: Is recovering?

MR. MALONE: -- comes down here. And then we start -- we came back up here, a pumping well turned back on, and we cycled through this zone. And now we're recovering our water levels again. This is the end of the time series which was yesterday right here.

MR. SCALMANINI: But reading the preceding graph, that four-tenths of an inch, is that what it was, roughly speaking?

MR. MALONE: Yeah.

MR. FIFE: So four-tenths of an inch divided by 12 is what? .03 feet? Is that right?

MS. ROJO: No. It would be an inch.

MR. SCALMANINI: I don't want to drag you through it. I was just trying to get located off in these little hysteretic loops. Okay. That's cool.

MR. MALONE: What these little loops represent are the short periods of time that the well, in this case, you know, shut off and then turned back on.

the pumping season, it looks like we had about two one-hundredths of a foot of inelastic compaction that may have occurred during this late stage of drawdown during the pumping season.

We actually wanted -- we were trying to do this with our pumping test. We turned on an additional well here in the late stages and tried to draw down water levels as far as we could draw them down and create a tiny bit of inelastic compaction to try to identify that threshold where we're transitioning the system from elastic into inelastic compaction.

Now, we shut off the wells here in October of 2004, and the water levels have been recovering and the system has -- the aquifer system has been expanding mechanically. We had this episode where we had one of the wells turned back on and turn off a couple of times, and we had this hysteresis loop, this kind of shorter period in time hysteresis loop that occurred here.

Since this point in time in March we've had some good recovery. The wells turned off continuously, and we've had some good recovery and we've got the recovery trend coming back to its original trend in this direction.

SPECIAL REFEREE SCHNEIDER: Would you expect, and if so when, that that curve would go back down to that?

MR. MALONE: Down to these levels here?

SPECIAL REFEREE SCHNEIDER: Yeah.

MR. MALONE: We're thinking towards the end of June, maybe some point in time in July, is what we're predicting by looking at the recovery rate. So I'd say to be safe --

MR. SCALMANINI: Couple months.

MR. MALONE: -- maybe two months, two more months.

MR. SCALMANINI: You're going to stay -- you -- is pumping going to stay off?

MR. MALONE: We've had discussions with Chino Hills, and they've assured us that they are committed to letting water levels recover down to about 105 feet, recover back to 105 feet below ground surface, which were our prepumping test conditions here in the summer of '04. So they've given us assurance that they'll keep their deep system wells off to allow full water recovery.

What it's looking like is that if this continues on this same trend here, it's looking like, if indeed this curve ends up here, that it's looking like we could have about two one-hundredths of a foot of permanent compaction that occurred over the last pumping season. And that would, if we go back here, that would match up with what we thought occurred toward the later part of the pumping season last year.

This is a pretty key point right here for you to understand. So if you have any questions on this, now is the time. Or we can talk about it in greater detail later.

Another thing to note here -- another thing to note here -- did you have a question right now?

MR. SCALMANINI: No. I'm going to look at something. You can go ahead, please.

MR. MALONE: Another thing to note here is that this short-term hysteresis loop where we had the well turned on for about a month or so and we drew down water wells to about 210 feet, well, its recovery trended in this direction here and intersected the same point that it started at. So what that's indicating is a purely elastic process occurred over this short time period of drawdown and recovery.

So we're clearly -- the stress-strain diagram is clearly indicating that operating in this range right here, at least for the pumping -- the location of the pumping that occurred, that we're operating within the elastic range of deformation.

But it appears that if this stress-strain diagram comes down and stabilizes out in this area here, that this is indicating that we operated in an inelastic range. And what we're saying is that that inelastic threshold was crossed at about 250 feet below ground surface during the later part of the pumping season.

MR. SCALMANINI: Going back to quite a ways ago, but that collection of hydrographs that was labeled Figure 9 which was the shallow water level histories that went back, whatever, six decades or thereabouts. Is there a, I'll call it a comparable collection of historical data in the deep aquifer available where you could do hydrographs from what nominally late '80s, or thereabouts, when this portion of the aquifer system was first developed?

MR. MALONE: We don't have very much deep aquifer system data in this area, water level data in this area. We have some from Chino Well 7. We have some data that dates back a ways. I'd have to look at that more closely to tell what exactly that time history is there.

MR. SCALMANINI: So you could or couldn't classify or speculate about 250 feet below ground surface being a, quote, historic low?

MR. MALONE: Well, we have some water level data in the 1990s from City of Chino Hills wells that show water levels much greater than 250 feet below ground surface.

MR. SCALMANINI: Really?

MR. MALONE: Yeah. And some pumping wells near

400 to 500 feet below ground surface for short periods of time.

MR. SCALMANINI: Okay. That's a pumping water level in a production well?

MR. MALONE: Yeah. Again, the quality of our data doesn't approach this where we have 15 minute data from transducers. It's monthly data that's gone out and collected manually.

MR. FIFE: Andy, are you getting to a point where you could break because lunch is here. And if this is a good point, or you're near one. Okay. Then if we could, we could go ahead and break for lunch. Dennis has got a comment?

MR. WILLIAMS: Yes. Dennis Williams, Geoscience, for Chino Hills. I just had some clarifications to Mr. Scalmanini's questions a while ago.

There were some deep -- there were some deep wells prior to 1990, albeit most of them were in the northern area of what's called the area of subsidence concern. But there was pumping prior to 1990 in the deep aquifer system.

Also there was some benchmarks, USGS. Some of them were approximate, but they showed like Pipeline and forget the actual -- but most of the subsidence recorded between '33 and '87, at least according to these benchmarks, was northwest of the fissure zone. And this is all in the report that I did in August of 2002.

Also there were some fissures. I don't remember exactly where they were. But there were some fissures recorded in the literature prior to 1990 also. And primarily, I believe, they were over on the State's property to the east. And also the water level changed between the early 1900s and 1975, 150 feet, we believe is one of the main results of this. But we just have to wait and see. And Andy has said that, you know, in a couple of months maybe we'll see what the trend is going to be as far as that. Thank you.

MR. MANNING: This is a good spot to break, then we'll go ahead and break for lunch.

(Recess in proceedings from 12:11 to 12:52 p.m.)

MR. MANNING: We should probably get started again. If we can get everybody back, we will go ahead and get started and we'll try and pick it up right where we left off, Andy, with the famous stress-strain diagram.

MR. MALONE: We can move this black line around a little bit further where this was an earlier trend in the year. And we're not exactly sure what's happened here, but we think that when this plays out to completion, that we will be within this range here somewhere. That's what it looks like to us that's going to occur.

Now, these stress-strain diagrams, and this is for our area here, but in Francis's experience he's constructed other extensometers and looked at similar data in different parts of the state and the western United States. And these are some, like here in particular is a stress-strain diagram from another area. And, Francis, I'd like you to explain this if you wouldn't mind, since this is your data.

MR. RILEY: Okay. This basically covers the time frame from about 1960 to, I think, probably the early 70's. I can't quite read the numbers on the graph there, but it looks like it goes into, what it is, Andy? About 1975?

MR. MALONE: 1980.

MR. RILEY: 1980, okay.

MR. MALONE: 1960 to 1980.

MR. RILEY: The top graph is the head change in the confined aquifer system, which as you can see, declined relatively slowly year by year with a fairly substantial seasonal fluctuation each year, until additional water was brought in through aqueducts and the production was diminished. And then we began to see a period of water level recovery but still with essentially the same amplitude of seasonal fluctuation.

The graph immediately below just translates those water levels into effective stress values which are virtually the same. And then below that, we see the graph showing two things. The long slightly wavy curve is the extensometer record for that time period. And the little straight line segments that are connected together in the earlier part of that history reflect successive measurements on a nearby benchmark which obviously is very closely tracking -- I should put it the other way. The extensometer is very closely tracking the benchmark elevation changes.

Now, at the bottom we have a stress-strain diagram. And you'll say, well, that doesn't look anything like what we were just looking at on the previous slide.

MR. MALONE: Francis, you can back off from the mike a little bit.

MR. RILEY: I'm sorry. I'm talking too loud. I'm sorry.

In the early phases of this subsidence phenomenon, as you can see from the basic data on the extensometer, it was essentially a continuous downward movement of the land surface. And although there were little seasonal wiggles, they are never sufficient to overcome that downward trend. As a result, the stress-strain plot never reverses itself, and it's always showing ongoing subsidence year by year by year. Each one of those little humps is one year's worth of data on the extensometer.

But as you can see, as time goes along, the amount of subsidence that's occurring, each compaction that's occurring each year gets smaller and smaller and smaller. And eventually over here, we begin to see a little bit of elastic rebound here, not really evident here, but definitely evident here. And then we're getting into something which looks very much like what we are now seeing in our Chino installation.

So in a sense you could say it's very likely that what we were looking at now at Ayala Park is this phase of something, which if we'd had extensometers in there for the last 30 years, might look quite a bit like this.

MR. SCALMANINI: You know where that is?

MR. RILEY: I beg your pardon?

MR. SCALMANINI: Where is that?

MR. RILEY: Santa Clara Valley in the City of San Jose.

MR. MALONE: So what we're showing is just a different record, same concept as the stress-strain diagram but a more complete record here of a lot of inelastic subsidence transitioning into elastic deformation.

So if you recall we --

SPECIAL REFEREE SCHNEIDER: Excuse me, Andy. Is the work that the Associated Engineers are doing trying to figure out if there is that kind of a history?

MR. MALONE: Yeah. Of course, we won't have a continuous history like that. But exactly. We're trying to get the total subsidence history dating back into the 1930s if we can back that far before we had significant head decline in the basin. We want to have some idea what the land surface was doing over that same period of time. That's going to help us calibrate our models that we will be talking about shortly.

So if you recall, we performed these deep system tests. We did one in 2003 which we weren't successful in transitioning the system into inelastic compaction to our satisfaction. We could only get water levels down to approximately 250 feet.

The City of Chino Hills had some production problems, mechanical problems with one of their wells that had to be shut down and I believe is still being repaired. So that ended our test prematurely back in 2003. We ran another test in 2004 where we were able to draw water levels down further down to about 280 feet.

And some of our preliminary conclusions from that test is that we were able to transition the system from elastic to inelastic like you saw on our stress-strain diagram there. It occurred when the water level exceeded 250 feet in our PA-7 piezometer. And again, this conclusion is pending confirmation. It's a preliminary conclusion right now. But we're looking for fully recovered water levels before we can draw this conclusion.

The groundwater barrier aligned with the fissure zone. We confirmed its existence through these pumping tests. And it looks like by close analysis of this data from both deep tests and shallow system tests, that the groundwater barrier is a competent groundwater barrier below about 250 feet but is not competent above 250 feet, meaning that head changes can propagate across the fissure zone above about 250 feet.

And because we were able to identify the preconsolidation stress, the current preconsolidation stress in the system through our pumping test, we think we have enough data now to proceed with the modeling.

So that ends our discussion of our results with our aquifer system monitoring. But again remember, we're also doing performing ground level surveys and InSAR data as well. So some of the results of our ground level surveys -- and we drew this conclusion prior to our study by looking at some of the historical data -- that we had nearly 2 1/2 feet of permanent subsidence near Ayala Park over the 1987 to 2004 time period. That we recognized the very steep gradient of subsidence across the fissure zone which suggested that the probable mechanism for the fissuring was the subsidence. And we also recognized that the rate of subsidence has declined over time. Now, again, these are statements, and I'm going to illustrate some of this with some graphics.

This is a figure from earlier on today. What we're going to be looking at are three transects, profiles of ground level survey data, over this time period here. First of all, we're going to be looking at -- actually not over this time period, but this first one will be.

We're going to be looking at a profile along Schaefer Avenue through this maximum area of subsidence here along Central Avenue. And that's what this is here. So this is west, this is east. And on this axis here, we're measuring the vertical deformation or the vertical displacement of our benchmarks. And our benchmarks are represented by these little points here. We have a benchmark here at Pipeline Avenue and a benchmark here at Monte Vista Avenue, at Central Avenue, at Benson, and then at Magnolia. And this line here represents our baseline in 1987. So that was the first survey.

Our next survey is this line right here, which is a June 1993 survey. And so you can see here along Central Avenue that this monument subsided about one foot over that period of time from 1987 to 1993. Then from 1993 to 1995, this benchmark subsided a little more than a foot again. And then from 1995 to 1999, we had a fraction of a foot, looks like about three or four inches of subsidence. From 1999 to 2000, another couple of inches. And then since 2000, we haven't measured too much permanent subsidence at all in this area.

So from looking at this, you can see that most of the subsidence occurred from 1987 to 1999. That's what the ground level survey data is showing us. It's slowed down progressively now. We're not having much permanent subsidence occur at all.

SPECIAL REFEREE SCHNEIDER: Where would the groundwater barrier be?

MR. MALONE: This is a cartoon of the location of the historic fissure zone. And so the groundwater barrier would be right approximately in this area. What we've also projected onto this profile are the nearby pumping wells. We have Chino 6 and Chino 4, which are shallow wells, right here projected onto the profile. And then Chino Hills 17 and Chino Hills 19 located right here.

So by looking at some of our current data, we know that pumping from these wells causes a lot of drawdown in this area. But at least in the deep zone, that drawdown does not propagate east of this fissure zone. And so --

SPECIAL REFEREE SCHNEIDER: So where your graphic shows the fissure zone, that's approximately the location of your barrier?

MR. MALONE: Yes. So the fissure zone and barrier seem to be coincident.

MR. SCALMANINI: So there really shouldn't be any significance attached to the straight lines between the points east and west of the barrier?

MR. MALONE: Over here?

MR. SCALMANINI: No. The next two points. From immediately east of the barrier to, I'll say, quote, immediately west. The straight line that goes from there down to the left over to there.

MR. MALONE: Over here?

MR. SCALMANINI: Yeah.

MR. MALONE: What do you mean there is no significance?

MR. SCALMANINI: If one went out and measured vertical displacement -- well, let's just say east of the barrier and west of -- is that Benson Avenue?

MR. MALONE: This is Benson Avenue here.

MR. SCALMANINI: So pick a point on that line. That line is now diagonally going down to the left. Would one expect to have that much vertical displacement on the east side of the barrier?

MR. MALONE: Right. I mean what we're doing here is we're just connecting the dots between two points.

MR. SCALMANINI: That's what I'm saying. So they're just connected dots. They are not -- the significance means, or the lack of significance means one should not expect that there is a linear relationship.

MR. MALONE: Right, right, exactly. I see what you're getting at.

The reason why we draw this here is to demonstrate that the gradient of subsidence on this side of the trough is steeper than the gradient of subsidence on this side of the trough.

MR. SCALMANINI: And arguably, it could be even steeper.

MR. MALONE: It could be if we had data points that were closer on the east side of the fissure zone and data points that were closer on the west side of the fissure zone. And I think that when you look at some of our InSAR data, which again is a continuous representation of the ground surface, that you'll see an even steeper gradient of subsidence than indicated by the ground level survey data.

So that was the historical data that we were looking at there. If we -- did you have another question?

If we look at some of the current data that we've been collecting, this seasonal data in this area that we've been collecting along Edison Avenue here and along Eucalyptus Avenue here across the fissure zone -- remember, we're doing both vertical and horizontal test distance measuring between monuments down in this area. And we're doing this on a spring to fall and a fall to spring interval. So we're looking at seasonal changes.

We know that we don't have much permanent compaction and subsidence at the current time. But we have also noticed that we have quite a bit of elastic deformation that occurs. So we're going to be looking at some of that elastic deformation in these next two profiles along Edison Avenue and along Eucalyptus Avenue here.

So this is along Edison Avenue. Again, we've got Monte Vista Avenue here, Central Avenue here, which has historically been our area of greatest subsidence, and Benson Avenue and Magnolia Avenue. And here again is the projection of our fissure zone. And we've projected on locations of some of the pumping wells near Edison

Avenue.

This is over a time period from April to November of 2004. This is a time period where we have pumping that's going on in this area. The forbearance agreement allows for it. And what you're seeing here is the April benchmark, our baseline for April. And then what we have here in red is the mainly elastic deformation that occurred over this time period from April to November in 2004.

When we go from November to the spring of 2005, these benchmarks rebound back to almost their same position. What you see here is also some horizontal displacement. We're not only recording vertical but we're recording horizontal displacement of these benchmarks as well.

So it's interesting to see how these benchmarks are displaced not only vertically but also displaced towards the center, the centers of pumping where we have our greatest drawdowns. So it makes a lot of sense.

You can also see the same sort of pattern that we saw with the permanent subsidence, you're seeing it with the elastic subsidence over this short time period where we're having more deformation that occurs on the west side of the fault where we have water level decline, significant water level declines, that don't propagate to any great extent across the fissure zone to the east where we don't have as much deformation occurring.

So looks a lot like the same pattern of subsidence that we saw with the longer time history of permanent subsidence, but this is elastic over a shorter period of time.

MR. WILDERMUTH: Andy, can I ask a question. Is that all right?

MR. SCALMANINI: Yeah, it's all right. Who's working for whom here.

MR. WILDERMUTH: What is the significance of the direction of these horizontal displacements?

MR. MALONE: This is Chino Hills 19, and again, remember, when we looked at the hydrographs, this is the main pumping well in this area. When we look at the hydrographs, this is the well where we have the largest cone of depression in the area. So this is where we'd have the greatest drawdowns. And it's showing us here that the land is moving towards this area of drawdown. So the aquifer is compacting or compressing elastically more in this area here where Chino Hills 19 is pumping from than the areas on the other side of the fissure zone or further to the west.

MR. WILDERMUTH: The same question relative to the fissure zone?

MR. MALONE: Say that again.

MR. WILDERMUTH: Same question relative to the fissure zone?

MR. MALONE: Same question?

MR. WILDERMUTH: What is the significance of the fact that the horizontal displacements are going now in opposite directions.

MR. MALONE: Are going in opposite directions here? We don't have a real good explanation. This is a fairly small movement of displacement that's occurring there. But we have a pumping well over here, CIM Well No. 3, which doesn't produce a great amount of water, but it is producing water. And we have other wells that are further off to the east too.

But again we don't see -- we have monitoring -- we have water level transducers in many wells that are out here, and we don't see the magnitude of drawdown in this area as we see in this area.

MR. WILDERMUTH: Relatively speaking or exactly, if you can, how much horizontal displacement are we talking about in feet or inches?

MR. MALONE: We made the scale to be as similar as possible. So this is half a foot here so this is a --

MR. WILDERMUTH: Tenth of a foot.

MR. MALONE: Tenth of a foot. So this is close to

45 degrees so it's probably a little less than a tenth of a foot. But it's significant.

And we see the same pattern down on Eucalyptus Avenue where we've again projected some of the main pumping wells in the area onto our profile. And again we see this similar pattern where we have greater subsidence on the west side of the fissure zone than we do on the east side of the fissure zone.

We also again are recording -- we're doing our ground level surveys not only in this area in the south, but we're also -- we've also extended these lines of surveying up into the central portions of MZ1. And what we've seen, we only have one good year of data behind us so far. But what we're seeing is that in the central regions of MZ1, that we are having some measurable subsidence that's occurring. It's on the order of about an inch that occurred from the April 2003 to April 2004. But it's an inch. And down in the southern area we're not recording any significant subsidence at all. So that's one finding that we've noticed.

When we are asking --

MR. SCALMANINI: Andy, when you say central, could you put some geography around that.

MR. MALONE: We will here with a map.

When asked to characterize this subsidence in this central portion of MZ1 as either elastic or inelastic, we don't have enough data to make that characterization yet. We have not analyzed the pumping and water level data to the same degree as we are analyzing it in the southern portions of MZ1. But we plan on doing that in the future, and we'll talk about that shortly too.

So this is going to illustrate the concept that I just talked about. What we're doing with this graphic here is we're showing two different sets of land subsidence data. In the dots, these big red dots, that get smaller as we move to the south and actually turn into green dots down here, these are benchmark monuments that recorded subsidence or rebound from April 2003 to April 2004. And again, our maximum subsidence during this time period occurred up here north of the 60 freeway along Philadelphia Street. And again about a maximum of an inch of subsidence occurred up here. While down here near the Ayala Park extensometer, we have virtually no subsidence at all recorded by our ground level surveys.

The InSAR data here is from the September '93 to December '95 so we're going back in history into those early '90s where we know from the ground level survey and the InSAR data we actually had over a foot of subsidence that occurred over this time period down in these areas here.

So the point of this illustration is that currently we're not showing much permanent subsidence occurring down here in the southern part of the MZ1. Back in the early '90s we had subsidence occurring up in this region as well. But in today's world, we're still having some subsidence occur up here as indicated by the ground level surveys. So that's -- the distribution of subsidence has changed over time, is the main point of this slide. We can illustrate that with some other graphics later on too, especially with the InSAR.

So transitioning into the results of the InSAR, what we can say about the InSAR data that we've analyzed to date is that it's generally consistent with the survey data both in its areal extent and its magnitude. We've made that point.

That the steep gradient of subsidence across the fissure zone is extending to the north, all the way up to about Francis Street. We will show a graphic of that.

And that the InSAR data is displaying this steeper gradient of subsidence across the fissure zone than the survey data, going back to your point, Joe.

The InSAR data also supports the existence of the groundwater barrier that's aligned with the fissure zone. The rate of subsidence has declined over time. We can show that with the InSAR data. That near Ayala Park it's primarily elastic compaction and expansion that's occurring.

But these central areas are now displaying greater rates of subsidence than near Ayala Park. But again the pumping and water level data has not yet been analyzed so it's difficult for us to characterize the nature of that subsidence as elastic or inelastic.

So what we're going to do now is take you through two of our time series of the InSAR data. And the maps as I page through them, the maps will show you what time period is of interest that's being displayed on the map. And these maps are cumulative in their series. So as we go from September '92 to October '93 and we move on to the next image, it's a cumulative map where we now go from September '92 to December '95.

So we're sort of adding on subsidence as we move through these time series. So that's what you're going to see.

If we look here for the September '92 to October '93, you can see our main area of subsidence and that there is more subsidence occurring down here near Ayala Park than up to the north. But we still do have in these central regions some subsidence that's occurring.

The scale here of the subsidence is a maximum of

50 centimeters of subsidence, and that will occur at the end of the time series in 1995. And then in these green dots, the bigger the dot, the greater the production over this time period here. So this time period is the water year of 1993. And this data comes from Watermaster's production database.

MR. FORDHAM: Eric Fordham. I might want to point out, Andy, also, that there is a mixture of both deep wells and shallow wells shown on this graph for production. And in kind of the location where the shallow wells are versus some of the deeper wells.

MR. MALONE: Yeah. Here's our Ayala Park extensometer. We have shallow wells and deep wells located right next to each other in this region and in this region here. Here these are some shallow wells. This is a deep well, and this is a deep well here.

Then as we move into the December '95 period, you can see that again we have a great deal of subsidence that has been occurring down in this region. We lose some coherence in this area, but you can see from the pattern that the reddest areas are down in this region.

But we do have this area of significant subsidence that is occurring here in the central regions of MZ1. You can see generally over this entire area here we have some low level, persistent subsidence that's occurring.

If we put contours to this, we have about 50 centimeters of subsidence down in this region, about 30 centimeters in this northern region, maximum of about 30 centimeters. And everything outside of this 10-centimeter contour is less than 10 centimeters out in these regions over this time period.

And remember, from our ground level survey data that the rate of subsidence slows down considerably after 1995. The next series of slides will show us the '96 to 2000 time period.

This slide here again shows the same InSAR data but we've added well ownership. These pink wells are the City of Pomona, the green wells are the City of Chino. And CIM, some of their production wells down in this region. And these are wells owned by City of Chino Hills out here. Monte Vista Water district has some wells in this region here. These are city of Ontario.

So if we look at the second series, this is a very interesting series. Again, it's a more detailed series, and you can see the last series from '92 to '95 we only had two interferograms to add up. But in here we have more like 20 interferograms that we're going to go through. They span shorter time periods, and you're actually going to be able to see some of the rebound of the land surface, not just the subsidence but actually some of the rebound which will show up as the blue values, as blue areas here.

I caution you that it's going to look a lot redder in this area, but we changed -- we've changed our scale here of displacement from 50 centimeters to 15 centimeters. And at the very end of this time series we'll compare the first time series to the second time series so you can see that comparison.

But as you can see here from our January to April 1996 time period, we have very little subsidence or rebound occurring throughout the Basin. But down here in this region, we are seeing a lot of elastic rebound.

As we move through the pumping season of 1996 to September '96, you can see now that that rebound has been replaced with subsidence. And here is the distribution of production in 1996.

As we move into January 1997, we see some subsidence that occurred over this time period in the central regions, but down here near Ayala Park it hasn't -- we haven't seen much subsidence at all. In fact a little bit of rebound down in these areas.

We move into February '97 and now into April '97, still in the non-pumping season or not quite into the pumping season yet. And you can see even more rebound occurring in this area.

We're into May '97 here, into July '97 so we're entering the pumping season of 1997. September 1997. And here is the production from 1997. Generally what we're just trying to do here, we haven't done a great deal of analysis, but just looking at the distribution and looking for patterns, production patterns, versus the subsidence patterns.

So now this is two full years of the time history, and again these northern regions showing some subsidence over this time period. Down here in the south not quite as much, if any.

April '98. We're moving into the pumping season of 1998. And the subsiding trough is really starting to develop here. And this is the production patterns for 1998.

So now this is three full years. We're into January 1999. We're into May '99 coming into the pumping season of '99. Now we're in October '99. I think what you can really see is this north-south lineament that is aligned with the fissure zone, you can start to see that steep gradient of subsidence. And the development of this trough of subsidence up in the central regions is showing up quite well. Here again is our production patterns.

Now we're moving into the year 2000 towards the end of our time series, into March and April. And while you can see that some subsidence occurred over this time period down here in the southern regions, it's not quite as much as what occurred up here in the northern regions.

Here is the production patterns for the year 2000, water year 2000. And these are the production patterns for the entire time series from '96 to 2000, so cumulative production over that time period.

One very interesting thing to note here is that while in these areas of subsidence down here we have wells that are centered on the areas of maximum subsidence, we don't really have that up in these regions here. Speculate on some of those causes, but that's what it would be is speculation at this point.

But again, note the very little amount of subsidence that occurred directly to the east of the fissure zone. But we have significant subsidence that's occurring just directly to the west again, the steep gradients of subsidence on the eastern limb of the subsiding trough.

So here we're giving you some values of subsidence, over 12 centimeters of subsidence over this time period, '96 to 2000, 12 down in here, a little less than 12 down in these regions.

Our well ownership again. Now, if we compare these two, again this is the first series '93 to '95. And this is the second series '96 to 2000. But again look at the contours, and you can see that in this area right here in '92, 95, we still had over 30 centimeters of subsidence whereas we had some, you know, a good amount of subsidence occur during this later time period but less than before. Go back and forth and compare these two images to each other.

Are there any questions about the subsidence diagrams, or does anyone want to add any clarification to that? Maybe Francis, you in particular?

MR. RILEY: No. No, no, no.

SPECIAL REFEREE SCHNEIDER: So there is no fissuring further to the north, but you're seeing as much subsidence there as in the Ayala Park area?

MR. MALONE: We have not -- we don't have any indication that it's occurred there. We haven't documented anything. But it certainly looks very similar in its pattern to an area where we had fissuring in the past. So it concerns us that it's a possibility.

SPECIAL REFEREE SCHNEIDER: How far north does your barrier extend, as far as you know?

MR. MALONE: Well, we haven't done any hydraulic testing in this area, but the InSAR here is suggesting that this barrier extends to at least up into this region. That's what the InSAR is suggesting something about that, the extension of that barrier. But again we haven't done any hydraulic testing in this area to confirm that.

SPECIAL REFEREE SCHNEIDER: I don't recall how far north Chino's work in looking at subsidence went from '87.

MR. MALONE: It went down to about this area. It was in this area right here.

SPECIAL REFEREE SCHNEIDER: So has no one studied subsidence historically above that point?

MR. MALONE: Up in that area, not a study like we're performing here. I'm not aware of any specific subsidence investigations that's occurred up in this area here.

What this is also suggesting -- Anne, we have a later slide in here where we talk about this -- that the InSAR can reveal certain things about the subsurface geology. In this case we think it's revealing the existence of this barrier or the extension of this barrier to the north.

Also, you can't have permanent subsidence occurring where you don't have compressible sediments. So these aquitards that we're talking about down in this region compacting and causing permanent subsidence at the land surface, this InSAR is suggesting the existence of those fine-grained sediments to the north too.

SPECIAL REFEREE SCHNEIDER: Can you show the distribution of deep pumping in the central area again.

MR. MALONE: Okay. If we go to deep pumping here, I think the well ownership, in this area here, I know that these wells here are some deep wells. In here, and then we've got a deep -- we've got two deep wells down here.

SPECIAL REFEREE SCHNEIDER: I mean up in the central.

MR. MALONE: This area here we don't have any wells to speak of in this area at all. But as -- forgot who mentioned it earlier, Dennis -- that a lot of these wells up here in this region are perforated deep. The water levels -- the depth to water is much greater up in these regions here. It can be 400 to maybe even 500 feet to groundwater in some instances. So as a result a lot of these wells are drilled and completed in deeper portions of the aquifer.

ERIC FORDHAM: Andy, maybe you can talk a little bit about how the geology, as you understand it from looking at well logs, varies from the southern portion of the zone that we talked about up in this northern area. You know, the water levels drop. And as you go further to the north, as you just said, how does the geology, the character of the geology change?

MR. MALONE: Off the top of my head, I can't tell you exactly how far some of these confining layers extend to the north. I know that the geology is fairly similar, though, as you go to the north, that we do -- looking at some of the well logs, that we do have fine-grained compressible units up in this area.

But as far as extending some of our detailed knowledge down here to the north, we haven't done that work in detail yet. But we plan on doing it.

MR. HILL: Can you comment on the depth of the well to the east of this fissure zone down to the south, as well as up here?

MR. MALONE: We don't know the well construction of every single one of these wells. But what we have obtained, we've obtained from Geomatrix that works for the State here on some of the well construction. They're generally shallower.

MR. HILL: Up further.

MR. MALONE: Up further up here?

MR. HILL: Down there, the 12 down there too.

MR. MALONE: Near the 12 here?

MR. HILL: On the 12 down there on the east side of this --

MR. MALONE: This well over here is a deep well, but it doesn't pump. It's constructed similarly to these other wells. These wells don't pump down here. They're old ag wells that are fairly shallow, maybe 200 feet in depth. But they've been preserved as monitoring wells so we have water level transducers in them. But they're basically providing us with shallow system data.

MR. HILL: What about up there?

MR. MALONE: Up in this region here I can't tell you off the top of my head, but I know generally as we move to the north, the wells become deeper in their construction. But I can't tell you specifically for each well up here.

But our plans are to come up here and do the same sort of investigation that we did down here up here by dropping in water level transducers in some of these wells, start to understand -- trying to understand the relationship between groundwater production and water level declines and the hydrogeology better in this region. Those are our plans.

So those are our results, and now we're going to talk about some of our conclusions to date.

What we're stating here is that under the current mode of aquifer system utilization, meaning that we have the forbearance agreement that we're operating under, and under the current distribution of pumpage both in location and depth, Chino Hills is limited somewhat by water quality issues like arsenic in their wells. And like I stated earlier, some of the -- one of their wells in particular is having mechanical problems.

But under what we've seen the past few years, under that mode of aquifer system utilization, the permanent compaction is minimal in these southern parts of MZ1. We're mainly seeing elastic deformation.

Anne, I think you had a question about this as far as the forbearance agreement and the impact of the forbearance agreement.

SPECIAL REFEREE SCHNEIDER: One of my questions has been whether you just happened to hit the right number with 3,000 acrefeet or not. But my question, is the main importance of what you've been looking at with the forbearance agreements in place and the forbearance going on, that the key may be that you don't go below a certain depth for more than a certain amount of time in order to ensure that you have elastic conditions versus any particular amount of water being pumped or not pumped under a forbearance agreement. What are the key factors that seem to make the most difference to be able in your stress-strain diagrams to come back and stay elastic in the changes you get?

MR. MALONE: So what you're asking -- so the forbearance agreement pertains to groundwater production.

SPECIAL REFEREE SCHNEIDER: Right.

MR. MALONE: What we've been --

MR. SCALMANINI: What it really pertains to is an amount of reduced groundwater production.

MR. MALONE: Right. And the relationships we've been establishing so far are between groundwater levels and aquifer system compaction.

Now, the next obvious link is, how does production affect groundwater levels. And that's really the next step in our investigation is to create groundwater models to simulate the groundwater production's effects on groundwater levels. And so at that point in time we will be in a better position to say what the effect forbearance has on groundwater levels in this area.

But we have not done any specific work to date on, has forbearance helped in mitigating subsidence. It was a mitigation measure that we took in the beginning, but we haven't done the work to quantify its effect.

MR. SCALMANINI: The number 3,000 acrefeet had -- I'll try it as a statement and you correct me if I'm wrong -- had nothing to do with, I'll call it, science. In other words, 3,000 wasn't calculated. It was an amount of available water that could be brought in as a substitute water supply if I remember correctly. Right?

MR. MALONE: I'm going to defer to Mark on some of this. You can chime in when you want to on the forbearance aspects of it. Maybe Mike will take it.

MR. WILDERMUTH: Let Michael take it.

MR. FIFE: I think that is a fair statement, and it kind of depends on where the discussion goes.

MR. SCALMANINI: It's not intended to go anywhere. It was an amount of water that people could agree to because it was an amount of water that could substitute for a reduction in pumpage while this work that's gone on for the last three years went on.

MR. KINSEY: Joe, it was originally a pipeline-convenient capacity, surplus capacity in --

MR. SCALMANINI: Yeah, that was -- had to do with hydraulics of the system also, I remember.

MR. BUNN: Say your name, Mark.

MARK KINSEY: Mark Kinsey, Monte Vista Water District.

SPECIAL REFEREE SCHNEIDER: And there was only capacity in that line in the non-summer season.

MARK KINSEY: Right. Restrictions were non-peak periods and surplus capacity.

SPECIAL REFEREE SCHNEIDER: I just wanted to see if there was something you could say about whether the ultimate program, the long-term program will be looking at constraints that are related more to the depth to which water can be lowered and the duration of time for which those lower depths can be allowed, more than not pumping a certain amount during a certain period of time or even pumping limitations in general.

So, you know, what little I understand about pore pressure and skeleton things, it would make sense to me that not allowing water levels to be lowered for long periods of time would be a good idea in terms of staying away from inelastic responses. Is that true?

MR. MALONE: I think that we have some empirical evidence that suggests that that's true, that when we operate in the forbearance agreement where we pump during the pumping season, but we allow the system to recover during the wintertime months, that we've demonstrated that we're operating generally in an elastic range.

And so to how far we can step out of that same pumping pattern and still operate within the elastic range, we have not determined that yet. But the models hold a promise of determining that.

Francis, would you say that that's --

MR. RILEY: Yeah. I would agree with that.

MR. SCALMANINI: Andy, I will ask a question about the very last one -- I don't know if it's the very last one. Yeah.

The distribution of pumpage location and depth. In light of the fact that the aquifer responds to what you do as compared to what you don't do, then if we wanted to somehow assemble a description of the spatial distribution and the depth distribution and volumes and rates and those kinds of things of what actually took place during this forbearance period, that could be done?

MR. MALONE: Uh-huh.

SPECIAL REFEREE SCHNEIDER: So you indicated yes?

MR. MALONE: Yes.

What we're seeing here is that looking at historical and current production from the deep system, that we believe that it has caused the greatest increases in stress. We showed many hydrographs showing that production from the deep system causes these great drawdowns in the deep part of the system in comparison to the drawdowns that we see in the shallow part of the system. And not only that, we're looking at maybe 175 feet of maximum drawdown in the deep system during our last pumping test and a maximum drawdown of about 15 feet that we were able to achieve in the shallow part of the system during the shallow tests.

Not only that in magnitude but we also see in lateral extent when production in the deep system occurs, we see this lateral propagation at significant magnitude of drawdown. So it's not only in magnitude, but it's also in lateral extent that we see the greatest stresses imposed upon the system.

MR. SCALMANINI: Lateral but constrained to the east.

MR. MALONE: But constrained to the east by the fissure zone. When we see wells located, deep wells located at significant distances to the west, we see that lateral propagation and head decline to significant degrees.

And again with our stress-strain diagram, this last bullet pertains to our stress-strain diagram where we're seeing that these head declines can induce permanent compaction. But again this is a preliminary conclusion because it is still pending fully recovered water levels. We're waiting for those water levels to be fully recovered to see if any inelastic compaction did occur over the last pumping season.

With regard to the groundwater barrier that we believe it exists in the deep system and that it has the potential to create differential subsidence and fissuring. Because it's a ground water barrier and does not allow these head declines to propagate to the east, that we set up a situation where we can have differential subsidence across the fissure zone as long as pumpage is concentrated on one side of the fissure zone.

MR. SCALMANINI: Andy, it's been a while since I looked at the cross sections that are in -- I forgot Initial State of the Basin Report and maybe other places, is there an equivalent, quote, deep system on the east side of this barrier?

MR. MALONE: What I can tell you is that we don't have a great deal of data.

MR. SCALMANINI: I didn't think so.

MR. MALONE: It's Chino Hills 18 that exists over there, and what it seems like is as we move towards the east, the fine-grained layers become more interbedded in the coarse-grained layers. And so it doesn't --

MR. SCALMANINI: Does not the basement dip up as you go to the east also?

MR. MALONE: To the south. It actually, you know, extends off to the north central part of Chino Basin. The deepest parts of the Basin are in the City of Ontario.

MR. WILDERMUTH: Eventually it comes out.

MR. MALONE: Eventually it comes out.

MR. SCALMANINI: Eventually it comes out.

MR. MALONE: If you move towards the Jurupa Hills, that's bed rock surfacing there.

I believe this is our last conclusion is that the central portions of Management Zone 1 require further study. I think by looking at some of that InSAR data, it's fairly obvious that it requires further study. That this InSAR data, like I stated earlier, is suggesting that something about the hydrogeology, the existence of these fine-grained sediments, and the possible extension of the groundwater barrier to the north, but that the source and magnitude of the drawdown and the material properties such as the compressibility of the sediments and the threshold for inelastic compaction, the so-called preconsolidation stress, those are all unknown in that northern part of the Basin. Where we think in the southern parts, where we've been studying it, where we've been studying it quite intensely, that we think we have a handle on a lot of this now, but not in the central regions of MZ1. And that the InSAR data is also showing us that we have this differential subsidence in these central parts of the MZ1 too which suggests the potential for fissuring.

So that brings us to our ongoing and recommended work. Continued monitoring. We're going to continue. Our monitoring program is almost on auto pilot in that a lot of it's automated. We have these transducers that are out there just continually collecting data at the extensometer and surrounding wells. We plan on continuing that.

For the ground level surveying, we're going to increase the frequency of ground level surveying. We're going to go twice a year across the entire network to get the seasonal fluctuations across the entire network, as well as the annual and ongoing subsidence and rebound that may be occurring.

We're also going to extend some of our horizontal monitoring further to the north. We have only been doing it at Edison and Eucalyptus Avenues. We're going to extend that distance measuring across the historic fissure zone up to Schaefer Avenue.

For the InSAR, again we're investigating the possibility of creating a similar time series that you saw here previously for the 2000 to 2005 time period. That would help us with some of the calibration of our models that we intend on developing. And what we're going to do is we're going to try to match our InSAR data with the data collection frequency that we're doing of ground level surveys. We're going to go spring-fall, spring-fall for the next two years with the InSAR data to match the ground level survey data. In that way, we're going to be able to compare the two technologies and see if we can't modify our long-term monitoring program to include a less -- maybe less frequent ground level surveying which is the more expensive method of surveying but it's tried and true. This down here is a little more experimental but there's many attractive features to it.

If we can show that the InSAR data is replicating what we get with ground level surveys, maybe we can back off on some of the ground level surveying and depend more on our InSAR data for our monitoring, our long-term monitoring.

Then these numerical models that we've been discussing, there's two of them. One is this one-dimensional compaction modeling that we're performing. And what we're trying to do there is come up with some estimates of the aquitard properties, these vertical hydraulic conductivities and these compressibilities of the sediments. And we're doing this modeling at Ayala Park using the data coming from Ayala Park. And then we hope to be able to extrapolate these properties into our three-dimensional groundwater flow and subsidence model that we'll be developing next year.

And what that model will be doing is it will be linking the areal and vertical distribution of pumpage to water level fluctuations and then the ultimate deformation that occurs in the aquifer system.

So again, we've been working mostly on this link between water level fluctuation and deformation. The model will, then, now take us from that to include pumpage, how it affects water level fluctuations, and then how the water level fluctuations affect deformation. And it will be a spatial three-dimensional model.

MR. FORDHAM: Question on the modeling. Eric Fordham. Will it also consider the time factor such as how long it would be for these aquitards to undergo the inelastic deformation once a certain withdrawal took place, so that there's time factors that will also be considered there?

MR. MALONE: Yeah. Francis is a little more familiar with the details of the model. Do you want to comment on that, Francis?

MR. RILEY: In general, yes, the modeling should allow us to predict what you might expect if pumpage were continued beyond the relatively short summer pumping periods that we have seen in the last two years during which we have been collecting detailed data.

But what little we've seen so far doesn't seem to suggest that there would be a dramatic change and the response is just over a longer period of time.

However, if we were to exceed the threshold of inelastic compaction, of course, you would extend your time delaying factor by whatever the multiplying factor on the compressibility is, which might be on the order of 50 or something of that sort.

Does that address your question?

MR. FORDHAM: Right. So essentially it does incorporate, then, what that factor would be?

MR. RILEY: Yes, right.

MR. FORDHAM: If it does exceed it, then you would know that this may continue to occur over a period of years following that exceedance of the threshold, if you will, or whatever the time factor would be.

MR. WILDERMUTH: In other words, you're saying if the change in the pressure inside the aquitard is dropped, we're going to see this over some period of time. Is that what you're saying?

MR. FORDHAM: That's what I'm asking, if the model would be able to accommodate that.

MR. RILEY: Yes, it would.

MR. MALONE: As far as future work goes, we plan on expanding our monitoring to the central regions of MZ1. And the first thing that we do, first, least expensive, and most bang for our buck would be to install these water level transducers in existing wells up there. Our experience with learning a lot about the aquifer system and how it works and how different pumping wells affect water levels in the region, we gained a lot of very valuable experience with this in the southern part of MZ1. So it's the obvious thing to do right away is to install water level transducers in existing wells.

And then what we're doing here is really speculating about what our group might want to consider in the future. And that would be to construct a new monitoring facility or facilities up in the central regions where we have our greatest amount of subsidence as indicated by InSAR and ground level surveys. And that new monitoring facility might include a multi-piezometer and/or an extensometer.

MR. SCALMANINI: Emphasis on the word "might." That's to be determined?

MR. MALONE: That would be to be determined. I think that what we want to do is continue to collect ground level survey data and InSAR data and water level data up in this area before we came to a conclusion as a group as to exactly what this monitoring facility should be.

But we're speculating right now that it would be at least piezometers, multiple piezometers that we could get some good geologic data up in this area that doesn't really exist. We don't really have any wells up in that area.

MR. SCALMANINI: That's where I was going to go next.

MR. MALONE: Hydrologic -- or the hydraulic data as well.

MR. SCALMANINI: Okay.

MR. MALONE: And then the development of the long-term management plan itself. The statement that were making here is that all this data that we've been collecting and the results and conclusions we've been coming to are providing what we call the technical foundation for the development of the management plan, the long-term management plan. It's not the long-term management plan itself. But it provides the foundation for the development of that plan.

That these groundwater flow and subsidence models will assist in the evaluation of any plans that we might develop. And the effectiveness of this plan can be continually evaluated based on a data collection and analysis and model verification.

As far as the schedule for this, over the next fiscal year, we plan on expanding our monitoring network to these central regions of MZ1 in the summer of this year. We have a piezometer replacement project that we're doing at Ayala Park. I think you're familiar with the piezometer issues that we've been having in some of our deep piezometers. We've come to the conclusion that we'd like to replace that piezometer with a new one.

MR. SCALMANINI: Okay.

MR. MALONE: And that is tentatively scheduled for the fall of '05. Ground level surveys again --

MR. SCALMANINI: Comment in passing, you're going to tear up all that landscaping and everything all over again? Might start working on the fence now. Just a little walk down memory lane.

MR. MALONE: Yeah.

Our surveys and InSAR again will both be fall '05 to spring '06 surveys. And modeling, we anticipate to be complete with our modeling in the spring of '06. And the final reports -- that would be the modeling report and the completion reports for our extensometer building and those types of reports -- we plan on being complete with those in summer of '06. So that's what our tentative schedule is right now that we hope to achieve.

MR. SCALMANINI: But that has no new piezometers in the --

MR. MALONE: No.

MR. FIFE: No new extensometer in it, none of that?

MR. MALONE: That's not put in the budget here either for the new facility. It's again that the new facility is something that we're speculating about right here that the group might recommend in the future. But we're not there yet.

MR. WILDERMUTH: The work we're doing right now in the southern part of the subsidence area was really as a result of a controversy that came up during the development of the OBMP. And going north would be -- what Andy calls the central area -- would be sort of a desire of this group to continue this work up there or not. I'm not sure this is necessary to meet the purposes of the OBMP yet, but that has to be determined. I mean, it's like Andy says, subsidence is like the weather. It may not be an issue up there or it may be, as Andy suggests, a potential for fissuring which should have everybody worried. That just sort of has to be articulated by the stakeholders.

SPECIAL REFEREE SCHNEIDER: I've been wondering how it would be determined that there is a problem of significance in the central area to the north. I mean, it's clearly of significance that there has been subsidence because there's been fissuring and impact to infrastructure where you have been studying. How does one determine significance before deciding to go into a lot more study and analysis and modeling and --

MR. WILDERMUTH: I don't have an answer to that question, but I understand your question.

SPECIAL REFEREE SCHNEIDER: Is that part of what the technical advisory group is looking at?

MR. WILDERMUTH: I think they are going to have to consider it at subsequent meetings.

MR. MALONE: A lot of what we've learned here with the InSAR data is brand-new to the group, that we've just recently got this data which has showed us in a lot greater detail the history of subsidence in the 1990s in this part of Chino Basin. So it's a relatively new concept that we're discussing in the group.

SPECIAL REFEREE SCHNEIDER: I have to observe, I guess, that I had expected that there would be sort of a new generation of working hypotheses that had come out of the work so far. As I understand it, you had a working hypothesis going into this work that seems to have been your conclusion that the deep pumping has had an effect and this somehow correlates to the subsidence and the fissuring historically. What working hypotheses do you have going forward here?

MR. MALONE: In these central regions?

SPECIAL REFEREE SCHNEIDER: Is there further work to do in the area that has been of concern? Are there questions you're specifically going to be trying to answer for that area as well as more work to the north and the central area?

MR. MALONE: We don't have any plans to do further testing in this region, testing being a method to answer a certain question. We feel like we're one with that. We feel like if the stress-strain diagram goes to where it seems to be going, that we've identified this threshold of preconsolidation stress that is the transition between inelastic and elastic compaction.

So we -- to answer your question, I don't think we have any further questions that we're trying to answer in this southern part of Management Zone 1. We're going to be developing the models that will help us provide that linkage between groundwater production and groundwater levels which would provide a tool to evaluate any management plan that might come out of this.

SPECIAL REFEREE SCHNEIDER: So one thing the model would do ultimately will tell you if everyone in concert does not pump more than X so that water levels don't go below Y for longer than Z amount of time, then you will stay in an area that will be elastic. Is that true?

MR. MALONE: Yes. I think that's generally accurate, yes.

SPECIAL REFEREE SCHNEIDER: Is that what the technical advisory group is waiting to find out? I'm concerned that there is nothing on your schedule as to when a long-term plan is going to be created. So the question is, does the model have to be developed and then applied in order to answer the question I just posed? And when that question is answered, is that when you would be able to develop a long-term plan, "you" being the technical advisory group.

MR. MALONE: If we were to develop a long-term management plan that said, you know, production should be limited to this or that, this type of pumping distribution for this period of time, what would the effects be in terms of inelastic subsidence. And what we're trying to do is get to a point where we have tools to evaluate what the effects would be.

MR. WILDERMUTH: Anne, I would tell you that where we're headed is kind of where the OBMP was headed at one time where the technical documents were done and then some institutional work probably has to be done.

SPECIAL REFEREE SCHNEIDER: Is that what you refer to as deal making?

MR. WILDERMUTH: That wouldn't be exactly how I would say it, but it would be about that, yes. I think we will come up with the technical basis from which a long-term plan can be developed. It could run a range from just being, here, here's the guidance information. You go. You go, "you" meaning the local pumpers, you go make this work. Just don't cross these thresholds, whatever they may be.

Another way to do it would be to be strong-arming. But that is the exact implementation, how you use this information, is something that is going to have to be done not by Watermaster staff and consultants, but it's going to have to bring in a broader group.

SPECIAL REFEREE SCHNEIDER: This is deja vu all over again, 'cause the transcript from the workshop a couple years ago, the same question is posed, when can you get to a long-term plan. The answer was five or six years of technical work and then a year to reach an agreement.

It sounds to me -- I pose this as a question. Is that still a fairly logical projection? So a few more years of studies and model development and analysis followed by 12 months to reach an agreement.

MR. WILDERMUTH: That's probably very reasonable. The 12 months on reaching the agreement is less certain than the technical part.

MR. SCALMANINI: This is not to argue. In the OBMP, did we not write language that said the objective of the MZ1 part of the overall OBMP was to eliminate subsidence or reduce it to an acceptable or manageable level or words to that effect. I think that's what it says. And again I'm not arguing with the need for a model. With the knowledge today, could that be, say, quasi-technically done, meaning stop short of a model because a model is going to allow you to analyze scenarios that would achieve some water level objective, the kinds of things that Anne said in terms of X, Y, and Z. An amount of pumping distributed a certain way over a certain amount of time.

And so the model will allow you to ask, so what will happen if I do this distribution over this period of time, et cetera, et cetera, et cetera. Ultimately all put in the context of the water demands of the affected parties are yet some other letter, A, and the pumping will supply a certain amount of that water supply, and then the rest of it has to come from somewhere else.

So that has to be sort of factored into it too ultimately, I guess, the deal part of this. But if the goal was as stated in the OBMP, to reduce subsidence, to eliminate it, or in some acceptable or manageable level, could in light of where you are with conclusions today, that be described short of analyzing scenario A, B, and C as to how to effectively implement it if it could be defined.

MR. WILDERMUTH: I'll take a crack at it. I'd say we're close to coming up with that kind of number. And from a management perspective, what the models do, and they're just models. I always make that --

MR. SCALMANINI: Recognize that, Mark, yes.

MR. WILDERMUTH: Put the word quote, closing quote, on the "just" part. They will give us some guidance, perhaps, on how to apply the criteria. So that's just another step of sophistication in trying to provide some results.

But saying that, once you got those model results, they're just model results. They have some accuracy. And what you'd have to do is you'd have to continue with the monitoring and come back to that. You'd still be coming back to those target levels that we're talking about or thresholds, management thresholds. You'd still be monitoring for that. And you would hope that the models would give you good information to help you get there.

But it's going to come back to a point where you're going to agree on something so you don't cross the thresholds and you have to monitor very carefully to make sure you don't.

MR. SCALMANINI: I don't want to, you know, jump to conclusions but for a collection of reasons that have to do with everything from arsenic to available, called substitute water supply, the interim plan has resulted in some conclusions that -- I should look up the word to use -- but it's minimal or basically no new inelastic subsidence in the focused study area to date. Right?

So one could possibly conclude you could go forward. A long-term plan to achieve OBMP objectives as stated, was it five years -- I'm losing track of time -- five or six years ago now, we kind of know now what it takes to do that.

MR. WILDERMUTH: In an empirical way, if you look at our pumping over the last few years, you could say if we read the data over again, you might not have -- it could be a low-cost way to do it. At least to provide them information.

MR. SCALMANINI: And the alternative, complexly, is to spend another million dollars or the better part of it subject -- I mean if the central portion of the Basin becomes more focused, wouldn't that piezometer installation cost $300,000? Extensometer costs a similar amount of money? So a million and a half dollars by the time the smoke clears if that gets added to this. And wouldn't you just extract three to five more years?

MR. WILDERMUTH: If you bring in the northern portion, this will go on more than what we talked about a moment ago, the central portion.

SPECIAL REFEREE SCHNEIDER: This may be just the world's most stupid question, but I've having a hard time understanding the connection between whatever is happening to the north and the problems that were the focus of the work so far, in the Ayala Park area. Can you help explain why it's logical that you need to go study further to the north? Does it have anything to with the problem so far? Or is there a perception that there might be a problem?

MR. WILDERMUTH: I'm going to give you my opinion. Francis and Andy may have a different opinion. I think that the interest to the north, to me, or I have a concern as a professional is the extension of that deep barrier and the likelihood of perhaps fissuring in the future, going up there and all the attendant issues of that. Whether or not we need to solve that problem in the north to come up with a solution to the south, I think we could probably bifurcate that. I think we can. I'm not a hundred percent sure. And from what I now know, I think it's possible.

SPECIAL REFEREE SCHNEIDER: Is it your sense that whatever the cause of the problem to the north is, it's more likely to be coming from the north than from the south?

MR. WILDERMUTH: I can't answer that question with certainty.

MR. SCALMANINI: I'm trying to decide whether to stop biting my tongue. I'm reluctant to bring it up, but I'm going to anyway. That given the stuff that we've just been talking about, which is that it seems like physically for at least part of the area and the part that's been focused on, going back to objectives to reduce or eliminate subsidence, that you're kind of there. And empirically, you know, or otherwise there's some level of detail that could be developed to say here's how to get there and stay there.

The issue that seems to me to be overarching is what all the liability pieces that go. You can stop it, but you still don't answer the question with definition as to, okay, so what about all the liability associated with fissuring, et cetera, in the past. We can stop it from getting worse or from advancing at all. But then you still have all that hanging out there.

I guess ultimately, it seems to me, like that's what will be fought over more than the physical solution to, quote, minimize or stop the advancement. It's kind of there now. I don't know how easily it would be to perpetuate something like this 3,000 acrefeet of substitute water supply to allow pumping to be in and about the range it's been, or words to that effect, or what other water supplies would be needed to meet projected increases in water demand, so that groundwater doesn't meet that.

But assuming that's a solvable problem, that then there's still all this overarching question of, then, what about all the liability things that seem to have prompted this process that we're in right now beyond the OBMP.

Is there anything in all of what's planned for additional work in the next -- what's the date, Andy? -- year, two years, spring of '06, summer of '06 for reports. Will that go in a direction of helping answer, I'll call it the question or the issue that I just added to the technical side?

MR. WILDERMUTH: Will the report address liability issues?

MR. SCALMANINI: Not so much address them but allow them to be addressed, I guess is maybe a better way to put it, Mark.

MR. WILDERMUTH: I'm not going there.

MR. FIFE: That's the right thing to do.

I think all those issues are potentially, potentially, wrapped up in the long-term plan and that's the -- I just go back to where we started today. This is a technical workshop, and we have not even addressed those issues. We've not approached those issues, and I think it would be premature to even address them in this workshop.

MR. SCALMANINI: With one qualifier I'll agree with you, Michael. The qualifier is that if the addressing or resolution of those is going to be technically based, we better be sure we're doing the technical work that's required to do that.

MR. FIFE: And this, I think if we look at a couple slides back that the future work they are proposing is geared toward providing the technical basis for addressing those issues.

MR. SCALMANINI: Okay. Well, then at the risk of being further argumentative, let me try a couple things. Let's go back to whatever slide it was, Andy, that listed all the potential mechanisms, you know, three years ago. It's on page 11 of the handout. There's -- what? -- three per, so it's 33.

MR. MALONE: Can you escape, and then go to slide 33.

MR. SCALMANINI: On this, if you take the first sub-bullet, subsurface fluid withdrawal, and subdivide it to where one of it's subdivisions is groundwater extraction, then there's been, going back to the -- when that list was first posed three years ago, that that's been the focus of the investigation.

And so it seems like to ultimately get there --

and again, Michael, I agree with you about, you know, we're not going to talk about solving the issue, but if we're going to talk about technical considerations that can affect the resolution of those, then it seems to me that to come in with the level of detailed focus, thorough, well-done and all those kinds of words that would apply to the work that's gone on for the last three years, unless you can say I have an absolute cause-and-effect relationship between ground water extraction and subsidence that unilaterally eliminates all the rest of these, then you have the potential for the debate to go on about, well, could some of the historical problem be the result of hydrocompaction or desiccation of soils.

Now, on its face or their faces, there's a handful of those, if not all of them, they're almost dismissable out of hand, but there hasn't been any work to dismiss them out of hand. But it seems like on the punch list of things, between now and, say, the summer of '06 or whatever, that there ought to be some effort to say that we've dismissed these. We didn't just pick one and study the heck out of it. We picked it for a collection of reasons, some of which were that these others don't have foundation in this location. And/or whatever other reason that can be dismissed. That's one thought that comes to mind as far as the list of things to go on from here.

You've been there. Maybe not as much as I have yet, but you've got a couple more years to go. The point is people can bring up things from a list like that. So how do you know it's not the collapsed underground caverns. I don't know who laughed. It's not. But, you know, the answer "I just know" usually doesn't work. Might for Francis.

So that's one thing that comes to mind, you know, to make sure that if we created this list of possibilities once, that we then paid some attention to them so they go away.

The other is -- and maybe it's embedded, Andy. I just don't flip memorywise fast enough. But the efforts that you have commissioned to the surveyors to try to extract what they can from what's available in history, will produce something, something ranging from nothing to hopefully a lot. Then is there -- well, I guess, (a), it's a function of what comes back. But let's assume that there's something. Then is there some intent to, I'll call it expand the focus of -- I'll stick with groundwater related causes, but that might go beyond just the deep aquifer or the deep portion of the aquifer system.

A thought that comes to mind, for example, in passing is that if I remember your classification of the lithology and broad bullets, there was an aquifer from 100 to 300, a fine-grained layer from 300 to 400 roughly speaking, and a deep aquifer system from 400 to, what, 1200 or more. I forget the depth, the bottom number.

If Mendenhall mapped flowing conditions and swampy conditions a hundred years ago, then that interval from zero to a hundred which wasn't classified as an aquifer is -- and I think you classified it as semi-confined, unconfined to semi-confined, maybe, or words to that effect -- then it seems like there's some suggestion that there was some relationship between that significant water level decline that goes back to, if Mendenhall started with a below-ground-surface of zero, or something very close to that, or maybe a positive head at that point, and then we come forward to today, a water level that's a hundred feet below the ground, then we've taken all that head off the shallowest formation. And so depending on what's available surveywise, it seems like some of the focus in this go-forward work might worthwhile be focused there.

MR. MALONE: Yeah. Again, Francis, you can help with some of the explanations of what the time period of the model will simulate, but we were aiming to have the model go back to these 1930s, hopefully, if we have water --

MR. SCALMANINI: That's to calibrate against water level data; right?

MR. MALONE: Calibrate against water level data. And simulate compaction through the entire system, not just the deep system but the entire system.

MR. SCALMANINI: Oh, okay. If you said that or implied it, I just missed that.

MR. MALONE: We didn't say that, but that's our --

MR. SCALMANINI: The reason I bring it up -- and I know Francis does some work up in what I call my neck of the woods. You look at parts of the Sacramento Valley where the head change has been pretty darn small and yet we do have some inelastic subsidence that sort of boggles the mind when you think of even numbers that are comparable to this, 2 or 3 feet in localized places; yet the static water level today is at 50 feet, you know, and used to be at 20 feet. It's not like it's been huge or anything dramatic like some other places like here -- meaning "here," the area we're talking about -- but it nonetheless has occurred. So one has to wonder if you can have that kind of thing in a setting like that. You know, what's happened historically here when you had the dramatic kind of water level change in the aggregate, not just since 1989 or -- I heard what Dennis said about maybe there being some deeper wells earlier. But whatever the head change has been vertically distributed over time.

Those are, I don't know, some, I guess you could say thoughts or reactions to the go-forward.

MR. MALONE: There is some historical information to indicate that some subsidence was occurring prior to 1990, that there was some fissuring that occurred located a little bit further to the east than where the current fissures are. But there were some fissures noted in the early 1970s. But then we had this focused event that occurred in the 1990s. So I know that occurs on a backdrop of a long history of water level declines and subsidence in Chino Basin.

MR. FORDHAM: If I can make a comment, please.

MR. FIFE: Before we go on, the reporter has been going on for two hours. If there -- if we're going to have a lot more discussion, maybe we could give her a break. We are done with slides. Do you want to take five minutes just to give the reporter a break?

MR. SCALMANINI: I have one other question.

SPECIAL REFEREE SCHNEIDER: I have some, so sure.

MR. FIFE: Let's take five minutes.

(Recess in proceedings from 2:28 to 2:58 p.m.)

MR. MALONE: Just a little clarifier here, that this is again 2000 data. We don't have much -- we don't have any recent InSAR data, at least, to indicate that this is still going on. We do have some ground level survey data in this area that indicates that in 2003, 2004 we have about an inch of subsidence in this area. But I was reminded that we also have since 2000 some new recharge programs that are going on up in this area that may manifest themselves and have an effect in this area at some point in time in the future if not already. So I think maybe the additional InSAR and ground level survey data that we collect in the future might show that.

SPECIAL REFEREE SCHNEIDER: Have you checked in the area to the north that you're calling the central part of the MZ1 for fissuring or any other problems connected to subsidence?

MR. MALONE: Francis, you can probably talk a little bit about this. We have just driven around a little bit. Nothing beyond just some reconnaissance driving around on the streets and looking.

SPECIAL REFEREE SCHNEIDER: No reports of problems?

MR. MALONE: No reports that I'm aware of.

MR. RILEY: At the machine shop that's pretty well established. That's, what, 200 or 300 feet north of

Schaefer Avenue.

MR. MALONE: That's down in this region here we have some --

SPECIAL REFEREE SCHNEIDER: No. I meant in the upper 12.

MR. RILEY: No. Up in there, no.

MR. MALONE: We've just sort of driven around and not really recognized anything. And there's been no reports.

MR. SCALMANINI: At the machine shop, that's where they put their waste fluids, though, in that fissure?

SPECIAL REFEREE SCHNEIDER: The key reason for this workshop was to check on work in progress and to figure out what the status was of the efforts to deal with the subsidence issues that were at hand in MZ1. And I need to report back to the Court in a report of referee which will be much briefer than the last one on this issue as to how the work is going.

I think one of the things that will need to be addressed by Watermaster probably in a motion to get a revised order is when a long-term plan would be completed. And I guess I'd just like to suggest that it would be worth thinking about what that schedule might look at. And I pose the question on whether it would make sense to try to phase the work in MZ1 potentially to come up with a workable pumping regime in the lower area that has been the focus of this effort, with potential phases with separate schedules for areas to the north.

I don't know how much you could address or Mark could address, but it would be interesting to see how this comes together in terms of when you get to a long-term plan. That's what the Court was hoping to hear about, and it's not on the schedule here. My sense is it hasn't been given a whole lot of attention.

MR. MALONE: Do you went to take that, Mark, or do you want me to --

MR. WILDERMUTH: When you say given a lot of attention, you're referring to the actual plan?

SPECIAL REFEREE SCHNEIDER: I'm referring to the need to get to a long-term plan as being what the Court was interested in in the order he signed in 2000; that he had hoped there would be a long-term plan by July of this year. There isn't. But when will there be? And is there some merit in thinking about phasing the future work so that perhaps you can get to a long-term plan, which, of course, could be changed over time, but still it would be a long-term plan with a pumping regime of some sort to address the issues that have been the focus of the work, and then in subsequent phases go to the north. Is that a conceivable way of looking at it?

MR. WILDERMUTH: In my professional opinion, yes. And I think to be clear, we haven't felt until very recently, last maybe six or eight months, that we were at a point where we were getting close to coming up with conclusions from which we could build a plan on, pull the parties together and talk about their deal making to implement a plan.

So I think we have been thinking about it, but we've just been postponing the deal portion of it, the actual how you put it together, until after we get enough technical information that the group would -- that we could buy in. So I would suggest that what you're saying makes a lot of sense, that we break it into maybe a southern portion and central portion, try to get the southern portion going, and then based on the interests of the stakeholders, do something in the central area.

SPECIAL REFEREE SCHNEIDER: Thanks. Does anyone else have questions or brief comments that they would like to make? Mr. Bunn.

MR. BUNN: Could I just make a comment on the last point. I'm Tom Bunn. Many of us in the room are seeing this information presented in this format for the first time at the same time that you are. And it is my feeling that what I at least as an attorney have got today significantly advances what I know about this situation here. And I think that this is a milestone of sorts that we now can do some sitting down and figuring out whether we're in a position to start formulating a long-term plan now, whether we want to await the results of the model in spring '06 to formulate the plan and so forth. So you might have some better information on that within just a few weeks.

SPECIAL REFEREE SCHNEIDER: Thank you. Is there anyone else?

MR. HENSLEY: Mark Hensley, Chino Hills. I agree to some extent, and Dr. Williams couldn't stay this afternoon, which is unfortunate. But he still has a number of questions with regard to a number of the questions that Mr. Scalmanini raised about the historical pumping. And there's a lot of information about how much has been taken out of the ground over the course of the last 70 years and subsidence that occurred prior to 1990 and those kinds of issues. I think -- and if that's important for purposes of coming up with a long-term plan, I think that those issues are probably going to slow down that long-term plan. How much I don't know. How much agreement there will ever be amongst the parties, I don't know the answer to that either. And I think those are pretty significant issues.

There's been a focus on a very small period of time with regard to what's occurred when you've got a basin that's been operating for 70, 80 years. I'm not as confident that we're going to move as quickly as perhaps others. Not that I don't want to, candidly. This is a slow and tortuous process generally. And I think it moves too slowly. I'd like to see it improve. I don't know how to do that. But Chino Hills will continue to cooperate in trying to come up with solutions.

But I know when all of the parties get together and try to work out the solutions, again it's a very painful process. I don't have as much history as some others do, but at least the seven or eight years I've been participating, it takes two or three years just to agree generally on relatively minor issues.

SPECIAL REFEREE SCHNEIDER: So you'd agree it makes sense to push for some sort of a schedule, though; right?

MR. HENSLEY: I think so. Yeah, I think there should be some schedule. I'm not quite certain when you talk about a long-term plan what that means. I think there's not going to be a willingness on the majority of the parties to address those solutions.

It's one thing to say, well, don't pump more than X amount. I'm not a technical person. I'm sure that comes right through. But it's easy to say you can only pump up to X amount from a portion of the basin. Well, then what? Where do you take the water from? Where do we get the replacement water from? Simply moving to another area of the basin may not be a good answer if there's starting to be subsidence in some other areas of the basin. It's moving our problems from one area to another. That may not be a good long-term solution.

SPECIAL REFEREE SCHNEIDER: I think your comment goes to the question of how difficult coming up with an agreement will be. I was concerned more on focusing on how to characterize what the technical work will be going forward, whether there is some discrete amount of technical work that, when completed, would allow that agreement process to proceed, maybe before a whole lot more work were to occur to the north. And that's just a question I leave for the technical advisory group to consider.

I think we're through on a technical basis here. I think you did a great job, Andy. Very long and complicated presentation.

MR. MALONE: Thanks. I want to make one comment on the cooperation comment that Mark just had. We got incredible cooperation from all the pumping parties down in this part of the Basin, the State and Chino and Chino Hills, all the way along in terms of installing the transducers and controlling the pumping. And all this work couldn't have been done without the help of their staff from the field level, you know, up into Mike and Dave at Dave's level at these agencies. So we really got a lot of cooperation, and they all seemed to us to be genuinely interested in the scientific study that we've been pursuing here. Just want to make that statement. It's been a while since you've been here. I don't think that we've ever expressed that.

SPECIAL REFEREE SCHNEIDER: That's good news.

MR. SCALMANINI: I would certainly second that. Although I have been here for a couple of technical committee meetings on occasion, and I've seen the ongoing work a little more frequently. But I sure second that and salute others, as you do, for their cooperation.

MR. FIFE: Thank you. And that's the workshop.

(TIME NOTED: 3:10 p.m.)

REPORTER'S CERTIFICATE

I, Winifred S. Krall, a certified shorthand reporter licensed by the State of California, hereby certify:

That the foregoing oral proceedings, taken down by me in stenotype, were thereafter reduced to typewriting by computer-aided transcription under my direction;

That this typewritten transcript is a true record of the foregoing oral proceedings.

I further certify that I am not in any way interested in the outcome of this action and that I am not related to any of the parties thereto.

Witness my hand the 30th day of May, 2005.

WINIFRED S. KRALL, C.S.R. #5123

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