CALIFORNIA ENVIRONMENTAL CONTAMINANT

BIOMONITORING PROGRAM

(BIOMONITORING CALIFORNIA)

SCIENTIFIC GUIDANCE PANEL MEETING

CONVENED VIA HYBRID FORMAT BY:

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

STATE OF CALIFORNIA

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TUESDAY, MARCH 25, 2025

1 P.M.

DIANA FLORES NUCHURCH, CA CSR NO. 14759

iDepo Reporters

info@iDepoReporters.com

323-393-3768

APPEARANCES

PANEL MEMBERS:

Carl F. Cranor, PhD, Acting Chair

Lara Cushing, PhD (Remote)

Thomas McKone, PhD

Amy Padula, PhD, MSc

Penelope (Jenny) Quintana, PhD, MPH (Remote)

José R. Suárez, MD, PhD, MPH (Remote)

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OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT:

Dave Edwards, PhD, Acting Director

Stephanie Jarmul, MPH, Section Chief, Safer Alternatives Assessment and Biomonitoring Section, Reproductive and Cancer Hazard Assessment Branch

Kannan Krishnan, PhD, Assistant Deputy Director, Division of Scientific Programs

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH:

Dina Dobraca, MPH, Research Scientist III, Environmental Health Investigations Branch

Susan Hurley, MPH, Research Scientist III, Environmental Health Investigations Branch

Nerissa Wu, PhD, MPH, Chief, Exposure Assessment Section, Environmental Health Investigations Branch

GUEST SPEAKERS:

Emily Pennoyer, PhD, MPH, Boston University School of Public Health, Maine Center for Disease Control

Wendy Linck, PG, PMP, Division of Water Quality, State Water Resources Control Board

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PROCEEDINGS

ACTING DIRECTOR EDWARDS: All right. Good afternoon. I would like to welcome all the Panel members and the audience to the March meeting of the Scientific Guidance Panel for Biomonitoring California, more formally known as the California Environmental Contaminant Biomonitoring Program. Thank you all for joining us today. It's definitely a little bit warmer than normal in Oakland, see all of us are in jackets.

All right. So the Panel last met on November 7, 2024. The November meeting included updates on Biomonitoring California Program activities including the launch of a new project evaluating results return materials from the Biomonitoring component of the San Joaquin Valley Pollution and Health Environmental Research (BiomSPHERE) study.

In the second half of the meeting, the Panel heard updates from Program staff on environmental monitoring results from the Farmworker women and Respiratory Exposure to Smoke from Swamp Cooler Air, otherwise known as FRESSCA-Mujeres project, followed by a guest speaker from UC Merced who presented preliminary results of urinary

biomarkers of response in adults and children from the San Joaquin Valley.

Key discussion topics included the study objectives and scope of work for the project evaluating BiomSPHERE results return materials. The Panel discussed communicating results for biomarkers of response, participant selection for interviews and focus groups, alternative methods for results distribution and additional formats, such as graphs and online platforms, to be tested with focus groups for feedback.

Air monitoring methods and environmental results from the FRESSCA-Mujeres project including additional analyses and other considerations when investigating the effectiveness of the swamp cooler filters and portable indoor air cleaners, potential exposure sources of PAHs and VOCs found in air, results from PurpleAir monitors.

Urinary biomarkers of response data from the BiomSPHERE study, including the ability to analyze consecutive daily samples with these specific biomarkers to better understand short-term variability, challenges in interpreting biomarker results in light of chronic versus acute responses to a variety of stressors and possible exposure

durations, differences in results between children and adults, additional variables captured in the participant questionnaires to consider for future analyses. The Panel also provided input on possible topics for 2025 SGP meetings.

The summary and transcript of the meeting is posted on the November meeting page on the Program's website at biomonitoring.ca.gov. So for today, we have Carl Cranor will be acting as the SGP Chair for the meeting.

Thank you, Carl, for taking on this role today.

And I will now invite the Panel members to introduce themselves by name and affiliation. Let's start with Jenny Quintana, who is attending remotely. Jenny has been granted a reasonable accommodation to attend this meeting remotely.

PANEL MEMBER QUINTANA: Hi everybody. My name is Penelope, or nickname Jenny, Quintana. I'm a professor at the San Diego State University School of Public Health.

ACTING DIRECTOR EDWARDS: All right.

Lara?

PANEL MEMBER CUSHING: Hi, I'm Lara Cushing, Associate Professor of Environmental Health

Sciences at the University of California Los Angeles.

ACTING DIRECTOR EDWARDS: Great.

And we also have José, who is attending remotely due to an unexpected flight delay.

José?

PANEL MEMBER SUÁREZ: Good afternoon. José Ricardo Suárez, Associate Professor and Director of the Climate Environmental Health Research Program and Division at the School of Public Health at the University of California San Diego.

ACTING DIRECTOR EDWARDS: Great. Thank you.

Now we'll go around the room.

Tom?

PANEL MEMBER MCKONE: I'm Tom McKone. I'm -- is it on?

Tom McKone, I'm Professor Emeritus, School of Public Health --

THE COURT REPORTER: I'm sorry. I'm so sorry to interrupt. I'm the Court Reporter, I'm just making a record. I cannot hear the person. I'm sorry.

STEPHANIE JARMUL: Can you just press the

button?

PANEL MEMBER MCKONE: How's that? It might be the batteries. Oh yeah, that one's not flashing.

All right. Let's start over again. I'm Tom McKone. I'm Professor Emeritus of Environmental Health Sciences at the School of Public Health, University of California Berkeley.

ACTING DIRECTOR EDWARDS: And, Amy?

PANEL MEMBER PADULA: My name is Amy Padula, and I'm an Associate Professor in the Department of Obstetrics Gynecology and Reproductive Sciences at the University of California San Francisco.

ACTING DIRECTOR EDWARDS: Great. Thanks, Amy.

And, Carl?

ACTING CHAIR CRANOR: Carl Cranor, Professor -- Distinguished Professor Emeritus in Philosophy and Faculty Member and Professor Emeritus Environmental Toxicology at UC Riverside.

ACTING DIRECTOR EDWARDS: Great. Thank you everyone.

And now I'll turn it over to Carl who will provide more details about today's meeting.

ACTING CHAIR CRANOR: Okay. We have some -- some further guidance: As a reminder to Panel members, please comply as usual with the Bagley-Keene open meeting requirements that all discussions and deliberations of the Panel about the subject matters at issue today will need to be conducted during the meeting not on breaks or with individual members of the Panel or on- or off-line including phone, email, chats, or text messages.

Panel members who have not been granted a reasonable accommodation and are attending remotely must visibly appear on camera during the open portion of the meeting. If you're unable to keep your -- keep your camera on during the meeting because it is technologically impracticable, please make announcement when you turn your camera off. Additionally, if someone older than 18 is in the room with Panelists who are attending remotely, you must disclose the presence of that person and their general relationship to you.

Do we have any under 18 members off-camera, off-site? No. Okay. So we've checked that.

We will first hear an update on Program activities. The Panel will also hear from two guest

speakers on perfluoroalkyl and polyfluoroalkyl substances, PFASs, and drinking water in California.

There will be time for question from the Panel and audience after each presentation. If Scientific Guidance Panel members wish to speak or ask a question, please raise your hand. I will call on you at the appropriate time and then you can ask a question or provide your comment.

If online webinar attendees have questions or comments during the question periods after each talk, you can submit them to the Q&A feature of the Zoom webinar or by email to Biomonitoring@OEHHA.Ca.Gov.

We will not be using the chat function during this -- this meeting. Please keep your comments brief and focused on the items under discussion. Relevant comments will be read aloud and paraphrased when necessarily -- necessary. If online attendees wish to speak during the public comment periods and discussion sessions, please use the Raise Hand feature in the Zoom webinar, and Rebecca Belloso will call on you at the appropriate time.

I'm not done. If you're attending in person and wish to comment during the public comment

periods and discussion periods, please come to the front or raise your hand, and I will call on you at the appropriate moment. For the benefit of the transcriber, please clearly identify yourself before providing comment and write your name and affiliation on the sign-in sheet at the back of the room. At the end of the meeting, there will be time for an open public comment period.

Our first speaker is Nerissa Wu who is the Chief of the Exposure Assessment Section in the Environmental Health Investigations Branch, EHIB, at the California Department of Public health and the overall lead for Biomonitoring California. She will provide a current update on Program activities.

Nerissa.

(Slide presentation)

NERISSA WU: Thanks, Carl. Thanks for serving as our chair today.

Welcome everybody. Good afternoon. I will be giving the Program update today, which will cover the usual components of the Program, but I actually wanted to start today by talking a little bit about wildfires.

So the wildfires in Los Angeles County have brought about, obviously, huge devastation and

also concerns about environmental and occupational exposures during the fire and in the aftermath. And we have been contacted by a number of researchers asking us if we would be trying to measure exposures related to the fire.

We as a Program did not go into the field to collect samples ourselves, but we have been considering ways in which we could support the efforts. So we're in discussion with research teams about conducting analysis for samples that they have collected. Details are still being worked out, so I'm not gonna go into details, but both labs may end up playing a role in these larger efforts to measure exposures both to fire and then during cleanup.

We've also offered CARE-LA data as a baseline comparison for metals and for PFASs and also let people that know we do have archived samples from CARE-LA that could be analyzed for additional analytes if that -- if that's something that they have interest in.

Here I'm actually going to move this over, I can't see -- there we go. We've also taken a look at the CARE metals data as part of our analyses, we took a look at the wildfire related data. CARE-LA was conducted in the first half of 2018. CARE-2 was

conducted in similar months the following year. And there were fires in the CARE counties in the months preceding our fieldwork. So we added two questions to our questionnaire to try to understand participants' fire or cleanup-related activities. And these tables just show the fires of a thousand acres or more that were active before and in the months that we were in the field.

So we had asked our participants if they had experienced any of these activities -- okay -- any of these activities related to recent fires in the preceding months, so things like performing emergency response duties such as fire suppression, performing debris or ash cleanup as part of a job or performing debris or ash cleanup for their own home or as a volunteer, or if they were living in an area with fire damage once the fires were out.

And you can see that the number of participants answering yes to any of these activities for both CARE-LA and CARE-2 was pretty low. Not unexpected. The study was not designed around wildfires, so neither participant selection nor the questionnaire were really designed with the objective of looking at wildfire impacts.

So we did not have sufficient numbers to

look at any occupational exposures, but we did look at participants who participated in ash and debris cleanup and also created a variable that included these last two: "Performing debris or ash cleanup" or "After the fires, I lived in an area with fire damage." And we also created an "any wildfire" variable which included anyone who responded yes to any of our questions about wildfire activities. And these variables were put into a model with our biomonitoring results for metals.

We did find that the participants who reported cleaning up debris and ash at their home or as a volunteer, had twice as high levels of urinary mercury than participants who said no to these questions. And then you add in the people who said they did ash or debris cleanup as a part of their work, the finding is roughly the same; it doesn't add that many people because there's a lot of overlap between those categories. But this difference was found in both CARE-LA and the CARE-2 study populations and persisted even after the model was adjusted for age, race, and income.

So we will continue to examine the data, see if there are other confounders or biases that we haven't accounted for. It is a very small sample

size, so there's not a lot we can do with this data, but it is something of note that we will be looking for in other data. And we did not see other associations between other metals levels and wildfire activities.

There have been elevated mercury findings in other California studies of firefighters, Biomonitoring California had the FOX Study in 2011, so not specifically looking at wildfire exposures, more general firefighting activities. And those firefighters had slightly elevated blood mercury levels and roughly the same urinary mercury levels compared with NHANES.

Tubbs firefighters had been -- were found to have -- the firefighters who had been deployed, were found to have higher blood mercury levels than nondeployed firefighters. And then following the Camp Fire, firefighters coming right out of deployment were found to have higher blood level mercury -- blood mercury levels compared to NHANES. And we could not compare urinary mercury 'cause NHANES detection frequencies are low enough that they don't post a median. But we know that detection frequency among the firefighters was higher than for NHANES.

And there could be multiple exposures for firefighters of mercury, including thermometer -- thermometers, thermostats, other household items that burn, other building components. Wildfires can also release inorganic mercury either as a gas or by attaching to particulates in the air from burning biomass and thermal volatilization of soils. But it's a concern for firefighters. It's also a concern to, just, people who live in the area as they go clean up and there's ash that has mercury bound to that particulate settling in the ash.

So there is this active research going on to learn about the environmental exposures that might happen in a fire, particularly important to California particularly as they're having more and more of these fires. And the hope is that this research will help us come up with appropriate public health actions and advisories.

So biomonitoring following wildfires and the firefighters, in particular is really complicated logistically -- lots of things to consider like the timing between when samples are collected and the exposure period, particularly a concern for chemicals that are of short biological half-life.

Collecting samples immediately following deployment in the chaos of a wildfire is, of course, very difficult. And then in studying exposures, it's important to think about the type of fire being fought, the actual firefighting activities. They all fall within firefighting activities, but there are many different things a firefighter could be doing, and if or how they are wearing protective gear. And then with all biomonitoring studies, of course, you have to think about the multiple places that exposure could be coming from.

So general surveillance might not be the right tool to look at specific exposure scenarios. Might not be quite the same population. Very small percentage of our CARE participants were part of the fire-related activities. The questionnaires might not be designed to get to the very specific information that we need. But surveillance provides baseline data that might be useful for comparison.

And as we've talked about CARE-LA as a baseline, and also last in -- in the July SGP meeting, we talked about PFAS and POP trends in some of our surveillance data. There was recently a paper by Kristin Knox and others at Silent Spring, that looked at trends in chemical exposures in

relation to Prop 65 listing. All of these things together really highlight the importance of having high quality representative surveillance data. And that's something that we're gonna continue to pursue with our surveillance work.

So this is a list of our surveillance studies that we have in progress. You have heard about the California Regional Exposure Study already. We're gonna continue our work to look at metals exposures and predictors of it. And you're going to hear about associations of PFASs in serum and PFASs in drinking water in just a few minutes. And -- and we have our STEPS, Studying Trends in Exposures in Prenatal Samples, or STEPS, for which we're in the laboratory phase looking at PFAS temporal trends, and we're continuing to consider study design options for our future surveillance work.

And then a little bit more detail on STEPS, the lab continues to make progress on our PFAS analyses. So we're getting close to having a full set of data for Orange County, which will enable us to look at time trends for that one county. Fresno County samples are about 30% complete, and this last month we were able to

complete our sampling for the 2024 births in Los Angeles County. And those will be in the queue for STEPS analyses.

And I turn to our community focused studies. I'll talk a little bit about the ACE, BiomSPHERE, and FRESSCA-Mujeres projects. For the Asian-Pacific Islander Community Exposures, or ACE, Project, Kelly -- Kelly Chen spoke last July about the work she has been doing to look at associations between seafood consumption and participant PFAS levels.

Kelly has continued this work. She has incorporated a two-stage meta-analysis approach to account for differences between the two ACE phases and improve power in the study. There are a few tweaks to the effect estimates, but overall the -- the similar patterns and association that she presented in July hold true. And that is a manuscript that should be ready for submittal to a journal this spring.

We also have a two-page fact sheet summarized -- summarizing the study, which our staff, Kiera Melton has been working on. And that is in conjunction with our website and social media post which will be used to disseminate the study

findings to a broad audience.

We have BiomSPHERE, the Biomonitoring component of the San Joaquin Valley Pollution and Health Environmental Research Study. We will be returning results for urinary metabolites of PAHs and nicotine this coming month in April. Staff are preparing results return materials for the urinary metabolites of VOCs. Staff are also reviewing biomonitoring, environmental, and questionnaire data and planning a meeting with the community in the summer.

And for Farmworker women and Respiratory Exposure to Smoke from Swamp Cooler Air, FRESSCA-Mujeres, staff have followed up with participants with elevated levels of urinary metals. So among the FRESSCA-Mujeres participants, there were five people with elevated mercury levels, two with elevated inorganic arsenic, and one participant with elevated total arsenic levels. So we conduct our usual level of concern follow-up with some more exposure surveying, reaching out to those participants to try to identify where they might have been exposed so we can work on reduction.

Analyses of urine samples is ongoing. Staff are preparing results return materials for

PAHs, VOCs, metals, and nicotine, as well as reviewing the biomonitoring, environmental, and questionnaire data, and for FRESSCA-Mujeres as well, planning a community meeting for the summer.

Over in the lab, the Environmental Chemistry Lab just completed the process to obtain ISO accreditation, formal recognition that they're meeting international standards. A lot of work on the part of staff. Luckily, it lasts for a couple of years. And they are also very busy analyzing those hundreds of STEPS samples I mentioned earlier. They've also participated in international proficiency testing for PFASs and POPs, and are continuing their work to develop cyclosiloxane and PAH methods in serum.

The Environmental Health Lab is working on CARE data. We're expecting the environmental phenols soon -- data back soon so that we can report it to participants. We have Intraprogram Pilot Project data that should be back to us next month, and PAH data for FRESSCA-Mujeres and VOC data for the Camp Fire. They're in that data review queue as well.

And all of our staff are working hard to get their findings from studies out to the public

and EHL staff have two presentations in the queue for the Association of Public Health Laboratories and the International Society for Exposure Science Conferences that are coming up this year.

I just want to spend a couple of minutes before I finish talking about communications. In 2023, we conducted evaluation interviews to collect feedback on how Program data and communication materials are being used outside of the Program. So we interviewed researchers, environmental health organizations, staff from State, Federal biomonitoring programs, and other California departments. And the information we collected was used to inform Program directions and also create recommendations for the 8th Legislative Report which covers from 2021 to 2023.

And these are the recommendations that were included in that 8th report, which is also in the queue for release, should be out in the next couple of months. These also just help inform our Program, help us focus on things that are -- that our partners are looking for in a program. And so, for example, one of the recommendations was to increase dissemination of Program materials, and we have created a new page on the website which

consolidates our fact sheets, newsletters, videos, and other resources in one page. And we hope this is a more accessible way to present information to the public, and we'll continue building out on this page to link more materials and additional translations.

And another effort is in getting our information out more readily to programs that can use it. The Safer Consumer Products Program at DTSC solicits input on potential exposures as part of the process to evaluate chemical product pairs. And in the past few months, this has included propyl and butyl paraben, as well as quaternary ammonium compounds, and we were able to submit Program data on parabens from multiple studies as well as QACs data from a recent Intraprogram Pilot study.

We're going to be conducting another round of interviews again with people from different programs that intersect with Biomonitoring California. And we'll use those recommendations for the 9th Legislative Report, which we're just starting to work on and again, to help us focus our Program priorities.

So thank you to the team that gets all this done. We have lost a couple of staff,

unfortunately including two of our Health Communication folks and two of our APHL fellows, but we do have new staff joining us all the time, and it's an exciting and productive time for the Program. So with that, we'll end.

Do I stay up here for clarifying questions?

ACTING CHAIR CRANOR: Thank you, Nerissa.

Time for clarification questions from the Panel, and then the audience and then more substantive questions.

Tom?

PANEL MEMBER MCKONE: Well, perhaps this is -- might be more substantive, but I was curious if -- I mean, well, first of all, I think it's great that you were able to hit the ground so quickly. I mean, nobody gets an advance notice about wildfires and so you can, you know, have months to prepare for this. But you were out there figuring out what you could use to focus on the impact of the wildfires, so that's really good.

And, I guess, because it's pretty clear that the composition of the emissions from urban wildfires is quite different from non-urban, I wonder if there's an opportunity to tease out or try

to identify populations that were exposed to non-urban wildfire smoke and those to urban wildfire smoke.

And again, this might be a broader discussion, but that would be an interesting insight about -- like, not only the composition of the smoke, but how the composition of the smoke affects the populations that breathe that smoke.

NERISSA WU: I do think there is a lot of work not being done by Biomonitoring California. Our role in it would probably be the analysis of those samples, but there is quite a bit of work being planned at different universities where, I think, they are collecting a number of air monitoring points as well as biomonitoring points, so they'll be able to combine those things together and hopefully get to some of that really important information.

I agree; it's so important to understand how do WUI fires differ from a typical wildfire.

STEPHANIE JARMUL: Carl, there's a question from Jenny.

ACTING CHAIR CRANOR: Okay. There was a place here for further questions either from the audience, any -- any indication off -- off --

off-site audience have questions?

If not -- I'm not rushing -- we can ask for the more substantive questions from the Panel members.

PANEL MEMBER PADULA: I think there's two up there --

ACTING CHAIR CRANOR: Pardon?

PANEL MEMBER PADULA: There's two --

STEPHANIE JARMUL: You got Jenny up there and José.

PANEL MEMBER PADULA: Two questions online.

ACTING CHAIR CRANOR: Oh, two? I'm sorry. I didn't understand the sign.

NERISSA WU: Jenny and José have their hands up.

STEPHANIE JARMUL: You can invite Jenny and then José, Carl.

THE COURT REPORTER: If I can interrupt very quickly and I'm so sorry for the interruption, if you could just make a conscious effort to speak into the microphone, it would be very helpful. Thank you.

PANEL MEMBER QUINTANA: So should I speak now? I got a request --

STEPHANIE JARMUL: Yeah, go ahead, Jenny.

PANEL MEMBER QUINTANA: Hi, this is Jenny Quintana from San Diego State University, and I had a question about some of your slides where you discussed returning results to participants. And I'm just wondering, do we embed evaluation of results return and understandability typically when you -- always when you return results, or is that only on special occasions? And I was thinking of the FRESSCA study specifically.

NERISSA WU: We have conducted results return evaluation in a number of times. And we have another -- I think Rebecca spoke about this at our last SGP meeting about a planned evaluation of the results return materials for BiomSPHERE. And we -- we're actually going to expand that to include an evaluation of the use of the DERBI platform that's put together by Silent Spring. So that's very exciting.

We don't do it for every round of results return. I mean, we always want feedback, but it's -- it's just a matter of how much we want to ask our participants to do. You know, it's -- there's a cost there to their time and effort. But we acknowledge that it's a really important set of

information to get, and we're always concerned about the accessibility and understandability of the materials.

PANEL MEMBER QUINTANA: Yeah, I was just thinking about that if you have a population with significant and cultural or language influences, it'd be even more important to evaluate results return, which I think -- you know, I'm really impressed with Biomonitoring Californian -- California results returns. You know, I -- I use that in my own work as the example of how to do it, so I -- I do think this is a really important and exciting part of this Program.

Thank you.

ACTING CHAIR CRANOR: Any other questions from offsite? Let's see.

PANEL MEMBER SUÁREZ: Sure. I can go next.

ACTING CHAIR CRANOR: Okay.

PANEL MEMBER SUÁREZ: So this is José Suárez from UC San Diego.

Nerissa, thank you for that presentation, and for the terrific work that -- that you continue doing at the Biomonitoring Program. I had a question going back to the wildfire exposures in

CARE.

Could you provide us a little bit more detail with regards to the -- the timing or how much time is elapsed between the measurement of mercury versus the actual fire event.

NERISSA WU: The measurement of mercury or the sample collection?

PANEL MEMBER SUÁREZ: Well, the sample collection.

NERISSA WU: Okay. Well, you can see from this slide when the fires were taking place, both in LA and in CARE-2, and in both of those cases samples were collected in February through June of -- of that -- of the following year. So it was within six months, I think -- which, Susan, actually, you probably have a better answer for this.

SUSAN HURLEY: Yeah, it ranges from about three to nine months.

NERISSA WU: Susan Hurley says three to nine months was the range.

PANEL MEMBER SUÁREZ: I mean, it's -- it's very interesting. Even though the -- the sample size is small, it's compelling and at least concordant with some of the other studies that you were presenting there as well with firefighters. So

it's interesting. So thank you -- thank you for clarifying.

NERISSA WU: Yeah, we would like to be able to dive deeper into that, and of course, stratify by time from sampling or time from the work that was the exposure and the work that was being done with ash and debris cleanup. We just don't have the numbers to do that, which is why a focused study that's being done in the LA County fires now will probably yield cleaner results. I mean, there -- there are lots of confounders in this data just because it wasn't the real intent of our sampling.

PANEL MEMBER SUÁREZ: Great. Thank you.

NERISSA WU: Lara -- Lara's got her hand up.

ACTING CHAIR CRANOR: Any other questions?

STEPHANIE JARMUL: Lara Cushing.

ACTING CHAIR CRANOR: Yes, please.

PANEL MEMBER CUSHING: Yeah. Hi, this is Lara Cushing. Thank you.

I also wanted to echo, you know, much appreciation for all the work that Biomonitoring California continues to do and that you've -- you've looked into the LA wildfires a little bit and are

supporting, you know, efforts to analyze samples collected by others during the wildfires just given how unprecedented that those events were in terms of scope, you know, 16,000 structures burned and the population impacted, not just population displaced or working in the fire zones but from the smoke, you know, a lot of people exposed during the fire event.

So I had a similar comment to José. It sounds like maybe it's not possible, but, you know, if -- if possible to do something pretty, maybe, crude, but just to add control for, you know, the time elapsed between the sample collection and the fire that occurred closest to the participant's home location, I think -- I think you have locational information. You know, maybe that would be a crude way to try to control for that a little bit, as well as diet. I don't know if you have anything on fish or seafood consumption with the mercury, but it's, kind of, curious that you -- you know, it's seen in urine but not in -- in blood as it was -- in the firefighters studies were seen in blood.

So those were just two suggestions if possible given the data limitations. And then I think my bigger picture comment or thought was just that it would be -- and again, I don't know if this

is possible, but given that, you know, the purpose of surveillance and the design of surveillance is, as you said, not very appropriate to studying these events like wildfires; nonetheless, you know, they're gonna keep happening, and it would be nice to leverage all the work that goes into this surveillance to be able to look at extreme events when they do occur.

So I'm curious whether it's possible to -- for the, you know, surveillance work going forward, if it's going to involve recruitment, if it would make sense or be possible to include like a recontact in the IRB protocols; so for example, you know, if people participating in CARE-LA could have been recontacted to ask if they'd like to give another sample post the LA wildfires, I think that would have provided some really, possibly, compelling information.

So if that's possible for future surveillance, I think that might be a nice thing to build in to allow, again, the surveillance data to be leveraged to look at extreme and random hard-to-predict events like wildfires.

NERISSA WU: Susan, do you want to address the first part, and then I'll address the second

part of that?

SUSAN HURLEY: Sure. This is Susan Hurley from Biomonitoring California.

So I'm the one who took a look at the CARE data. And I'm trying to remember what your questions were.

The first is in terms of the timing of the exposures, you know, the timing of the sampling with respect to when the wildfires are -- I don't know that we could incorporate that into our models.

Was that one of your questions?

PANEL MEMBER CUSHING: Uh-huh.

SUSAN HURLEY: Okay. Because also, there were -- I assembled this list of, sort of, major wildfires in the area, but there were a lot of wildfires. And there could have been in the -- I only -- on this slide, only list, sort of, the major ones which were over a thousand acres, but there could have been a lot -- there may be other fires that are much smaller but much closer to the participant's homes that could be more relevant for exposures.

And so I don't think we could easily do much more with the fire data, although we have discussed possibly trying to look at residential

location and linking that to like plumes, the smoke plume data. So there may be something we can do there but, you know, given the sample size and the amount of effort that would be involved in doing that, we're not sure if that would be a fruitful way to go.

And then with -- I think you had a question about looking at some of the other --

NERISSA WU: Diet.

SUSAN HURLEY: Diet, yeah.

So we don't really have the power to do, you know, full on multivariate modeling. These are adjusted for income --

NERISSA WU: Sex.

SUSAN HURLEY: -- sex, and race ethnicity.

For CARE-LA, I did take a look to see just who cleaned up, you know, their ash, you know, sort of, characterize a bivariate, sort of, summary of who cleaned up their ash and who didn't and how they might be different.

And in CARE-LA, you actually -- well, in both -- both studies, women are more likely to do it. And in CARE-LA, actually the people who did the cleanup were more likely to eat fish, which is a source of methylmercury or organic mercury. And,

so, we could do a little bit more, I think, with the diet data, and I think we will.

Did that -- do those answer your questions, or did you have another question?

PANEL MEMBER CUSHING: (Indicating)

SUSAN HURLEY: Okay.

NERISSA WU: I'd like to respond to the part about writing in something to IRBs going forward. I think that's a great idea and something that's been brought up in these discussions before about making our consent a little broader to enable us to do recontact.

IRB permissions and study design are one of the hurdles for us to getting out into the field following a big event like this. So I -- it's been a few years since we've talked about this in this forum, but at one point we did talk about having an emergency response IRB which would just be in existence -- enabling us to, you know, really go out and have a consent form existing so we don't have to go through those administrative, that can be a couple months, which then you miss your window of exposure.

So having something like that ahead of time would -- would help us respond to some of these

events. And as you said, they're gonna keep happening; so as a Program, we're thinking about that. I think going back to the participants again would have been really welcome by a lot of our LA residents. So good comment, good suggestion.

PANEL MEMBER CUSHING: Thank you.

ACTING CHAIR CRANOR: Any other questions?

I have one -- oh, go ahead.

PANEL MEMBER PADULA: I just also was curious -- am I close enough?

STEPHANIE JARMUL: And just state your name.

PANEL MEMBER PADULA: Oh, I'm sorry. Amy Padula, UCSF.

I was also wondering which other metals were detectable kind of overall but not different between any of the groups or what other ones were examined?

And then also, if any other non-occupational studies are -- have found levels of mercury elevated in wildfire exposed populations?

NERISSA WU: We included all the metals that we measured in the model, so mercury, lead -- I'm gonna have to rattle these off now.

PANEL MEMBER PADULA: Okay. Sorry I can

look this up too --
NERISSA WU: Arsenic, molybdenum, cadmium --
PANEL MEMBER PADULA: Okay.
NERISSA WU: -- thallium, uranium --
PANEL MEMBER PADULA: Okay.
NERISSA WU: -- manganese? I can't --
SUSAN HURLEY: Cobalt --
NERISSA WU: -- cobalt -- okay. And the other part of your question was?
PANEL MEMBER PADULA: If any non-occupational studies support this finding.
NERISSA WU: You did some lit searching on that, right?
Sorry.
PANEL MEMBER PADULA: They're probably -- there may not be any studies.
SUSAN HURLEY: I don't recall.
PANEL MEMBER PADULA: Okay.
SUSAN HURLEY: I'm sorry.
PANEL MEMBER PADULA: No problem.
NERISSA WU: Yeah.
ACTING CHAIR CRANOR: In some sense, I might have a -- an analogous question:
When I looked at your comparison, it

focused on mercury. And my understanding is, with fires, there's all kinds of toxics that come out of the fires.

Do you have a speculation? And I guess at this point, it would just be that.

What else might show up if you have the time to look at it?

You -- you have comparisons with mercury, but what else would have been there?

NERISSA WU: I expected to see more of a signal with lead just knowing how much contamination there is in the LA area, which we did not see a signal with that. And I mean, I think any of the metals that are in household products. I mean, as -- as Tom was saying, you know, there's so many things different about a woodland fire. I -- I don't know a lot about the composition of houses in the LA neighborhoods compared to other places --

ACTING CHAIR CRANOR: Yeah.

NERISSA WU: -- but I would think that would be like age of homes would help you determine what things you might be looking for.

But certainly all of the metals, right?

ACTING CHAIR CRANOR: Yes. Yeah.

That's helpful. Yeah.

We have one or two minutes. Any -- any last questions? Tom?

PANEL MEMBER MCKONE: Tom McKone.

So you alluded to it, I'd just like to make it a little more explicit:

Is it possible to consider mercury, you know, at two times, even just a small sample, I mean, that's not a small differential, and it seems to be supported in some ways by the firefighters.

Is there a way to figure out first, by looking at the composition of ash, if there's mercury in the ash; but even more, where would it come from?

And I'm -- I'm suspicious that it could be electronic consumer products and electronics. I'm not an expert, but that might be, I mean, there might be mercury components in capacitors and other things. I doubt it's -- I don't think anyone has mercury thermometers anymore. I'm pretty sure those are gone, but there -- there could be, you know, we could do a little survey of what kind of products of what's -- whether there's mercury in phones, computers, all the electronics that's in everything now, refrigerators, stoves, they're all full of circuits that monitor everything, so...

NERISSA WU: I think that's beyond what CARE can do or what Biomonitoring can do, but certainly the work that's being done in LA now, where there is a lot of ash analyses being done, I would think that would be the best way of getting at that environment to human exposure piece of it.

So regardless of where it's coming from in your household, if you're finding it in the ash, that would -- that would help give you clues. And then maybe the second part of that would be to try to figure out where it's coming from.

And I hope that work is happening in LA. There's so many researchers looking at it now, so you know --

ACTING CHAIR CRANOR: Nerissa, thank you.

We need a 10-minute break. It's 1:45 to 1:55.

STEPHANIE JARMUL: I think we have time for one more question.

It looks like Jenny has her hand up.

This is Stephanie Jarmul.

PANEL MEMBER QUINTANA: I hate to keep anyone from their break, but just a quick question. It seemed like this is also an issue you might pursue, maybe not for mercury but exposures to fire

using the STEP data where you have potential for temporal data and exposure to fires. 'Cause you have the date that they were collected, right, for the STEP study?

NERISSA WU: Correct. We do have the date for STEPS --

PANEL MEMBER QUINTANA: STEPS, sorry.

NERISSA WU: -- we do have -- yeah, and we do have the residential address, so we can look at environmental monitoring data for those. Not for metals though, because --

PANEL MEMBER QUINTANA: No, not for metal.

NERISSA WU: Okay. With -- I mean, yeah --

PANEL MEMBER QUINTANA: But for PAHs, I saw you're working on serum PAH method or, I don't know, just thinking there might be some exposures, you know, that could be looked at with that data.

But, thank you.

ACTING CHAIR CRANOR: Any -- have I missed anyone else?

Okay. Thank you. I have 1:46. We will reconvene in 1:56 p.m.

(Break taken at 1:46 p.m. to 1:58 p.m.)

ACTING CHAIR CRANOR: Our next speaker is

Emily Pennoyer.

Please go ahead.

EMILY PENNOYER: Thank you so much I'll just share my screen here.

(Slide presentation)

EMILY PENNOYER: And can you hear my audio okay on Zoom and those in the room?

Okay. Great.

Well, thank you. My name is Emily Pennoyer. I currently work as a toxicologist for the Maine CDC, but I will be presenting today work that I conducted during my doctorate at Boston University School of Public Health.

So I will get started here. I will be presenting today some of the work that we have been doing on the CARE study along with several collaborators at Biomonitoring California. My co-authors and I have no conflicts of interest to disclose.

So the CARE study, as some folks may be familiar, was designed by Biomonitoring California as a series of cross-sectional studies measuring environmental chemicals in California adults living in three regions in Southern and Eastern California. Participants were recruited sequentially in three

phases during 2018 to 2020 and recruitment was done using a convenience sampling approach with applied quotas by subregion, gender and race and ethnicity to improve representation of the underlying population.

CARE-LA included 430 adults from Los Angeles County recruited in 2018. CARE-2 included 359 adults from Riverside, San Bernardino, Imperial, Mono and Inyo Counties recruited in 2019. And CARE-3 collected samples from 90 adults in San Diego and Orange Counties in 2020, though the full recruitment from CARE-3 was not completed due to COVID-19. Serum was collected and analyzed for 12 PFAS from 879 participants. Personal demographics and residential addresses were collected using survey questionnaires.

People can be exposed to PFAS from multiple sources. Ingestion of contaminated food and water are two of the best studied routes of exposure. The majority of studies in the US have focused on legacy PFAS in water supplies, particularly in populations where drinking water supplies have been heavily contaminated, for example, private wells impacted by a nearby fluorochemical facility. Studies have shown

significant associations between concentrations in private well water and concentrations measured in serum providing evidence to support a linear relationship between PFAS in drinking water and serum.

PFAS used in indoor material like carpeting and furniture can migrate into dust which can be unintentionally ingested. Some PFAS have been measured in cosmetics and may have the potential to be absorbed through skin. And people can also be exposed indirectly through inhalation of precursor compounds that can break down to form legacy PFAS, as well as other sources that are less understood. But while several exposure pathways have been identified, the extent to which people are exposed from different sources, is not known.

The general population can be exposed to PFAS in drinking water supplies as well, which has been linked to nearby wastewater treatment plants, airports, military training areas, and industrial facilities that use PFAS in their processes. This map shows the detection of PFAS in public drinking water supplies serving over 16 million US residents. The data shown here were collected in 2013 to 2015 as part of the EPA's Third Unregulated Contaminant

Monitoring Rule; it's also called UCMR 3.

Human exposure studies in the general population, including the nationwide Nurses Health Study and the California Teacher's Study suggest relatively low levels of legacy PFAS in drinking water can lead to elevated levels in serum. In these populations, large exposure sources are not known or have not been documented.

People can also be exposed to PFAS through their diet. PFAS used in grease repellent packaging can migrate into foods. Foods can become contaminated when grown in soils that are amended with residuals from sewage sludge also called biosolids. Contaminated crops used as feed for livestock can result in elevated concentrations in cattle and dairy products. The contaminated fields can also result in elevated concentrations in chicken eggs and other agricultural products. And some PFAS can bioaccumulate in fish and shellfish.

The traditional approach used in exposure assessment relates the concentrations of PFAS measured in food, water, dust samples with internal levels estimated in blood usually in an estimated daily dose like a nanogram per kilogram body weight per day. Studies using this approach in Europe and

Canada estimate diet to be the major source of exposure in the general population; however, much of the existing data on dietary exposures come from Europe and can't be easily applied to the US due to differences in dietary habits.

Also the timing of when samples were taken is important because levels found in food and water reflect chemical production from that time period. Many studies on diet are from several years ago, and PFAS production has changed dramatically in the last two decades. There is limited data available on levels of PFAS in foods in the US with the exception of seafood, but even these data are quite scarce.

So in absence of these data, we can use an alternative approach that combines biomonitoring data which measures PFAS in serum directly with questionnaires on potential exposures. This approach uses epidemiological methods and regression to estimate differences in exposure from various sources and can provide insights into dietary consumption patterns that are associated with increased serum PFAS and ultimately help identify potential opportunities to reduce exposure.

Cross-sectional studies in the US using this approach have linked serum concentration to

increased consumption of animal products and certain packaged foods, but many of these types of dietary studies have relied on older biomonitoring data which may not reflect more recent changes in PFAS production and do not account for contributions from drinking water or potential confounding from other sources.

To our knowledge, no study has used the epidemiological approach to assess contributions from diet and water simultaneously. So using data collected in CARE, our goal was to characterize PFAS body burden in the CARE population and estimate the relationship between serum PFAS with diet and drinking water.

Participants in CARE completed food frequency questionnaires prior to serum collection, and they were asked how many times in a typical week they eat different types of foods. These questionnaires were typically completed within three weeks prior to serum collection.

To assess drinking water exposure, finished drinking water data from UCMR 3 were linked to residential addresses of CARE participants using the polygon feature layer which was developed by the State Water Resources Control Board. For the

purpose of this analysis, drinking water exposure was characterized using a binary variable based on whether or not an analyte in UCMR 3 was detected above the reporting level. This is different from some other CARE analyses; for example, Toki Fillman is using the CARE data in conjunction with the California Water Board PFAS Monitoring data from source wells.

So there are some important differences between the UCMR 3 data used in this analysis and the California Water Board Data. UCMR 3 monitoring was from finished water, while the Water Board sampling focused primarily on source wells, which is untreated, though they did have some samples that included treated water. The UCMR 3 data included all public water systems serving over 10,000 people while the Water Board Monitoring focused on areas with known or suspected PFAS contamination, for example, wells near potential sources like airports, landfills, and military facilities, or those that had detections previously from UCMR 3. The California Water Board data also has 10 times lower reporting limits than UCMR 3 and analyzed a much broader range of PFAS.

And just lastly, the availability of water

data overlapping with CARE participants resulted in slightly different sample sizes. So this analysis had 700 participants, Toki's analysis has 563.

In our analysis, our goal was to estimate the causal relationship between two exposures, diet and water, and levels of PFAS in serum, such that intervening on an exposure, would lead to a reduction in serum concentration. We used robust linear regression to model the additive relationship between multiple exposures and nontransformed serum concentrations.

Unlike the traditional approach that uses log transformation to address issues with skewed data, which is typical in environmental data, robust regression down-weights extreme values to relax the assumptions of regression. We chose not to log transform serum concentrations because this imposes an exponential dose-response relationship between the exposure variables and serum.

Robust regression allows us to model the linear additive relationship that's been shown to exist between exposures and serum at steady state concentrations. This also means that our results, the beta coefficients, are reported in absolute terms, the nanogram per milliliter increase in serum

per change in exposure rather than the relative percent difference that is generated from a log linear model after exponentiation.

And lastly, the covariates in our analysis were selected using a directed acyclic graph, also known as a DAG. A DAG is a diagram used in epidemiology to describe the causal relationships between variables, informed by what we know from the literature, and to identify potential confounders. So the potential confounders in this analysis were identified if they influenced exposure and acted as predictors of PFAS concentrations in serum.

There were 700 CARE participants with complete serum and survey data that successfully matched to public water systems monitored in UCMR 3. When possible, we used imputed demographic data for any missing observations. About 60% of the study participants were female. Most participants had completed some education above high school, and the majority of participants were either Hispanic or Latino or White.

Serum was analyzed for 12 PFAS by the Environmental Chemistry Laboratory at DTSC. Seven PFAS were detected in 65% or more of participants and included in our analysis. The box plots on the

right show the distribution of the seven PFAS analytes in serum, each of those analytes is listed along the x-axis, and the concentration of each analyte is on the y-axis. You'll notice this is a log scale. The horizontal bars on each of these boxes represents the median concentrations. The highest median concentrations in our study was observed for PFOS and PFOA, though in general, serum concentrations in CARE were somewhat lower than those reported in the general US population based on data from a similar time period.

Four of the six PFAS measured in water supplies under UCMR 3, overlapped with the PFAS included in our analysis. I've listed those here, PFOA, PFOS, PFHxS, and PFNA. And the minimum reporting levels for these PFAS ranged from 20 to 40 parts per trillion. PFOA and PFOS were detected most frequently, and about 8% of participants had at least one of these four compounds detected above the reporting level in their drinking water supplies. No water supplies in CARE, that were monitored in UCMR 3 data had detectable levels of PFNA.

The California Water Boards monitored a larger suite of PFAS in source wells and at lower reporting limits. But for the PFAS shown here, the

minimum reporting level for the source wells was 4 parts per trillion. And as indicated on the right, the lower reporting limits resulted in much higher detection frequencies for these four PFAS using those data.

This figure shows the average frequency that participants report eating foods in a typical week with the number of times consumed per week on the x-axis and the different food groups in our analysis on the y-axis. Categorical survey responses from the exposure surveys were converted to a continuous numerical variable for our analysis.

Seafood here includes fish and shellfish. Dairy includes milk and butter. These are consumption frequencies, but they do not take into account how much of each food was consumed because portion size was not asked about in the survey. Our results showed positive associations between serum levels and PFOA and PFHxS in drinking water. We also saw significant positive associations between levels of PFAS in serum and consumption of seafood, eggs, as well as brown rice. We observed other positive nonsignificant effects for PFOS, P-F-O-S, including red meat and dairy; and unexpectedly, we observed significant negative associations between

some PFAS and heat-at-home foods. These were described as store-bought food that you heat in its paper or cardboard package. So CARE participants were given examples such as pizza, frozen meals, and garlic bread.

These are the beta efficient -- sorry -- the beta estimates from the robust regression for dietary effects that were highlighted in the previous slide. This is showing the change in serum PFAS per weekly meal consumed. Again, these reflect the absolute difference in nanograms per milliliter associated with exposure. These methods prevent direct comparison between our beta coefficients and those from studies that log transformed serum concentrations, but, qualitatively, several of the patterns we observed were consistent with previous studies including significant associations between seafood and long-chain carboxylic acids as well as egg consumption.

The positive associations for PFOS, while not significant, are also consistent qualitatively with studies that have shown positive associations between serum PFOS and consumption of animal products. We do not think that the heat-at-home foods are causing a reduction in serum PFAS, as the

negative beta coefficients here would suggest; instead, we suspect there may be residual confounding related to packaged heated foods and serum PFAS, perhaps through some socioeconomic factor not adequately controlled for in our analysis. So unlike other environmental pollutants, people of higher socioeconomic status typically have higher serum levels thought to be related to consumer product use. Now, this is just one hypothesis we have that might help explain the negative associations that we see.

CARE participants with detectable PFOA and PFHxS in drinking water showed higher serum levels of these PFAS compared to those without, with the most significant increase seen for PFHxS, which was 0.64 nanograms per milliliter higher on average for those with detectable levels in their water. And I will add a note that Toki's analysis using the California Water Board data also showed the greatest effect for PFHxS.

Overall, our study quantified PFAS exposure in the CARE population and identified possible sources and behaviors associated with increased PFAS body burden, specifically drinking water being identified as a source of exposure to

PFOA and PFHxS, which provides further evidence that relatively low levels of PFAS in public drinking water contribute to PFAS body burden.

Diet may influence certain PFAS in serum like those effects seen for PFNA, PFUnDA, PFDeA, and Me-PFOSA-AcOH, but based on studies that suggest diet is a major source of exposure, we expected to see more positive associations between PFAS and foods. This could partly be due to shifts in PFAS production leading to lower concentrations of legacy PFAS in foods. We don't have conclusive data to understand how levels of PFAS in the US foods have changed, but we do know that legacy PFAS like PFOS and PFOA, are no longer being used in food contact materials, and this would likely lead to lower levels in foods.

The FDA only started measuring PFAS in a subset of total diet study samples in 2019, but recent results from store-bought seafood and processed foods have shown limited detections of PFAS. And of the foods with detectable levels, concentrations are several-fold lower than foods analyzed in the 1990s from the Canadian Total Diet Study. So while these data are limited, they could suggest declining levels of legacy PFAS in foods

over the last 20 years.

As strengths of this work, we had a large diverse general study population and recent biomonitoring data collected in CARE. Other strengths include using robust methods to estimate effects of PFAS body burden from multiple sources of exposure and using information from the literature to guide our thinking around the selection of model covariates. The CARE study also includes data on compounds like PFDeA and PFUnDA, which are not always included in biomonitoring studies.

This work also had several limitations. Our assessment of diet was semi-quantitative, and we know that food frequency questionnaires can introduce error associated with self-reported food consumption. The high reporting limits for UCMR 3 were also a major limitation, and contributions from drinking water at lower levels of exposure could not be assessed in this work. But, hopefully, Toki's work using the Water Board's data will address this at least partially.

The high reporting limits and low detection frequency in this study led us to categorize drinking water exposure into a detect/non-detect variable which may also have

introduced exposure misclassification. As mentioned earlier, we cannot rule out the possibility for residual confounding from other exposures like indoor exposures, but we did try to reduce this by controlling for factors that link indoor exposures and diet and water. Lastly, this data used -- this analysis used unweighted data, and therefore may not be generalizable to the larger population.

With that, I would like to thank my co-authors and collaborators, Dr. Wendy Heiger-Bernays and Dr. Tom Webster from Boston University, as well as the staff at Biomonitoring California and the CARE study participants and our colleagues at DTSC for all of their great work in the laboratory.

Thank you so much.

ACTING CHAIR CRANOR: Time for clarification questions from the Panel.

I saw Tom's hand.

PANEL MEMBER MCKONE: I'm Tom McKone, University of California Berkeley.

Thank you. That was really interesting work. Congratulations on finishing it and being able to present it.

I just want a little clarification: I

think the way you did this is really effective. I'm not trying to get too quantitative because then we get into all these issues of how much food people eat and start multiplying numbers by numbers you don't know, so I think it's more powerful just showing the relationships. And I think you alluded to it, I'm just curious about some of the relationships between food and drinking water, because a lot of foods we prepare, you know, use the tap water like when you make rice and pasta, even some vegetables, a lot of things we make at home, we add water. And I know it kind of shows up, I don't know if you went into that more deeply about how the use of water in preparation affects the relationship between drinking water levels and food intake.

EMILY PENNOYER: Yeah, we did consider this in a few different elements of our analysis. First, you know, is our measure of -- the effect of water in food preparation being accounted for in our measurement of water that was linked to the UCMR 3 data. But we also looked at this through a number of sensitivity analysis to see, you know, how our results maybe would look different if we modeled the effects of food without including water in our model, and vice versa, if we modeled the effect of

water without accounting for food preparation.

The results of those sensitivity analyses didn't show major differences in our beta estimates for most of the analytes that we looked at, which to us would suggest that, you know, those two sources are not confounding each other. There may be other ways that we could look at this. I think, particularly, if we had data like Toki's that -- rather than a more crude estimate of exposure with detect and non-detect, there may be more opportunities to -- to suss that out a little bit more.

Does that answer your question?

PANEL MEMBER MCKONE: Yes. Very good. No, I think that's a very effective way -- the sensitivity analysis is a really -- I mean, in my mind, a really useful way to see if there is an effect: just do with and without and different -- different options and see if it makes a difference. So that's good. Thank you.

ACTING CHAIR CRANOR: Other clarification questions?

Amy?

PANEL MEMBER PADULA: Actually, maybe it's more substantive so, it can wait for other

clarification questions.

ACTING CHAIR CRANOR: We have a fuzzy line.

PANEL MEMBER PADULA: Okay. Thank you, Emily. This is really interesting work.

I was also wondering, given the low -- or I guess the high reporting limits for UCMR 3, I was wondering if you had any plans to access the UCMR 5 data.

PANEL MEMBER PADULA: (Indiscernible)

PANEL MEMBER PADULA: Sorry. And I forgot to say my name. Okay. Amy Padula. Rewind.

Great job, Emily. I was wondering if you were planning to examine the UCMR 5 data, which is, I guess, still in the process of coming out, but some of it is available to verify some of the UCMR 3 data and have lower detection limits, if there are more sensitivity analyses in your future or perhaps maybe for another study?

EMILY PENNOYER: Yeah, we did take a look at the UCMR 5 data to see how much of the available data overlapped with the CARE participants. As you noted, that data is still coming out, so it's not complete. But our larger concern was around the timing of the UCMR 5 data collection. Since UCMR 3

and the serum collection for CARE, there have been many events in California that may have impacted water concentrations. Some of those include orders that went into effect concurrent or after serum collection around notification levels, so it was more a question of the temporality with the UCMR 5 data that it's likely that those levels are no longer reflective of what CARE participants were drinking in the years leading up to serum collection.

Although, it would have been nice to have some data to cross-reference with lower reporting limits, though future analyses, hopefully, will be able to use that you UCMR 5 data for analyses similar to ours.

ACTING CHAIR CRANOR: Other questions beyond clarification?

STEPHANIE JARMUL: Actually -- this is Stephanie Jarmul. I have a clarifying question.

When you asked about seafood consumption, did you differentiate between shellfish and general fish?

EMILY PENNOYER: There were differences across the CARE regions in how participants were asked about their seafood consumption. Some

participants were asked more specifically about freshwater fish -- or sorry -- self-caught fish versus store-bought fish, and differences in seafood combined versus shellfish. And I think that Nerissa, in the room, might have a few more details on the specifics of those questionnaires, of which ones were asked, which questions; but for the purpose of being able to harmonize the food frequency questionnaires across all three study regions, we decided to combine shellfish and seafood to match the participants that weren't asked to differentiate.

STEPHANIE JARMUL: Thank you.

PANEL MEMBER PADULA: Lara has a question.

ACTING CHAIR CRANOR: Oh, up there.

Question?

PANEL MEMBER CUSHING: Hi. Lara Cushing, UCLA.

Great presentation, Emily. Really interesting. I had a quick question about whether --

ACTING CHAIR CRANOR: Can you speak closer to the mic? You're kind of quiet.

PANEL MEMBER CUSHING: Oh. Can you hear me now?

ACTING CHAIR CRANOR: I can a little better.

STEPHANIE JARMUL: That's better. Thank you.

PANEL MEMBER CUSHING: Should I start over?

STEPHANIE JARMUL: Yes.

PANEL MEMBER CUSHING: Okay.

Lara Cushing. Great presentation, Emily.

I was wondering whether there was a question about bottled water usage?

EMILY PENNOYER: Yeah, participants -- sorry, go ahead. Was there another part of the question.

PANEL MEMBER CUSHING: (Indicating)

EMILY PENNOYER: Participants were asked about their drinking water source, and bottled water was one of the options. And -- is that my sound coming in?

PANEL MEMBER PADULA: No.

EMILY PENNOYER: Okay. So people were able to respond whether they used public water supplies, private wells, and bottled water consumption. We limited our analysis to everyone on public water supplies. We did not take into account

the amount of bottled water consumption. So we were really just looking at detect and non-detect of the public water coming into their home. But that's an important consideration. I think if you were to go look at bottled water consumption, there might be, you know, more beyond the scope of what we were doing in our study that would be interesting to look at.

PANEL MEMBER CUSHING: So just to make sure I understood you correctly. People who said -- who reported drinking bottled water, were excluded from your analysis?

EMILY PENNOYER: No. People who reported having a private well were excluded from the analysis.

PANEL MEMBER CUSHING: I see.

EMILY PENNOYER: But if they were -- if their house was served by a public water supply, they were included. Any additional stratification based on tap water versus bottled water consumption was not considered.

PANEL MEMBER CUSHING: I see. Okay. Thanks.

STEPHANIE JARMUL: We have Toki online too, who I think also wants to say something.

TOKI FILLMAN: Hello. Can everyone hear me?

STEPHANIE JARMUL: Yes.

TOKI FILLMAN: Great. Toki Fillman from Biomonitoring California.

And as Emily mentioned, I -- we carried out, kind of, a parallel study focusing on the CARE study participants using the exposure to drinking water and associations with serum using the California Water Board's data.

And I just wanted to add regarding the bottled water question, that there is just over around 40% of CARE participants who report drinking primarily bottled water. But in our analysis, when we stratified participants by people who primarily drink tap water versus people who primarily do not drink tap water, which is mostly bottled water, we found that the association for PFHxS was stronger among people who report primarily drinking tap water, suggesting that this effect is indeed from -- from tap water.

Thank you.

ACTING CHAIR CRANOR: Any other questions?

We can invite clarification questions, but also more substantive questions if you have them.

STEPHANIE JARMUL: Nothing from the audience at the moment.

ACTING CHAIR CRANOR: Tom.

PANEL MEMBER MCKONE: I wanted to expand a little bit more on the water source question.

And I don't know if -- I mean, I know a lot of people have filters, or refrigerators now come with filters, almost standard, the activated carbon filters. I don't know how much they pull out, the PFAS-type compounds. And that's a hard question to ask, but if -- I'm guessing if people get a lot of their water from filtered sources, or if they have a filter on their sink, that means -- and again, I don't know the efficiency of these filters for removing these compounds, but it might be an interesting follow-up, something to look at in terms of how many households could be removing the PFAS-type compounds with their filtering system.

EMILY PENNOYER: Yes, and I don't know the range of efficiencies of those different types of filtration. You know, countertop, under sink, refrigerator, some of them are very effective at removing PFAS. I think your question is right, that would be a hard thing to assess with this data based on the type of -- you know, given that so many of

those filters are out there, and their efficiencies can range. But it is certainly something worth considering.

PANEL MEMBER SUÁREZ: Hi, I have a question. Very nice presentation. Very interesting findings. Actually, two questions.

So for the take-out group, looks -- I'm assuming that you did not find any associations, right, with -- with any of the PFAS measured --

EMILY PENNOYER: For the take-out, we did not find significant associations with take-out, but we did see associations -- negative associations with the packaged heated food.

PANEL MEMBER SUÁREZ: Negative associations?

EMILY PENNOYER: Yes.

PANEL MEMBER SUÁREZ: Okay. Well, I mean, a lot of it -- a lot of the PFAS have been phased out since, what, 2016-2017, somewhere around there. So, and the -- other than the short-chain PFAS, which you don't have any measures for, which would be very interesting to --

EMILY PENNOYER: Uh-huh.

PANEL MEMBER SUÁREZ: And then jumping into the heat-at-home. Right, so the negative

associations, I think you're mainly thinking this is more a residual confounding -- or -- or a construct of socioeconomic status, I'm guessing.

Do you know what other socioeconomic constructs that may be available for you to dig in a little bit deeper?

EMILY PENNOYER: Yeah. I think that the potential for confounding that we're looking at -- you know, our thinking is that we have, perhaps, an imperfect measure of socioeconomic status. We're using education and income as proxies. We also know that education and income are imperfect proxies. There's the, you know, overeducated underpaid, you know, associations that exist for folks. So it may be that there are, you know, additional socioeconomic differences that are not adequately controlled for with the variables that we have.

It's also, perhaps, worth noting that, you know, in these exposure surveys, income can often be, you know, misreported or not reported at all. We used imputed data for those observations when we could, but it's possible that the methods that we were using to, you know, ensure complete data set were imperfectly controlling for the real true differences in socioeconomic status.

So that doesn't answer your direct question about what else not included in our analysis might we consider. I would have to think on that little more to see, well, what other data would we want to have to make sure that, you know, the association that we're trying to measure here is adequately controlled for.

PANEL MEMBER SUÁREZ: Okay. So I'm just looking at your slide here. You're saying that you did adjust for -- for income in the --

EMILY PENNOYER: We did.

PANEL MEMBER SUÁREZ: In the slide, it doesn't list it, but maybe it's just an omission there.

EMILY PENNOYER: I'll double-check that to make sure that the correct information is available for the slides that are posted.

PANEL MEMBER SUÁREZ: Okay. All right. So interesting for -- for the income. I just lost my train of thought there.

Oh, yeah, so for -- I mean, it will be interesting to see what other data is available, if there's housing -- other types of housing data, owning, renting, or what type of housing that you may be able to create some sort of factor analyses

about housing situations --

EMILY PENNOYER: Yeah.

PANEL MEMBER SUÁREZ: -- in relation to income.

EMILY PENNOYER: Yeah. There have been some interesting studies looking at, you know, housing, year, as well as cleaning habits in the home, you know, mopping and dusting.

I think another consideration we had to work with, with this model, we had lots of covariates and, you know, running into challenges of potentially including too many covariates in a model. Especially considering, you know, the size of some of our groups of people with water detections and ensuring we had enough, you know, power to be able to do that; not to mention that the robust models, sort, of runs in this iterative process.

And some of the challenges of working with the specific model we use is -- particularly when there are lots of covariates in the model, so thinking a little bit harder on future analyses, you know, to adjust for those socioeconomic differences, yeah, I think will be really informative for this work moving forward.

PANEL MEMBER SUÁREZ: Yeah, I think so. I mean, there's different ways, right, you can create indices, or a construct, in this case of housing, for example, or some sort of a construct for socioeconomic status that may incorporate, like through factor analyses or something related to that, you can incorporate the scores of different related variables. And then you're adding, really, one more covariate to that.

Very interesting. I mean, it's important to dig in a little deeper with the heat-at-home because probably the heat is not introducing PFAS into the air and they're inhaling it or something like that. It's --

EMILY PENNOYER: Yeah.

PANEL MEMBER SUÁREZ: I think -- I think you're right. I think it's probably more of a socioeconomic construct, but important to dig in a little deeper if you have --

EMILY PENNOYER: Yeah.

PANEL MEMBER SUÁREZ: -- you know.

EMILY PENNOYER: Yeah.

PANEL MEMBER SUÁREZ: Very interesting presentation.

EMILY PENNOYER: Thank you so much.

ACTING CHAIR CRANOR: We have about 10 minutes for questions. Comment?

STEPHANIE JARMUL: Go ahead, Lara.

PANEL MEMBER CUSHING: Sorry, this is Lara Cushing again. Are we in the constructive -- are we in the clarifying question section or the --

STEPHANIE JARMUL: Any question.

ACTING CHAIR CRANOR: We take anything now.

PANEL MEMBER CUSHING: Okay.

ACTING CHAIR CRANOR: Try to keep your questions, maybe, a bit shorter. We have about 10 minutes before our next speaker.

PANEL MEMBER CUSHING: Okay. Great. I -- I was just curious about -- it looked like -- if I understood correctly, you know, maybe 20% of participants were excluded because of missing data from your analysis. And if -- I guess, I'm just curious, like, how their PFAS levels looked compared to the ones that you did include in your analysis. And I'm just thinking, you know, about the drinking water, if -- because UCMR 3 doesn't require every system to test, and smaller water systems have less -- often have higher contaminant concentrations of different contaminants, not necessarily PFAS but

other things. You know, if this -- if there's anything we can say about -- or you might be able to say about the -- the ones with missing data on drinking water levels so that we're not, just, kind of, assuming, you know, there was no data so there's no problem and these folks don't have measurable PFAS.

EMILY PENNOYER: Yeah. And I -- Toki might be able to chime in at the end of this, if she wants to add anything.

We did look at the -- the characteristics of the study participants, the 879 participants and the 700 that we included. So the -- the participants themselves in those studies were -- in those two groups were very similar. I say that just to point to, you know, we're not expecting the subset of folks that we've included in our analysis to bias our estimates. But, to your point, the results that we're looking at may not necessarily be generalizable to people in smaller water systems that we didn't have data on.

I don't know, off the top of my head, how the distribution of PFAS in smaller versus larger water systems, how those play out. I think that key -- key factors to that are going to be proximity

to nearby sources, so airports, we think of being near larger water systems that may not be impacting a smaller water system, but there are other sources that, you know, might be influential that the smaller system, not included in our study, could still be significant.

So I don't know, off the top of my head, with that dynamic is. But, and, it may --

STEPHANIE JARMUL: We do have Toki.

EMILY PENNOYER: -- be different from state to state.

STEPHANIE JARMUL: Yeah. We do have Toki, who I think also wants to provide comment.

EMILY PENNOYER: Thank you.

TOKI FILLMAN: Hi, this is --

ACTING CHAIR CRANOR: 5 more minutes --

TOKI FILLMAN: -- Toki Fillman again from --

ACTING CHAIR CRANOR: -- any question.

TOKI FILLMAN: -- Biomonitoring California.

To address that question a bit, so as Emily mentioned in her presentation, she -- her study includes 700 participants, ours included 563. But there's actually a lot of overlap between our

studies and -- and also the -- the water systems that the participants were matched to tend to be, as you mentioned, larger water systems.

So in our work, we also did compare the serum PFAS concentrations of the participants included in -- in the study and the participants excluded who would be -- would be matched to smaller water systems. And the overall serum PFAS concentrations were actually pretty similar between the groups.

EMILY PENNOYER: Thank you for adding that, Toki.

STEPHANIE JARMUL: We have one more comment from the room.

DINA DOBRACA: This is Dina Dobraca, Biomonitoring California staff member.

It's not applicable to this study, but UCMR 5 released the January data update earlier this year that accounts for about two-thirds of UCMR 5 data. And they have one table in that data update which addresses PFASs with a maximum contaminant level, so it would be PFOA, PFOS, PFHxS, PFNA, and then they have this, like, composite variable. And they stratify that table by large and small water systems within UCMR 5, and they found that there was

a higher proportion above the maximum contaminant level for PFOA, PFOS, PFHxS, with the flip for PFNA. At least for, you know, UCMR 5 data.

ACTING CHAIR CRANOR: Any last questions?

We have a few minutes, a couple of minutes, and then our next speaker.

STEPHANIE JARMUL: Nothing from the attendees online.

I think we can go ahead and move on to Wendy if there's no other questions.

ACTING CHAIR CRANOR: Go onto the next speaker?

STEPHANIE JARMUL: Yeah.

ACTING CHAIR CRANOR: Okay.

Next speaker is Wendy Link; she is a Senior Engineering Geologist in the Division of Water Quality in the State Water Resources Control Board. She is managing the State Water Board's response to the PFAS efforts in the Division of Water Quality. Wendy graduated with a Bachelor of Science degree in Geology from Sacramento State. She's a Registered Professional Geologist in the State of California, Certified Project Manager Professional by the Project Management Institution -- Institute.

Today she will discuss some preliminary results of California Water Board's PFAS testing of drinking water and potential sources.

Wendy, you're on.

WENDY LINCK: All right. Well, good afternoon, everybody. You've heard the word State Water Board a lot. We'll I'm from the State Water Board. So we're gonna talk about PFAS in -- in the public water supply, currently a very large project that's going on right now. And so let me do the honors here.

(Slide Presentation)

WENDY LINCK: And, okay. All right. Hopefully, everybody can see the presentation. If I can get a thumbs-up, that would be great.

Okay, Lara, I can see you, see you, see you.

Okay. So as the introduction, I work in the Division of Water Quality within the State Water Board, but both the Divisions of Drinking Water and Water Quality have been working hand-in-hand for many years in regards to understanding PFAS, both at those industrial source sites that Emily mentioned that those airports and landfills, but also in the public drinking water supply.

So I'm gonna go over, kind of, a little bit of a scope about where -- where we -- where we are and where we have been collecting data. I'm gonna talk a little about the maximum contaminant level regulatory timeline for the Federal EPA in relation to what the activities are going on at the State Water Board.

As a foundational portion of this, is that we, as part of the State Water Board, issue monitoring orders in order to require monitoring and collection of data at either public water systems or at other -- other parties like at airports and landfills in order to gather this information and data for PFAS. That's how we get that information to us.

And as part of that, all that data that's collected, we knew that we needed to do some comparison studies in order to, kind of, understand the -- well, entire world of PFAS not just what's on the targeted list. And that will lead us up to a recent order that was issued in 2024 for this large project that's going on right now where we are sampling disadvantaged communities across the state, this is the Community Water System Project, and we'll go over some results. So that's what we're

going to do.

Okay. So we are using the good old iceberg analogy that's our latest one that we're using. You know, folks understand that's a lot of -- there are some targeted analytical methods out there that are being used to analyze for PFAS. In the drinking water world, that's EPA Method 533. That includes 25 analytes. It includes those short-chain -- Emily kind of mentioned some long-chain, and -- and if there's any questions about what short and long are. And so it's a good, kind of, representation of the newer. There are some newer PFAS, the newer chemistry PFAS in that list as well as the older legacy ones that are in there as well.

There are other drinking water -- other methods that we use in non-drinking water. And we're currently trying to understand these ultrashort PFAS. These are the ones that are the C1, C2, and C3 PFAS. The ones that are on that 533 list are C4 and above, and those are really much smaller molecules. And we'll provide some information about data that we're seeing in regards to those. And complementary to target analysis, we're doing a -- what we're calling, kind of, a

proxy for total PFAS -- it's not perfect -- and that's using adsorbable organic fluorine. That's a modified method based upon EPA Method 1621.

And last but not least, we are fortunate to have funding in order to also include non-target analysis. And I'll talk about more a scope of the Community Water System Project coming up.

But first we've got to talk about this regulatory timeline in regards to where we are in regards to EPA. EPA issued those maximum contaminant levels for six PFAS back in April of 2024. Right? And there's an initial monitoring period going on right now for all public water systems to be sampling. We are trying to make it possible for this large statewide project that that data can also be used as part of their initial monitoring. That will go on until 2027. And then after that, there's a post-monitoring period that's gonna happen. And if the MCL is still hanging there, there will -- public water systems will have to be in compliance by 2029. They'll have to already be serving compliant water by 2029.

So what we are currently doing, is we're trying to understand what the total PFAS is in drinking water, and really work towards, instead of

a contaminant-by-contaminant, analyte-by-analyte MCL approach, in addition to, to try to understand PFAS as a class and move forward with a treatment based regulatory approach for public water systems.

So I mention those -- those orders. Those orders that the State Water Board have to issue. In regards to drinking water, there are two orders that have been issued, one back in October of 2022 that was for all those public water systems that were in the vicinity of those industrial source areas that Emily mentioned. We're talking airports, we're talking about refineries, bulk fuel terminals, they're all associated with the use of aqueous film forming foam which has a source of PFAS, chrome platers, they use a universal, and had been using a universal mist suppressant for hexavalent chromium emissions. And those secondary receivers that receive PFAS, which are our landfills and our wastewater treatment plants. So those public water systems have been sampling since 2022 and are currently sampling on a quarterly -- quarterly monitoring schedule.

In 2024, we were awarded some state funds from the general fund to initiate this project. And as part of that, the Public Water Systems, all those

that are serving disadvantaged communities, is part of this scope. So that includes one-time sampling for all those water systems, those wells. As mentioned, as well as what Emily mentioned, these wells are -- the wells are being sampled, not what is being served is at the wellhead themselves. All of the samples are being analyzed for EPA Method 533, and as well as adsorbable organic fluorine, AOF. We're talking about 3,800 wells that are gonna get these two analyses.

We are supplementing about 20% of them, because of cost mostly, to analyze for ultrashort PFAS, there's about five analytes on that list, and as well as non-targeted analysis on that subset. We are hoping and we will have to be done by 2026, because our funding ends at that point in time, and we are on schedule to do so.

In leading up to all of this, were two studies that happened. Because it was really important in the drinking water world, we needed to understand what else was likely in and about, not just what's on the targeted list. There's a lot of research coming out -- out and about that there's not just 25 or 18 PFAS analytes out there, there's a lot more than just that.

So in 2021, we went to -- actually, Division of Drinking Water staff went to nine drinking water supply wells all across the state. They were either associated with an airport or a landfill, somewhere where we knew that there were going to be PFAS in the well. We wanted concentrations in those wells. And we analyzed those samples using all the targeted analytical testing methods that were available. And we also used adsorbable organic fluorine.

And this is a representation of one of the well results, and it is showing that the adsorbable organic fluorine is in the blue bar, and the rest of those bars are comparing other targeted analytical techniques. So essentially, what we are finding out, back in 2021, which may not have been, you know -- not unknown, that there are a lot of unknowns that are not being picked up by the targeted method, and there's a lot -- there are more perfluorinated or polyfluorinated alkyl substances in drinking water than -- than what can be seen by targeted analytical techniques.

So from there, two years later, we -- we needed to go back to those nine wells one more time. So we went back to those wells, and in -- and in

this case, we also analyzed them for 533 again. We analyzed them for AOF, and we also supplemented for the ultrashorts. AOF is in blue, the sum of the 533 targeted are in that dark brown, and the gap between the two is the ultrashorts. Those are those compounds that are just not on the targeted list at this point in time. And so it can be quite a bit that can be associated with the ultrashorts in regards to drinking water.

So knowing that, how are we going to regulate; right? How are we going to -- we can't contaminant-by-contaminant. We've got to, kind of, get our arms around PFAS in regards to drinking water. So we were awarded a large -- some bill funding in regards to the state fund. And we had several items that we needed to do in order to respond to that. One, we needed to select a PFAS broad-spectrum method. The second one is this DAC order; we were going to go out, issue the order and start sampling around 4,000 wells, there's actually about 3,800 now that are serving disadvantaged communities. The different analyses that we needed to do in regards to those wells and also understand more about ultrashorts. But really, kind of, understand what's going on in the non-target -- what

else is -- could be out there in those.

When we did the broad-spectrum method, we picked AOF as our broad-spectrum method. It's the most commercially available method that's available. There are others out there, but we found that it produced and shown better in regards to capture of PFAS in regards to drinking water in the State of California.

This is a current status of where we are in regards to the sampling of statewide. The yellow are these wells that already have been sampled. And we are still sampling, those ones that are planned, are in green. This is about a month old right now. At that point in time, we are -- have already sampled 1700 wells. This is all being done under subcontract to Sacramento State University. The consultant is going around the state and collecting these samples. They're being sampled, and the samples are being sent to our state contracted lab, which is Babcock Laboratories located in Riverside, California.

Babcock Lab is currently doing all the analysis currently. They are doing the 533, the ultrashorts by IC-MS/MS and the non-target analysis by high-res mass spec. We're probably over 2,000

wells as we speak right now, but currently we're running at about -- they're collecting about 170 samples that are going to 170 wells a month right now and touching about 39 water systems a month. Some water systems are much larger than others, and so some of that is gonna vary month by month. But that is our current rate and we continue to accelerate that at that rate. We may be done early, actually, at this rate. And we'll see where we are probably in early '26 where we are.

So this is gonna provide some data and to show some of the results based upon this sampling. This is as of -- data that was in our database as of -- in December. It's a couple of months old, but there isn't much I anticipate changing from this. We're seeing a lot of non-detects, which is really great news for the data of the samples that are coming in for EPA Method 533.

This is a percent detect chart. Your y-axis is the analytes, what are they being detected at. And on the x-axis are the analytes that are part of 533. They are grouped in specific groups from the carboxylates, the C4, the C12s, the sulfonates, and the C4 to the C8s. Those ethers, those polyethers, those are those, kind of,

precursors. So they are the newer legacy. The fluorotelomers are definitely newer PFAS, newer chemistries. The ultrashorts, farther to the right, and then AOF to the farthest right in orange.

We're currently only seeing a very few of the carboxylates and sulfonates, at less than 10% detect right now. They are the same analytes that we have been seeing ever since, actually, sampling has been performed in the public water systems. They are predominantly the PFOA, C8, and C4 to C4 carboxylates. We do have PFHxS. That was also mentioned in the sulfonate range and other sulfonates as well as PFOS, P-F-O-S.

As you move your way farther to the right, we don't see any of the ethers. We don't see any of the fluorotelomers in drinking water. And AOF currently is being detected a little bit over 30% of the time. The one large green bar that you see -- now, please keep in mind that the -- the ultrashorts are being done on a subset of the whole. So there's currently about 227 samples that were a part of this chart, and every -- every one of them is showing trifluoroacetic acid. And this is a C2 ultrashort.

We do not expect, and would not expect to see ethers or other newer chemistries. Those are

precursors. I think what we're finding out -- really understanding that, you know, most of those precursors are -- are -- they're definitely at the source sites. They are hanging around up there. But by the time they get to drinking water, they have already transformed. They are degradates and they will show and come up either a PFA -- or PFHxA or other carboxylates, and that's what we're seeing in drinking water in -- so far. We do not see any -- any of the precursors in drinking water that are on the 533 list.

So these, two, next two charts, are gonna kind of give you a range of concentrations that you see in drinking water so far at these disadvantaged communities, these public water systems. And so pretty much most of the bulk of -- the middle 50% of all the data is really less than about 20 nanograms per liter. Really low concentrations in comparison to this -- in the industrial source sites where we can see multiple magnitudes much higher there. And so you can see some of -- you can see the ranges of those -- of those -- in the carboxylates and the sulfonates in regards to there.

We have a couple that have a pretty high result, if you had noticed, the maximum

concentration for PFHxS and PFOS there, and a couple -- that one pretty much and the PFOA one, though that is at one well that we know about. It is a well that is near an airport, and it currently has extensive treatment -- treatment on it, and it's the only one that is actually at that high. But you can see what the median concentrations are -- are all below 10 nanograms per liter.

We're gonna switch to the trifluoroacetic acid in the ultrashorts. And notice that the concentration on the y-axis up a magnitude. We see trifluoroacetic acid I had mentioned in all the wells so far that are analyzed for them. And so our current median concentration, as of that -- this dataset is about 600 nanograms per liter. I think in reference to this, I wanted to point out is that currently the European Union, the -- I believe the Danes and Germany are currently have -- their, kind of, maximum contaminant level for trifluoroacetic acid around 9,000 nanograms per liter. I think what we are seeing, in general, is that as you get a shorter-chain length in regards to PFAS, the -- the toxicity, you know, it's not as -- as -- as terrible as PFOA and PFOS. It's still -- PFOA and PFOS are still gonna be the leaders, that's why the maximum

contaminant level is at 4. PFBS MCL is around 2,000. That's a shorter-chain. So we see just a little bit of TFMS. And of the other ultrashorts, we don't see them at all. These are the only two. This is it.

So we decided we're gonna do a heat map. And so to orient you on this, the x- and the y-axis are the same analytes. And we start with a very short-chain on the carboxylates and move our way up into longer-chain and then flip over to sulfonates and ethers, FTSs and the ultrashorts, and the same -- on the x as you go from left to right.

Let's talk about the blank space. That's all non-detects. We don't have data. Any correlations with -- is all non-detects. We don't have any -- enough data to correlate for those. Down in the lower left part of the chart is the correlations that we're seeing with those carboxylates. We are seeing carboxylates, as I mentioned before, which are degradates of other precursors that are -- that are in that association over there.

We see little bit up, over in those sulfonates, that other part of that other little colored box towards the middle of the heat map. And

the other thing that's very interesting, is if you actually looked at AOF and you looked for any correlation with AOF, we are not seeing much correlation with AOF with any of the other analytes.

I looked at the data in particular, and we're only seeing in every well, where we have an AOF concentration, only about 10% of them may have one of the other analytes in them, either PFOS or PFOA or PFHxS. So that's something that we've got to think about and understand. But we need more data, and we'll continue to, kind of, ponder on why we are not seeing that much correlation with AOF for that.

So we then took a look at the results in regards to -- and some of this may explain a little bit about the previous heat map, is that it has to do with detection limit. So AOF has a higher detection limit. Currently, right now, we actually can receive estimated data, and so our current detection limit for AOF is around 200 nanograms of organic fluorine per liter. We converted all the PFAS analytes into nanograms or organic fluorine per liter and summed them up, and that is represented by the blue bars. And then the orange bar is the AOF concentrations.

So you can see, kind of, that hole in between there where we don't -- can't see with AOF. And so, but, that's where most of the sum -- 533 sums are located down in that lower range. Most of our data, in regards to even adding up everything, is below 10% of the wells, of -- below 10 nanograms of organic fluorine per liter in most -- almost 40% of the wells, and we have a lot of non-detects. We have both a lot of non-detects for AOF as well. So that is something we need to, kind of, work on and ponder, and we'll get more data and look at that.

We need to start pairing this. We currently are -- are receiving a lot of data. We are -- there is so much data that's coming in, that we're -- you know, we're trying to keep -- keep aboveboard. And so one of the things that we still have to work on and look at is the non-target. How does that, in those non-target analysis, how do they relate to this AOF, and by abundance, and in relation to the targeted as well.

This is just a chart to, kind of, give you understanding of where -- there was some references to notification levels. In drinking water, currently, all these wells we provide a notification to the water system what the results were and where

they are. There are certain actions that may be required based upon -- there are advisory non-regulatory levels that are issued by the Division of Drinking Water. This gives you an idea of comparison to the current EPA MCLs that have been issued back in April and in comparison to the notification and response levels.

Response levels means that the public water system either has to take that well off-line, they either have to treat, or they have to do public notification. That means sending a mailer to your home address. They don't want to do that. Most of the public water systems are already reacting to the notification level, which is very close to what the -- the MCL is for -- for -- the EPA MCLs.

And then, yeah, so that's where we are. And then if we were to take the actual data that's being reported for these water systems, this gives you an idea in comparison to them. The advisory levels are at the top of the screen, and the federal MCL exceedances are at the bottom. We see most of our -- we only have one exceedance of any response level for PFOA and PFOS currently. PFHxS is out there. That's the one. We have been hearing that for the last hour or so about PFHxS. And it's the

one that's causing the most exceedances in regards to the public drinking water supply. In comparison to the MCLs, you can see, kind of, the relation there for those. So but, otherwise, the -- the higher-chain PFBS, that's much higher maximum contaminant level. We don't have any -- won't have any exceedances most likely, and very little on -- on PFNA.

So all this does is, kind of, compare those exceedances based upon the DAC order versus the combine of all the public drinking water systems that are sampling and currently reporting. And you can, kind of, see the difference. We've been very low exceedances of the response level based upon the four analytes that are listed there that have notification response levels issued by the State there. But once you get closer to the source sites, those response level percentages go up. We are moving towards the source area there, and then we do have some -- we do have some exceedances there.

The difference between the level, the response level and the MCL is one little bit notch down, and there's quite a bit. There's gonna be some differences there in regards to an increase that the public water systems will be moving towards

in treatment.

Last but not least, our last slide, and then I'll have my thank you slide after that. We look forward to questions or comments.

This, kind of, gives you an idea geographically where the wells are -- currently have exceedances based upon the federal MCLs. A lot of them are located in Southern California. There is a lot of effort, there is currently 50 permits that are already issued by the Division of Drinking for -- for PFAS treatment, and most of them are down in Southern California. A lot of those systems are already online and are either using GAC or a combination of GAC and ion exchange to remove -- to remove PFAS from the drinking water supply.

And so that, kind of, gives you an idea of where we are. And I appreciate your time this afternoon. And I just want to shout out to my colleague Dan Newton; he's the Assistant Deputy Director of the Division of Drinking Water. His nighttime job, other than regulating 4,000 water systems, is PFAS. So him and I are the ones that are trying to understand this huge world and be, you know, the best -- the best to, yeah, to try to figure it out what is the next steps for that.

So I'll end it there.

ACTING CHAIR CRANOR: Thank you, Wendy.

We have few minutes for clarification questions, and then the remainder of the time until about 3:45, we're open for Panel and audience questions of various kinds and then open discussion if there is some.

Take it away.

WENDY LINCK: Hi Jenny.

PANEL MEMBER QUINTANA: Hi. Thank you for that very detailed talk, and I'm not sure I followed all of this. And you may have already said this at the beginning, so this is just a clarifying question.

Were these wells also -- were you covering tribal lands in California as well as non-tribal lands?

WENDY LINCK: Yeah, so I know of one system that's one -- so that's a very interesting story, Jenny. So the EPA actually regulates tribal. There are some tribes that are being regulated by the Division of Drinking Water, but most of them are -- as you know, are sovereign nations. And so there are very few tribal nations that are on this list. But the one that I know of is non-detect.

PANEL MEMBER QUINTANA: Thank you.
WENDY LINCK: You're welcome.
ACTING CHAIR CRANOR: Other clarifications?
WENDY LINCK: Lara?
PANEL MEMBER CUSHING: Yeah. Hi Wendy. This was great. I learned a lot.
I was curious -- could -- I may have missed it, but could you go over how disadvantaged community was defined in this 2024 order?
WENDY LINCK: Yeah, it's based upon median household income. It's stated in the regulations in regards to that.
PANEL MEMBER CUSHING: And I guess, just a follow-up, like, what -- what proportion of community water systems statewide are designated as disadvantaged and being subject to this sampling that you described?
WENDY LINCK: Well, it's my understanding that there is over 14,000 wells in the State of California, and we're trying to sample 4,000. And that --
ACTING CHAIR CRANOR: I have a question. I have a clarification --
WENDY LINCK: Not all water systems --

ACTING CHAIR CRANOR: Excuse me.

WENDY LINCK: Yeah. Some water systems -- yeah, they're a combination. It's, you know, not -- there are some wells and some water systems that are not considered disadvantaged. That makes a lot of sense, doesn't it? But anyway.

ACTING CHAIR CRANOR: May I ask a question about the disadvantaged communities? Are the water systems obviously more contaminated?

And if so, do you have a speculation about why?

WENDY LINCK: I'm sorry, could you speak that up -- speak up a little louder, please.

ACTING CHAIR CRANOR: In the disadvantaged communities, are the water systems more obviously contaminated with PFAS?

WENDY LINCK: (Indicating)

ACTING CHAIR CRANOR: No.

WENDY LINCK: No, in fact that's one of the wonderful things about this; so far, we are not.

There's a few outliers out there. I think every state is, you know, trying to -- kind of noodle, like, why is that there, but otherwise, overall, because such a low percentage of detection, like, less than 10%. We are -- it has been

wonderful news not to see PFAS in every well and everywhere.

ACTING CHAIR CRANOR: Just a clarification, less than 10% of the wells tested in the disadvantaged communities have contamination problems or less than 10% --

WENDY LINCK: Less than 10% are detecting PFAS in the samples that are currently -- currently. So we're at that -- we're currently at that point in time, at 1300 wells, and we're only detecting 10%.

ACTING CHAIR CRANOR: Tom?

PANEL MEMBER MCKONE: If it helps, I can move this to the general discussion. We can cross the border, and then we're on time.

ACTING CHAIR CRANOR: Let's see. We have until -- from now until 3:45. You can edge us into that.

PANEL MEMBER MCKONE: Well, I don't know if it is, but it could be either one.

So I'm curious about -- so clearly -- as is typical, California sets response levels drinking water guidance that's slightly different from EPA.

Are there other states that engage in doing this?

And are -- are you going to compare, you

know, the California response threshold or limits to those other states or is that relevant? I'm curious.

WENDY LINCK: That's a good question.

A lot of states have -- have been regulating PFAS for a while. We just -- EPA just issued theirs back in 2024. Some of those states over in the East Coast, sir, have had some significant issues, and they needed to move. And they need to regulate sooner than later, and so they have done so.

Now, some of them are now going to have to figure out what the next step for them are, and may have -- have to lower those. But, yeah, there's a lot of states that have already been regulating for PFAS. It could be a single analyte. Some have gotten to the point where they're summing them up and using that sum as their -- as their approach for regulation. So it's all over the -- it's all over the -- it's all over the place, sir.

I think the Division of Drinking Water will be lowering their response levels and notification levels down to the MCLs. So we're gonna -- they're gonna match them.

ACTING CHAIR CRANOR: Amy?

PANEL MEMBER PADULA: Just a follow-up -- this is Amy Padula -- on what you just mentioned.

So you expect the -- the detection limits for the AOF to go down for the total PFAS or not necessarily?

WENDY LINCK: Not necessarily. No. I think it has to do with -- it's using combustion ion chromatography. We are currently using an extraction process that actually is one of the better ones based upon a study -- and I can provide a link to that study if anybody's interested in that -- in order to capture as much as possible.

But it may be just -- it's gonna be a limitation based upon the available technology. So --

PANEL MEMBER PADULA: That's too bad, 'cause I could see the conundrum.

WENDY LINCK: Oh, I know; right?

And so we're -- we're -- we can't see that -- that in drinking water. I think that's what we've got to consider here in the State of California. Drinking water concentrations are -- are not that high. I know they're above 4. But in relation to other states, you know, we -- we don't have a primary manufacturer in the State, of PFAS.

Everything is coming in secondarily. And so all of our concentrations are much lower.

And so that technique is great at a source site, great for screening. And so we're trying to figure out how we're gonna move forward in regards to treatment technology approach. 'Cause one of the things that we're going to do next is we're gonna actually go to treatment systems, and we're going to analyze those same set of analytes on the influent and the effluent, what's actually coming into those systems and what's actually leaving those systems and how much is that.

But the -- the silver lining, I think, is that, one thing, if you don't get anything, I think, is that what we're seeing now is what we have been seeing, and there hasn't been anything different, at least on the targeted list. And that's been a huge difference in regards to drinking water.

We know we've got some other unknowns, but we're getting there to try to understand what those are, and are they gonna be an issue.

STEPHANIE JARMUL: I think Jenny had her hand next.

PANEL MEMBER QUINTANA: Hi, actually, I think you answered my question, Wendy. It had to do

with the treatment systems. So thank you.

WENDY LINCK: Yeah.

José?

PANEL MEMBER SUÁREZ: Indeed, this has been a very educational presentation. I think the biggest highlight for me here is just the ubiquitous presence of the ultrashorts, the FTA in all of the samples that you measured --

WENDY LINCK: Yeah.

PANEL MEMBER SUÁREZ: Which really makes it quite compelling to start considering this in Biomonitoring and also expanding the measurements of this in many, many different places.

I'm looking at, right now, at the -- at the map here that geospatial where you're showing the different areas in the State of California that had elevated or -- or values exceeding the MCLs for various of the legacy PFOS --

WENDY LINCK: Uh-huh?

PANEL MEMBER SUÁREZ: -- PFAS, but I really wonder what this would look like for FTA in particular. I'm guessing that the use of FTA must be very widespread. I -- I do research with pesticides, and I know that they're being used for certain herbicides and certain fungicides. So

bringing that, looking at the map here, it will be very nice to see how these different well sites in relation to, proximity to agricultural crops --

WENDY LINCK: Yeah.

PANEL MEMBER SUÁREZ: -- may be related to this.

WENDY LINCK: Yeah.

PANEL MEMBER SUÁREZ: I mean, they're also used in medications, I belive, like Prozac, I think, has some component --

WENDY LINCK: Yeah. I don't know. I think -- you know, I don't think we've ever -- or at least in my 20-plus years career ever dealt with PFAS before. You have such layered issues with it.

First, you've got the different chemistries; right? And different -- and chemistries in regards to the evolution of making them, the phaseout of them, and then the replacement products that then degrade to them; right?

And so TFA is one of those ones that can be -- one, that can be a degradate of another thing, but it can also be a source of something. And it was being used in the 50s widely, you know, in the -- in the HFC market. And so you've got this combination. Once again, you got this parent, but

also can be a daughter, so to speak. And so it's -- it's just a crazy thing.

And so since we're seeing it in drinking water, right, it had to come from somewhere. And it had to come -- and it -- and it's been around a while. You know, some of these wells are really deep, José. We just don't get there immediately, so...

PANEL MEMBER SUÁREZ: And unlike other persistents like PBDEs, there are no known natural sources of --

WENDY LINCK: Right.

PANEL MEMBER SUÁREZ: -- TFA or anything like that.

WENDY LINCK: Right. Yeah.

PANEL MEMBER SUÁREZ: Yeah. So, I mean -- I mean, this is phenomenal work. It gives us a little bit of insights of that tip of the iceberg that you were showing us where we --

WENDY LINCK: Yeah. Right.

PANEL MEMBER SUÁREZ: -- all the PFAS, they --

WENDY LINCK: We're trying to draw the water -- water line down.

PANEL MEMBER SUÁREZ: And it gives us, I

mean, a pretty compelling rationale here for maybe those total PFAS that you're not, really, measuring --

WENDY LINCK: Yeah.

PANEL MEMBER SUÁREZ: -- and targeting. That may be these -- so very educational. At the same time, you know, something that we're gonna be thinking a lot more --

WENDY LINCK: Yeah.

PANEL MEMBER SUÁREZ: -- also on the biomonitoring side.

WENDY LINCK: I appreciate it. Thank you, José.

PANEL MEMBER SUÁREZ: Thank you.

NERISSA WU: This is Nerissa Wu from Biomonitoring California.

I just wanted to address something José said. And thank you, Wendy, that was really informative.

Yes, of course, all of this water data makes us think about what we should be measuring in humans. And we have been investigating with different methods that are available to us.

They are, unfortunately, not standardized at this point, so it's -- we don't have a method

that we can apply broadly. But we are planning to run a pilot with TFA and see how that looks with some -- with a small subset of our samples. And we look forward to having more -- to fill in -- to help supplement some of this water data coming up.

PANEL MEMBER SUÁREZ: Phenomenal. Thank you.

MARTHA SANDY: Martha Sandy with OEHHA.

So thank you, Wendy, that was a great talk.

I'm thinking of your slide with the correlations of the different --

WENDY LINCK: Yeah.

MARTHA SANDY: -- things that are measured. And that AOF, they're -- you're not seeing a correlation with other targeted PFAS, if you will, short-chain or long-chain.

So I'm -- I'm wondering, is the adsorbable organic fluorine, that's gonna pick up the pharmaceuticals; is that right? And so maybe that's what's missing? And -- and some of the pesticides as well that are fluorinated.

WENDY LINCK: Yeah, we're already have looked at some of the non-targeted data, and that you -- you got it. Yeah. That's all.

Actually, a lot of non-fluorinated. Not fluorinated, non-fluorinated.

DINA DOBRACA: This is Dina Dobraca, Biomonitoring California staff member.

I was just wondering, you had a slide that showed that about --

ACTING CHAIR CRANOR: Could you put that mic closer to your mouth? We'll hear better.

DINA DOBRACA: Okay. You had a slide that showed about 50% of all wells sampled had 0% detect for AOF. And in combination with 100% of your ultrashort subset having TFA detected, has the Water Board thought about creating almost exposure profiles for these wells?

Like, this subset of wells is TFA, nothing else. What's around them? Who do they serve? What does it look like? This subset of wells is -- has maximum contaminant levels that we've studied for a long time and know about? Who do they serve? What's around them?

Yeah. That's the extent of my question.

WENDY LINCK: Yeah, I think the one thing that you saw, except for the end, was some kind of map, so that's where we are. We need to now, kind of, look at the geospatial relationships, and we're

just trying to -- we're still receiving data every day. And it's a small group of us that are looking at it. So those are really great ideas. We hope to be doing that.

Hi, Lara.

PANEL MEMBER CUSHING: Hi.

WENDY LINCK: You got time to help us? No.

PANEL MEMBER CUSHING: Yes. Yes. We'd love to help you.

I had one other quick question. Oh, I was wondering about the degree of overlap between your data and the UCMR 3 or 5, and if you looked at all to see, like, time trends or correlations across those different sampling efforts?

WENDY LINCK: Yeah. Yeah, there is some overlap. Yeah. But we -- no, we haven't looked at that. And I believe UCMR 5 is not done in California yet. At least that was an email I saw a couple of weeks ago. They're not quite finished.

ACTING CHAIR CRANOR: A few minutes left.

Questions? Any questions? Comments? Substantive or otherwise?

STEPHANIE JARMUL: Nothing online at the moment.

ACTING CHAIR CRANOR: Wendy, you seem to have silenced the crowd.

PANEL MEMBER QUINTANA: There's a hand up online on the Zoom.

WENDY LINCK: Kannan? Did I say that right?

KANNAN KRISHNAN: Yeah. Thank you.

Thanks for the nice presentation.

One question, I thought I saw in one of the slides, the sum of the targeted plus the sum of the ultrashort was greater than the AOF.

WENDY LINCK: Yeah, that's right. How does that happen, Kannan?

KANNAN KRISHNAN: Yeah. You first.

WENDY LINCK: Yeah, there's more stuff out there; right?

AOF is not perfect. I mentioned that, so -- but it's the best that we can -- we're doing it all in a commercial lab, you know. So right now, that's what we have so far.

KANNAN KRISHNAN: Okay. Well, the general thought is that it's better than the TOF?

WENDY LINCK: Yeah. But, you know, that's interesting. I think for drinking water, probably. But I think that -- I think that detection limit

also has something to play with it, a little bit, Kannan, as well. So we'll keep looking at ways. We've already done quite a bit on -- on the extraction technique to try to not lose as many PFAS in the extraction process. But when you're talking adsorbable organic fluorine, you're still talking a wax carbon cartridge, so it's whatever is gonna adsorb, and stuff is gonna pass through.

KANNAN KRISHNAN: Science is evolving --

WENDY LINCK: Yeah. Oh, my god. We've gone so far in the last four years. It's really leaps and bounds. Just having the ability to do non-target analysis on a commercial lab level is huge.

KANNAN KRISHNAN: Thank you for sharing all of these thoughts and data. You covered a lot.

Thank you.

STEPHANIE JARMUL: We do have one more question.

Toki, go ahead.

WENDY LINCK: Hi Toki.

TOKI FILLMAN: Hi Wendy. Thank you so much for this very interesting presentation.

I was just wondering if you could expand a little bit more on the plans to monitor treatment

systems, influent and effluent. Is that gonna be on -- on a small number of treatment systems or more extensive monitoring?

WENDY LINCK: For the -- for the testing part to see what was there?

TOKI FILLMAN: Yeah.

WENDY LINCK: Is that what you mean?

Yeah, we need to probably start planning for that sooner than later. That same funds that's gonna expire at the end of 2026, has got to be used for that too, Toki. So we've got to do some update to our QAPP and figure out which water systems are willing to help out here.

We're looking for a good section, cross section of different water systems. They are currently already doing PFAS treatment across the state. Southern California is an obvious candidate pool down there, and they are receptive of that, but we also need to reach out to others across the state. But there aren't many other that are really down in Southern California so we can test different types of combinations.

TOKI FILLMAN: Thank you.

WENDY LINCK: Thank you.

STEPHANIE JARMUL: Lara.

PANEL MEMBER CUSHING: Hi. Lara Cushing again. I keep thinking of questions.

I'm just curious if you could say more or if you have given thought to surface water sources and are they excluded because you don't think there is much potential for PFAS in the surface water sources or they're just not as commonly used?

WENDY LINCK: The bill funding was directed to groundwater, to wells, so that's why the study is focused on that.

As part of the interim monitoring period, that's by the federal -- by the federal, right, with the MCLS, they have to sample both surface and they have to start -- so that data will be coming -- coming in to find that out.

We did do a study. We did a small study a year or so ago where we did sample along the Sacramento and Feather Weather -- River in regards to water intakes, and we didn't see anything. But, you know...

PANEL MEMBER CUSHING: Thank you.

ACTING CHAIR CRANOR: Other questions or comments? We have 15 minutes of allotted time if you wish to use it.

STEPHANIE JARMUL: We can move to open

public comment. Do you want to announce the open public comment, Carl?

And thank you so much, Wendy.

ACTING CHAIR CRANOR: Let's see. So the for the wrap-up period, the listeners should know that web attendees can submit written comments and questions via the Q&A function of Zoom webinar or by email to biomonitoring@oehha.ca.gov. And we will read them out loud. If you wish to speak, please alert us through the Raise Hand feature of the program, and Rebecca will call on you at the appropriate time. If you are attending in person and wish to comment, please come in, raise your hand, I will call on you -- call on you. For the benefit of the transcriber, please clearly identify yourself before providing comment.

So those are the ground rules for the last 15 minutes. Opportunity for -- to submit comments.

STEPHANIE JARMUL: If any, public comments are welcome on anything we've discussed today or anything else.

No public comments at this time.

ACTING CHAIR CRANOR: No public comments. No in-room comments? Is there a move -- I don't think we're on Roberts Rules of Order, but is there

a move to adjourn?

STEPHANIE JARMUL: You can go ahead and -- and wrap up.

ACTING CHAIR CRANOR: Did I miss something? Oh, wrap-up and adjournment; sorry.

There we go. So a transcript of the meeting will be posted on the Biomonitoring California website when it is available.

The next Science Guidance Panel meeting will take place on August 27, 2025 from 10 a.m. to 4 p.m. in Sacramento. That's an important difference. Information regarding options for attending the meeting will be made available closer to the August meeting date.

So this meeting, obviously, is here in Berkeley. You're all present. The next one is in Sacramento, that's a little trickier to get to.

And thank you Panel and thank you audience, and the staff has been most helpful.

We appreciate it. Thank you.

(Thereupon the California Environmental Contaminant Biomonitoring Program, Scientific Guidance Panel meeting adjourned at 3:45 p.m.)

CERTIFICATE OF REPORTER

I, DIANA FLORES NUCHURCH, a Certified Shorthand Reporter of the State of California, do hereby certify:

That I am a disinterested person herein; that the foregoing meeting of California Environmental Contaminant Biomonitoring Program Scientific Guidance Panel was reported in shorthand by me, Diana Flores Nuchurch, a Certified Shorthand Reporter of the State of California, and thereafter transcribed under my direction, by computer-assisted transcription.

I further certify that I am not of counsel or attorney for any of the parties to said meeting nor in any way interested in the outcome of said meeting.

IN WITNESS WHEREOF, I have hereunto set my hand this the 11th day of April, 2025.

Diana Flores Nuchurch
Certified Shorthand Reporter
License No. 14759