IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM: 2010-2012

Report to the California Legislature

California Department of Public Health
In collaboration with
California Environmental Protection Agency's
Office of Environmental Health Hazard Assessment and
Department of Toxic Substances Control

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- Industry and manufacturing representatives for sharing their viewpoints and technical data.

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Executive Summary

People come into contact with many chemicals each day through using common materials such as personal care products, plastic items and cleaning agents, as well as consuming food and water. Biomonitoring measures chemicals in people's blood, urine, or other biological specimens to help determine which chemicals are present and in what amount. The California Environmental Contaminant Biomonitoring Program, also known as Biomonitoring California is a collaborative effort involving the California Department of Public Health (CDPH), the Office of Environmental Health Hazard Assessment (OEHHA), and the Department of Toxic Substances Control (DTSC). Biomonitoring California is the only ongoing legislatively mandated state biomonitoring program in the country. In SB 1379 (Perata, 2006 Session, chaptered as California Health & Safety Code sections 105440 et seq.), which established Biomonitoring California, the Legislature found that:

"…the establishment of a statewide biomonitoring program will assist in the evaluation of the presence of toxic chemicals in a representative sample of Californians, establish trends in the levels of these chemicals in Californians' bodies over time, and assess effectiveness of public health efforts and regulatory programs to decrease exposures of Californians to specific chemical contaminants. "

Measuring environmental chemicals in California residents will help scientists and policymakers answer such questions as:

- Which chemicals are in people's bodies and how high are the levels?
- Are the levels of chemicals changing over time?
- Are there groups or subpopulations in California that have higher exposures to specific toxic chemicals?
- Do regulatory efforts, including bans or phase-outs of chemicals, actually reduce exposures?
- Do certain chemicals contribute to the development of chronic diseases or conditions?

The principal goals of Biomonitoring California are to monitor, analyze, and report on specific environmental chemicals detected in blood, urine and potentially other biological specimens from a representative statewide sample of Californians and to assess the effectiveness of existing public health programs in reducing these chemical exposures. The Program is required to submit progress reports every two years to the Legislature, beginning in January 2010. This document is the second of these reports.

Program Structure and Resources

CDPH is the lead entity, with primary responsibility for: (1) overall design of the biomonitoring program, including both statewide and community surveys; (2) participant recruitment and sample collection; (3) receipt, storage and analysis of blood and urine samples for metals and chemicals that are not biologically persistent; (4) quality assurance and interpretation of laboratory test results; (5) communication of test results to participants; (6) data analysis; (7) generation of reports to the Legislature; and (8) dissemination of information to the public.

OEHHA has primary responsibility for: (1) administering and supporting the Scientific Guidance Panel; (2) evaluating and summarizing scientific information for the SGP's deliberations on chemicals for biomonitoring; (3) evaluating and summarizing scientific information used in returning test results to study participants (4) collaborating with CDPH on study design and data analysis; and (5) conducting public outreach efforts, including the program website.

DTSC has primary responsibility for: (1) analysis of blood samples for biologically persistent chemicals, and (2) quality assurance and interpretation of the laboratory's test results.

Biomonitoring California was envisioned in SB 1379 to include a statewide survey, in which the Program would measure levels of environmental chemicals in blood, urine, and possibly other biological specimens obtained from a representative sample of California residents. By successfully acquiring supplemental extramural support through a cooperative agreement with the U.S. Centers for Disease Control and Prevention (CDC), Biomonitoring California has been able to undertake smaller-scale community-based studies. The Cooperative Agreement's award period spans 2009-2014, with funding contingent upon available federal resources and adequate programmatic progress.

Scientific Guidance Panel

A nine-member Scientific Guidance Panel (SGP) appointed by the Governor and the Legislature provides technical peer review for the Program. SGP meetings provide opportunities for Biomonitoring California staff to update Panel members and the public on Program activities, request feedback and recommendations from the SGP members, and receive public comments. The SGP has played a critical role in advising the Program in many areas, including study design, collaborations with other researchers, reporting results to participants, and selection of chemicals for biomonitoring.

Study and Sample Design

During 2010-2011 Biomonitoring California staff conducted three pilot studies:

- Program staff collaborated with researchers from the University of California (UC), Berkeley and the UC San Francisco Program on Reproductive Health and the Environment on a pilot project in San Francisco County assessing exposures of 92 pregnant women and their infants to over 70 chemicals.
- Working with UC Irvine Center for Occupational and Environmental Health and the Orange County Fire Authority, staff conducted a project to measure levels of more than 75 chemicals in 100 Orange County firefighters.
- Biomonitoring California is collaborating with the Kaiser Permanente Northern California Research Program for Genes, the Environment and Health on a biomonitoring survey of California's Central Valley. Participants are similar in age, gender, and race/ethnicity to the general population in this region. This is the Program's first effort to obtain a sample representing the population of a large geographic region of the state.

The Program is exploring other methods of approximating a statewide survey. This includes examining whether blood samples collected through the State's Prenatal Screening Program (approximately 400,000 women annually) or dried blood spots from the Newborn Screening Program (approximately 500,000 infants annually) could be used for population-based biomonitoring surveillance.

A distinctive feature of Biomonitoring California is the requirement that biomonitoring results be returned to study participants who request them. The Program is collaborating with researchers at UC Berkeley and others to develop best practices and materials for returning individual test results to participants.

Laboratory Status

CDPH's Environmental Health Laboratory (EHL) and DTSC's Environmental Chemistry Laboratory (ECL) have implemented state-of-the-art testing methods for several types of chemicals in biological specimens. They have also developed standard operating procedures and quality assurance measures for chemicals analyzed as part of biomonitoring studies. Supplemental funding through the CDC Cooperative Agreement has allowed substantial augmentation in both laboratory capacity (i.e., the number of samples that can be analyzed in a given time) and capability (i.e., the types of chemicals that the laboratory can measure).

Public Participation Activities

Biomonitoring California staff has finalized a Public Involvement Plan (PIP) with goals and objectives that will guide the Program's efforts and activities. Staff also developed a brochure to provide basic information about the Program. Links to electronic versions of the PIP and brochure are available in the report.

A main portal for information about Biomonitoring California is the Program website, which provides public access to materials from past and upcoming SGP meetings and other Program activities. In addition, more than 750 stakeholders regularly receive Program email updates via the Biomonitoring California listserv.

Conclusions

In the years January 2010-December 2011, Biomonitoring California has made significant progress. Specifically, the program has:

(i) greatly increased laboratory capability to analyze environmental chemicals;
(ii) collaborated with several researcher partners;
(iii) made significant progress on two targeted biomonitoring studies as well as a survey representing the population in a large region of California;
(iv) detected elevated levels of mercury in the blood of a mother and infant in one of our studies which resulted in the two being referred to medical care providers; and
(v) expanded outreach and developed materials to communicate biomonitoring results to study participants.

Notwithstanding the significant growth and development supported by CDC funding, the biggest challenge facing Biomonitoring California continues to be identifying sufficient stable, long-term resources to implement the mandate of the enabling legislation for a statewide biomonitoring survey and to continue operation of its complex laboratory infrastructure and functions. Biomonitoring California staff will continue to leverage State resources to acquire external funding to support and expand community and regional biomonitoring studies. Community-based projects focusing on specific populations add value by highlighting exposures in groups at particularly high risk for possible harmful effects from environmental chemical exposure; such studies provide information on chemical exposures in vulnerable populations and can inform environmental justice policies. Regional surveys complement community studies by providing information about exposures in large portions of California's diverse population. Surveys that represent the entire state's population are also needed to evaluate the effectiveness of California's environmental regulatory programs and provide information about environmental chemicals that pose the greatest hazards.

Note – this report covers the period through 2011 – subsequent reports will update this information. For updates about Biomonitoring California, visit our website at: http://oehha.ca.gov/multimedia/biomon/index.html.

I. Introduction and Background

A. Introduction

Biomonitoring is the science of measuring chemicals in blood, urine, or other biological specimens. The California Environmental Contaminant Biomonitoring Program, also known as Biomonitoring California, offers important public health information that cannot be provided by traditional monitoring of air, water, soil or other environmental media. Biomonitoring California was established through legislation in 2006 by Senate Bill (SB) 1379 (Perata) and codified in Health & Safety Code (H&SC) Sections 105440 *et seq.* (see Appendix A).

Under SB 1379, Biomonitoring California is a collaborative effort involving the California Department of Public Health (CDPH), the Office of Environmental Health Hazard Assessment (OEHHA), and the Department of Toxic Substances Control (DTSC), with technical advice and peer review provided by a Scientific Guidance Panel (SGP), and substantial opportunities for input by the public.

Direct measurements of environmental chemicals in people, combined with information on chemical toxicity and likely exposure sources, can help scientists and policymakers answer such questions as:

- What chemicals are people exposed to and are these levels increasing or decreasing over time?
- Do some groups in California have higher exposures to specific toxic chemicals compared to others or to the state's population as a whole?
- Do regulatory efforts, including bans or phase-outs of chemicals, actually reduce exposures among Californians?
- Are certain chemicals contributing to the development of disease?

California residents experience some exposures to environmental chemicals that are different, either qualitatively or quantitatively, from the rest of the country. For instance, California residents have some of the world's highest exposures to long-lived flame retardant chemicals as a result of our state's unique furniture flammability requirements. Biomonitoring can help assess the extent of these and other exposures from all sources, including consumer products, diet, and occupation. It is expected that biomonitoring will play a key role in assessing the efficacy of a number of recent measures to reduce specific chemical exposures, and in helping to inform the state's efforts to identify and regulate chemicals of concern in consumer products.

Biomonitoring California's enabling legislation requires biennial reports to the Legislature. Specifically, H&SC Section 105459(a) states:

> "*By January 1, 2010, and every two years thereafter the department* [CDPH], *in collaboration with the* [California Environmental Protection] *Agency, the Office* [OEHHA] *and DTSC*, *shall submit a report to the Legislature containing the findings of the program, and shall include in the report additional activities and recommendations for improving the program based upon activities and findings to date. Copies of the report shall be made available via appropriate media to the public within 30 calendar days following its submission to the Legislature."*

This report is intended to inform the Legislature and the public of the current status of Biomonitoring California and includes information about its activities and findings during calendar years 2010 and 2011.

B. Background

California residents experience widespread exposures to a multitude of environmental chemicals, such as flame retardants, pesticides, mercury, and substances used in manufacturing plastics, many of which pose health concerns. Recognizing that Californians' health can be improved by reducing exposures to harmful chemicals, the Legislature and the Governor established Biomonitoring California, which is the first legislatively mandated, ongoing state biomonitoring program in the country.

The principal goals of Biomonitoring California are to monitor the levels of specific environmental chemicals in a representative statewide sample of Californians, conduct studies of targeted subpopulations within the state and to help assess the effectiveness of existing public health programs in reducing these chemical exposures. When fully implemented, Biomonitoring California will:

1. Produce information on the levels of environmental chemicals in Californians and whether these levels differ among sub-populations or over time.
2. Offer insights into possible exposure sources that may contribute to the levels of environmental chemicals found in California residents.
3. Assist policymakers in determining the effectiveness of California's environmental regulatory programs and in taking future actions to reduce the exposure of Californians to harmful chemicals.
4. Produce data that researchers will be able to use to help study relationships between levels of chemicals in Californians and health effects.
5. Facilitate the identification of emerging environmental health issues.

Resources available to the Program are insufficient to undertake statewide surveys for the foreseeable future. As described in the following sections, Biomonitoring California is undertaking a number of smaller-scale projects that in themselves will provide valuable information and will also establish a strong foundation for statewide surveys in the future.

II. Program Structure and Resources

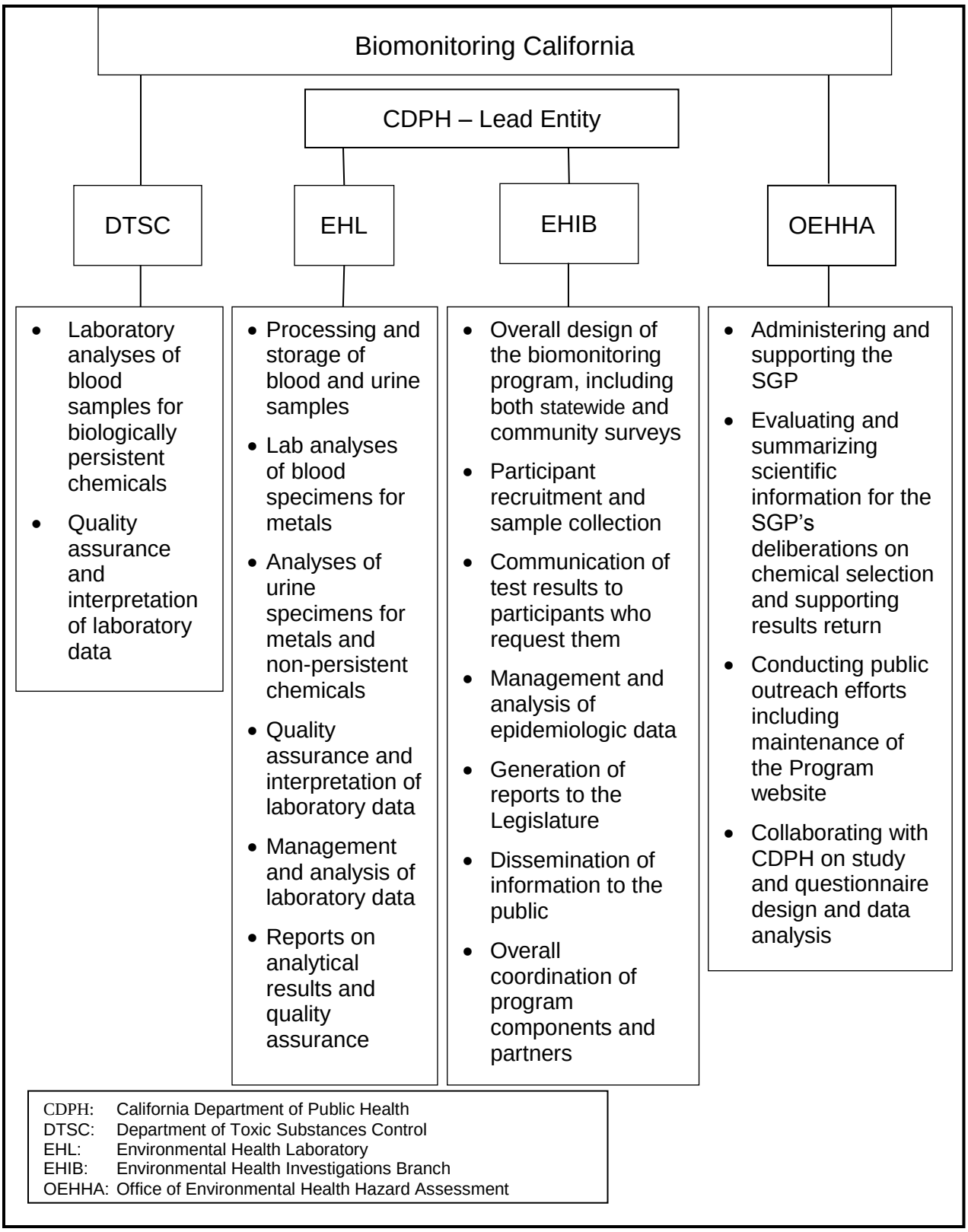
A. Program Structure

SB 1379 requires that Biomonitoring California be developed and implemented collaboratively by CDPH, OEHHA, and DTSC. Staff members from the three departments constitute the Biomonitoring Interagency Group (BIG), which meets twice per month to coordinate activities.

General roles and staff responsibilities for Biomonitoring California are listed in Figure 1. Staff members in all three departments collaborate on multiple activities, including program design, SGP meetings, and data analysis. For instance, OEHHA and DTSC staff members contribute to the program design for which CDPH is the lead. Similarly, OEHHA convenes the SGP and provides scientific support, while representatives from DTSC and CDPH provide scientific and other programmatic input to meeting content, as well as make presentations to and respond to questions from the Panel. The three departments share responsibility for analyzing data collected by Biomonitoring California, focusing on different scientific issues so that analyses are not duplicative. OEHHA hosts the Biomonitoring California web site (http://oehha.ca.gov/multimedia/biomon/index.html).

The design and implementation of the various elements of Biomonitoring California are iteratively reviewed and evaluated by staff, the SGP, and the public. More details about the work to address program mandates are provided in subsequent sections of this report.

Figure 1. Biomonitoring California Departmental Roles and Lead Responsibilities



B. Program Resources

The three departments initially developed a five-year plan to implement the mandates of SB 1379, focusing on the statewide biomonitoring program (per H&SC Section 105441). This plan entailed collecting data and biological specimens every two years from a representative statewide sampling of Californians. The costs were estimated at $9-10 million per year. However, the legislation stated that program implementation would be contingent upon appropriations provided through the annual Budget Act or other measure, but did not include any dedicated funding or identify a funding source (H&SC Section 105453).

The 2007 Budget Act appropriated $5.2 million for Biomonitoring California's initial planning and program implementation, including $3.3 million in one-time equipment purchases and contracted services. In FY 2008-09, due to the state's fiscal crisis, the Legislature transferred Biomonitoring California's funding source from the General Fund to the Toxic Substances Control Account (TSCA). Program baseline funding was set at approximately $1.9 million.

The Biomonitoring California budget is currently augmented by a cooperative agreement with the U.S. Centers for Disease Control and Prevention (CDC). The Cooperative Agreement's award period spans 2009-2014, with funding contingent upon available federal resources and programmatic progress toward objectives. Activities funded by the CDC Cooperative Agreement are described in Section IV.

Biomonitoring California's baseline TSCA funding supports 13 core staff. CDC Cooperative Agreement funding supported eight staff in FY 2009-10 and 13 staff in FY 2010-11. Tables 1 and 2 below present the allocation of funding and staff among the three departments.

Table 1. Biomonitoring California's Budgets for FY 2009-2011

	CDPH	OEHHA	DTSC	**Total**
FY 2009-10				
TSCA[1]	$938,000	$498,000	$371,000	$1,807,000
CDC[2]	$2,652,487	$0	$0	$2,652,487
Total	**$3,590,487**	**$498,000**	**$371,000**	**$4,459,487**
FY 2010-11				
TSCA	$1,066,000	$596,000	$371,000	$2,033,000
CDC	$1,701,718	$0	$950,769	$2,652,487
Total	**$2,767,718**	**$596,000**	**$1,321,769**	**$4,685,487**

[1] TSCA – Toxic Substances Control Account
[2] 5-year Cooperative Agreement with U.S. Centers for Disease Control and Prevention

Table 2. Biomonitoring California Staffing for FY 2009-2011

	CDPH	OEHHA	DTSC	**Total**
FY 2009-10				
TSCA[1]	8	3	2	13
CDC[2]	8	0	0	8
Total	**16**	**3**	**2**	**21**
FY 2010-11				
TSCA	8	3	2	13
CDC	10	0	3	13
Total	**18**	**3**	**5**	**26**

[1] TSCA – Toxic Substances Control Account
[2] 5-year Cooperative Agreement with U.S. Centers for Disease Control and Prevention

While a 2008 budget trailer bill authorized use of TSCA funds for Biomonitoring California, it did not authorize new fees or an increase in existing fees to cover the Program's costs. Given the current gap between TSCA's annual revenues and expenditures, TSCA cannot indefinitely cover both the current Biomonitoring California allocation and other DTSC program activities intended to be supported by this source of funds. CDPH, OEHHA, and DTSC are attempting to identify stable, long-term funding mechanisms that will both sustain current Biomonitoring California functions and allow the Program to grow and fulfill its legislative mandates.

III. Scientific Guidance Panel and Chemical Selection

A. Scientific Guidance Panel Meetings

As mandated in SB 1379 (H&SC Sections 105448 and 105449), scientific peer review of Biomonitoring California is provided by a nine-member SGP appointed by the Governor and the Legislature. The SGP plays an indispensable role in recommending chemicals to be

included in the biomonitoring program; identifying a sub-set of chemicals that are a priority for biomonitoring in California; providing guidance on the design and implementation of the Program; and reviewing the results and conclusions of biomonitoring studies. Appendix B provides short biographies of current Panel members.

SB 1379 requires the SGP to meet at least three times per year. OEHHA is responsible for convening and staffing the Panel and providing scientific materials to support the SGP's deliberations. The SGP has met thirteen times since the inception of Biomonitoring California:

- December 17, 2007
- June 10, October 24, and December 4 - 5, 2008
- March 2 - 3, July 28 - 29, and October 6, 2009
- February 9, May 24, and November 2, 2010
- March 16, July 14, and November 10, 2011

Meetings have taken place either in Oakland or Sacramento. Meeting agendas, presentations, background materials, transcripts, and recordings (when available) are posted on the Biomonitoring California website (http://www.oehha.ca.gov/multimedia/biomon/agendas.html). Summaries of SGP recommendations from several recent meetings are available on the Biomonitoring California website and in Appendix C.

The SGP adds to the list of "designated chemicals" (H&SC Section 105449(c)) and, from this list, makes recommendations for "priority chemicals" for biomonitoring in California (H&SC Section 105449(a) and (b)) (see explanation of this process below). The SGP also provides feedback on the overall implementation of the program, including the development of laboratory capacity and the design of Biomonitoring California pilot projects. In addition to these ongoing discussion items, a range of special topics has been covered at SGP meetings in 2010 and 2011. At the May and November 2010 meetings, the Panel discussed and commented on the Program's draft Public Involvement Plan. The SGP gave the Program valuable input on understanding and interpreting biomonitoring results as part of the regular November 2010 meeting and at a special workshop held on March 17, 2011. At the March 2011 meeting, the Panel reviewed the Program's template for returning participant test results, which was developed and tested as part of the Maternal and Infant Environmental Exposure Project, described in Section IV below. At the same meeting, the Panel also provided input to Program staff that was designed to aid program planning. The SGP's guidance provides a robust scientific underpinning for Biomonitoring California.

The SGP meetings have also provided an important forum for stakeholders and the public to express their views on choosing chemicals to analyze and on other aspects of the structure and implementation of the Program. In 2011, a new open public comment period was added to the SGP agenda to allow stakeholders to comment on any biomonitoring-related issues.

B. Chemical Selection

Chemicals tested in Biomonitoring California studies come from the Program's list of "designated chemicals". "Designated chemicals" are defined in the legislation as those included in the CDC's national biomonitoring program, plus additional chemicals recommended by the SGP and adopted by the Program (H&SC Sections 105440(b)(6) and 105449(c)). SB 1379 lays out specific criteria for the SGP to follow in adding chemicals to the designated chemical list, including known or potential exposure to the public, known or suspected health effects, and the need to assess the efficacy of public health actions to reduce exposure to a chemical.

The statute also calls for the SGP to identify "priority chemicals" for biomonitoring in California from the designated chemical list. The SGP recommends priority chemicals based on the degree of potential exposure, the likelihood of health effects, the technical limitations of laboratory detection, or any other criteria the panel may agree to.

Since the Program's inception, the SGP has recommended adding five classes of chemicals, one chemical mixture, and six specific chemicals to the list of designated chemicals. A set of priority chemicals, drawn from the list of designated chemicals, has also been recommended by the SGP. Appendix D provides the Biomonitoring California lists of designated and priority chemicals as of February 2011; these lists incorporate all of the Panel's recommendations to that date. The Panel may recommend adding other chemicals to either the designated or priority chemical list in the future.

The list of priority chemicals includes:

- Lead, cadmium, mercury, and arsenic, which are metals used in many industries and found in a variety of products. Lead was also formerly used in house paint and gasoline, leading to widespread environmental contamination. Mercury exposure comes mainly from eating certain types of fish. These four metals can cause many adverse health effects, including cancer and toxicity to the developing infant or child.

- Diesel exhaust, which causes lung cancer and contributes to a range of other health problems, such as asthma and cardiovascular disease.

- Certain pesticides, including organophosphates such as chlorpyrifos, malathion, and naled; pyrethroids, such as cyfluthrin, permethrin, and resmethrin; and DDT, a banned pesticide that is persistent in the environment, Pesticides have been linked to a range of adverse health effects, such as cancer, developmental toxicity, and damage to the immune system.

- Brominated and chlorinated compounds used as flame retardants, which include polybrominated diphenyl ethers (PBDEs) and chlorinated tris. California's stringent furniture flammability regulations have resulted in substantially greater use of chemical flame retardants in products sold in California than in many other states and countries. Many flame retardants accumulate in humans and in the

environment. The world's highest levels of certain flame retardants have been measured in the bodies of Californians. Certain flame retardants are associated with impaired neurological development and learning in young children, decreased fertility in women, endocrine disruption and cancer. Some flame retardants, such as chlorinated tris and deca-BDE, are suspected of causing cancer.

- Environmental phenols, including bisphenol A (BPA), triclosan and parabens. BPA is used in certain plastics and to line some food and beverage cans. Triclosan is widely used in antibacterial soaps. Parabens are used as preservatives in a wide variety of products, including cosmetics, personal care products and pharmaceuticals. These chemicals are suspected of harming health by disrupting hormone systems.

- Perchlorate, a component of rocket fuel that has contaminated drinking water and food throughout the U.S. Perchlorate interferes with the proper functioning of the thyroid gland, which could affect neurological development in young children.

- Phthalates, a group of chemicals used primarily in flexible plastic products. A number of phthalates have been identified as developmental and/or reproductive toxicants. The male reproductive system is especially sensitive to phthalate exposure during development.

- Perfluorinated compounds (PFCs), used in a variety of consumer products, such as non-stick cookware, stain-repellent carpets and clothing, and grease-repellent food containers. Two PFCs, perfluorooctanoic acid (PFOA) and perfluoroctanoic sulfonate (PFOS), have been widely detected in Americans. Based on studies of PFOA and PFOS, there is concern that PFCs may harm the fetus and developing child by impairing growth, brain development, learning, and behavior; decrease fertility and affect hormone balance; and contribute to cancer.

- Cyclosiloxanes are used in applications such as dry cleaning and personal care products and are persistent in the environment. There is a concern that certain cyclosiloxanes may contribute to cancer and affect the reproductive system and other organ systems in the body.

- Three polycyclic aromatic hydrocarbons (PAHs), a chemical class of ubiquitous air pollutants that have been shown to cause cancer.

- Polychlorinated biphenyls (PCBs), a class of chemicals formerly used as coolants and insulating fluids. PCBs persist for many years in the environment and accumulate in people. Exposure today mainly results from eating high-fat foods, such as certain types of meat, fish, and dairy products. PCBs are known to cause cancer, harm the developing child, and disrupt hormone balance.

The Program makes the final decisions on which chemicals to include in a biomonitoring project, taking into account the SGP's recommendations for priority chemicals, laboratory capability and capacity, Program resources and other factors.

IV. Biomonitoring California Study and Sample Design

A. Community Studies

The enabling legislation directs the Program to conduct community-based biomonitoring studies "… contingent on funding" (H&SC section 105441). To undertake such studies, Biomonitoring California has pursued external funding and collaborations with other researchers, including analyzing biological samples routinely collected by other public health programs statewide or in large areas of California. These collaborations are described in more detail below.

1. Archived biospecimens from researchers

In September 2008, Biomonitoring California disseminated a request to researchers throughout the United States to identify those in possession of stored blood or urine specimens collected within the preceding five years from California residents. Biomonitoring California staff has pursued two options for obtaining biospecimens:

- The Program finalized agreements with researchers at three academic institutions, Columbia University, the University of California (UC) Davis, and UC Berkeley, to analyze archived samples for a limited number of chemicals. More information about these investigations and the chemicals analyzed is presented in Section V, subsection E.

- Biomonitoring California has initiated discussions with the Kaiser Permanente Research Program on Genes, Environment and Health (RPGEH) regarding the logistics, costs, and benefits of analyzing archived blood and urine specimens collected.

Biomonitoring California staff will continue to assess the feasibility of analyzing archived biospecimens collected by other programs, considering such factors as how the specimens have been stored, costs to obtain and analyze the specimens, and appropriate sampling strategies to track chemical trends in California's population.

2. Maternal and Infant Environmental Exposure Project(partially supported by the CDC Cooperative Agreement)

Mothers and infants were identified by the SGP as susceptible populations of particular interest for biomonitoring. In collaboration with the UC San Francisco (UCSF) Program on Reproductive Health and the Environment (PRHE) and the UC Berkeley School of Public Health (SPH), Program staff designed the Maternal and Infant Environmental Exposure Project (MIEEP).

The goals of this project are to:

- Measure selected priority chemicals in the urine and blood of pregnant women and umbilical cord blood of their newborns (cord blood measurements represent fetal exposures);
- Test analytical procedures and program coordination for the selected chemicals;
- Identify potential sources of exposure for a subset of these chemicals;
- Develop and test an approach to convey information and guidance regarding biomonitoring results to study participants (see Results Communication below); and
- Evaluate whether an association exists between exposure to these selected chemicals and either pregnancy or birth outcomes.

The pilot is supported by the CDC Cooperative Agreement and the California Wellness Foundation (TCWF). CDC funding supports: (i) development and testing of two exposure questionnaires (one administered by an interviewer to gather demographic, occupational, diet and other information and one completed by the woman at home to identify products used in her residence), (ii) recruiting and enrolling participants, (iii) collecting urine from pregnant women during their last trimester of pregnancy, (iv) obtaining maternal and umbilical cord blood at the time of delivery, (v) shipping specimens to the Biomonitoring California laboratories, and (vi) analyzing the urine and blood samples for priority chemicals. UCSF PRHE and UC Berkeley obtained additional resources from TCWF to support questionnaire administration, additional data analysis, and development of a best practices results communication framework. The framework will help staff communicate the results of chemical analyses to participants, even when the health implications of those results may be uncertain or unknown.

MIEEP protocols, forms, and questionnaires were reviewed and approved by both the UCSF Committee on Human Research and the California Committee for the Protection of Human Subjects (CPHS). Recruitment of participants began in July 2010 and was completed in June 2011; 92 mothers and newborns were enrolled. Collection of data and biological samples was completed by July 2011. Laboratory testing of samples and data analysis began in 2011 and will be completed in 2012. A key early finding in this study was the detection of elevated blood mercury in one mother-infant pair. The source of mercury exposure was identified as an adulterated face cream from Mexico, and a Health Alert about these types of creams from Mexico was distributed to health care practitioners and clinics. This case is an excellent illustration of the public health benefits of biomonitoring.

3. Firefighter Occupational Exposures Project (partially supported by the CDC Cooperative Agreement)

The SGP also recommended that the Program consider biomonitoring a chemically exposed occupational group. Firefighters are exposed to toxic chemicals in their work environment more frequently and in higher concentrations than the general population. The Firefighter Occupational Exposures (FOX) Project is being conducted in partnership with the UC Irvine Center for Occupational and Environmental Health and the Orange County Fire

Authority. This project is expected to provide information on exposures to environmental chemicals among California firefighters. In addition, the protocols and procedures developed in this pilot study of 101 firefighters will serve as a basis for later and larger occupational biomonitoring efforts.

CDC funds support the design of the FOX Project; field testing project protocols and documents, including an exposure questionnaire; collecting, processing, and shipping blood and urine samples; measuring of chemicals in blood and urine at Biomonitoring California laboratories; and testing and refining methods for returning biomonitoring results to participants in an understandable and meaningful way.

The FOX protocols, forms and questionnaires were reviewed and approved by both the UC Irvine Institutional Review Board and the CPHS. The FOX Project began recruiting participants in fall 2010 and completed data and biosample collection in early 2011. During 2011 and 2012, Biomonitoring California laboratories will be analyzing firefighters' blood and urine samples for heavy metals, brominated flame retardants, perfluorinated chemicals, and selected substances formed during incomplete burning of wood and other materials. Participants completed a short questionnaire to help identify potential sources of exposure for some of the chemicals being biomonitored. In addition, at each fire station with a FOX participant, a firefighter conducted a brief standardized walkthrough evaluation and recorded possible exposure sources to some of the chemicals being measured for this project. To complement the latter effort, a separate funding source allowed staff to collect dust samples from several fire stations. The dust will be analyzed for some of the same chemicals being biomonitored in the firefighters.

B. Results Communication

A distinctive feature of the Program is the statutory requirement to return biomonitoring results to study participants who request them(H&SC Section 105443), even if the health implications of these results are scientifically uncertain. During 2010-11, Biomonitoring California continued to collaborate with the UC Berkeley SPH to develop and refine approaches for communicating biomonitoring results to study participants.

A draft "report-back template" for communicating results to project participants was developed. The template includes explanatory materials providing participants with visual representations as well as narrative descriptions of their results. Participants are also presented with background information about the chemicals tested, such as potential sources of exposure. The template can be customized for individual projects and communities, as needed. The draft template was developed to convey, simply and clearly, complex biomonitoring findings to participants. Usability testing was conducted to determine the extent to which project participants could find their results and understand the information in the template. This testing was completed during one-on-one meetings with individual participants. The template was refined through a series of usability tests with both English- and Spanish-speaking participants in MIEEP.

Staff and collaborators from the UC Berkeley SPH presented the development and refinement of the template at the March 2011 SGP meeting, and discussed with the Panel

some of the challenges that remain. Overall, Panel members expressed their support for the approach and provided positive feedback on the template. To further improve our report-back materials, Program staff conducted further testing of the template materials with participants in the FOX Project. This included evaluating how participants understood graphic representations of the results and various other elements of the report-back materials.

Biomonitoring California is also developing protocols to guide follow-up actions with participants who are identified as having high levels of biomonitored chemicals for which clinical health information is available (lead, cadmium and mercury). The protocol includes notifying participants with high levels of these substances by letter and providing relevant advice regarding additional follow-up, if warranted. Appropriate informational materials, such as a fact sheet on choosing low-mercury fish, are being developed and will be included in communications to participants where needed.

A challenge for Program staff is how to interpret biomonitoring results and convey their potential health implications to participants, particularly for chemicals whose toxicity in humans has not been well studied. In March 2011, Biomonitoring California held a public workshop on understanding and interpreting biomonitoring results, bringing together national experts, the Program's SGP and the public in a discussion of these issues.

The objectives of the workshop were to:

- Discuss approaches for understanding and interpreting biomonitoring results, including strengths and weaknesses;
- Discuss methods for developing comparison levels[1] in blood or urine;
- Discuss scientific challenges with interpreting biomonitoring results, including how to address multiple chemical exposures and sensitive sub-populations; and
- Provide guidance to Biomonitoring California on approaches for understanding and interpreting biomonitoring results.

The workshop agenda and a summary of key findings of the workshop are included as Appendix E. Additional information about the workshop, including the presentations, can be found at: http://www.oehha.ca.gov/multimedia/biomon/sgpwrkshp031711.html

C. Method to Approximate a Statewide Survey

Biomonitoring California's legislatively mandated goals include determining the levels of environmental chemicals in a representative statewide sample of Californians and monitoring those levels over time. However, implementing a statewide biomonitoring program has been

[1]A "comparison level" is a level of a chemical in blood or urine that can be used to provide context for biomonitoring results or evaluate possible concerns. For example, levels in blood or urine measured in the US national biomonitoring program are useful for providing context. As a second example, CDC has set levels of concern for lead in blood of adults and children, which California uses to evaluate blood lead levels for possible medical follow up.

limited by California's budget crisis. In order to approximate statewide and regionally representative samples, Program staff is leveraging existing resources by exploring the feasibility of analyzing chemicals in blood specimens previously collected by another state program, and collaborating with Kaiser Permanente Northern California, a large Health Maintenance Organization with a statewide presence.

1. Biomonitoring Exposures Study (BEST) (partially supported by the CDC Cooperative Agreement)

Biomonitoring California is collaborating with Kaiser Permanente Northern California's (KPNC) Research Program on Genes, Environment, & Health (RPGEH) to conduct the pilot project known as BEST. KPNC membership in California's Central Valley is similar to the entire population of northern California in characteristics such as educational attainment and race/ethnicity. BEST will recruit KPNC members who reside in areas of Sacramento, Stockton, Yolo, Modesto, Merced, Madera and Fresno counties. This collaboration is the first time that Biomonitoring California will be recruiting and enrolling participants through a random sampling design that will approximate a representative sample of California's Central Valley.

The goals of this pilot project are to:

- Recruit adult KPNC members in California's Central Valley;
- Obtain questionnaire data as well as biological samples;
- Analyze the blood and urine samples for concentrations of selected priority chemicals; and
- Continue to refine approach to communicating chemical test results to participants, as well as the implications of those results.

BEST will enroll approximately 100 English-speaking adults categorized by age (18-55 and greater than 55 years of age), gender, race/ethnicity (Non-Hispanic whites, African-American, Asian/Pacific Islander, and Hispanic), and residence location (urban/suburban or rural). KPNC members in these categories will be randomly selected and then invited to participate in BEST. Blood and urine samples will be collected from participants, who will fill out a questionnaire to help evaluate possible exposure sources for some of the chemicals being biomonitored. The protocols, forms and questionnaires for this project have been approved by the KPNC Institutional Review Board and the CPHS.

V. Biomonitoring California Laboratory Status

A. Laboratory Organization

CDPH's Environmental Health Laboratory (EHL) in Richmond and DTSC's Environmental Chemistry Laboratory (ECL) in Berkeley conduct the analyses of designated and priority chemicals measured by Biomonitoring California.

EHL has primary responsibility for the development of methodologies for analyzing metals in blood and non-persistent chemicals in blood and urine (Table 2). In addition, EHL has responsibility for developing analytical methods for measuring priority chemicals in DBS and ultra-low volume blood specimens.

ECL serves as California's reference laboratory for analysis of toxic chemicals in the environment, biota and consumer products. Within Biomonitoring California, ECL has primary responsibility for developing analytical methods for persistent chemicals in serum (the liquid part of a blood sample that remains after the blood clots).

B. Instrumentation

Biomonitoring California relies on our laboratories' ability to precisely measure very low concentrations of chemicals in blood and urine. In order to identify emerging chemical exposures, the laboratories must be able to develop new testing methods, as well as insure that they can support the biomonitoring studies described previously. Biomonitoring data that may influence future chemical policy must be based on advanced analytical procedures conducted with state-of-the-art instruments.

With CDC Cooperative Agreement funding, EHL was able to purchase and install:

- A Gas Chromatography-Mass Spectrometer (GC/MS-MS) to develop a new method for testing organophosphate pesticide breakdown products;
- Two High Performance Liquid Chromatography-Mass Spectrometer (HPLC/MS-MS) instruments – one for developing a test for environmental phenols and one for developing a procedure to test for hydroxy-PAHs;
- An Inductively Coupled Plasma Mass Spectrometer (ICP-MS) to develop methods for testing metals in urine; and
- An Ion Chromatography-Mass Spectrometer (IC-MS/MS) for perchlorate analysis.

CDC Cooperative Agreement funds allowed ECL to acquire:

- A Liquid Chromatography-Mass Spectrometer (LC/MS-MS) to analyze polar persistent contaminants, such as several new flame retardants, environmental phenols and hydroxy-metabolites (breakdown products) of PCBs and PBDEs; and
- Additional auxiliary equipment to be used for sample preparation and extraction.

C. Quality Assurance

The Biomonitoring California Laboratory Quality System incorporates all aspects of quality assurance and quality control for EHL and ECL. Staff funded by the CDC Cooperative Agreement is responsible for tracking laboratory and analyst certifications, overseeing blind audit samples, establishing control limits for audit samples, meeting compliance requirements for recertification, developing protocols and procedures for specimen management to meet the specific needs of the field studies being conducted with Biomonitoring California collaborators, and coordinating participation in laboratory proficiency testing programs.

D. Laboratory Information Management System (LIMS)

Biomonitoring California laboratories will fully operate within a computerized Laboratory Information Management System (LIMS). This system also links sample collection information with analytical results. Recent improvements to the LIMS include adding modules to track samples (e.g., storage locations and test analysis status), developing laboratory reports, and delivering chemical test results securely to other Program staff for data analysis.

E. Current Chemical Testing Methods

The environmental chemical analyses that Program laboratories have developed or revised and validated and that are currently in use are listed in Table 3.

Table 3. Current Chemical Testing Methods Used in Biomonitoring California Laboratories

Chemicals	Specimen	Laboratory*	Date Developed
Lead, Cadmium, Manganese and Total Mercury	Whole Blood	EHL	December 2009
Lead, Cadmium, Manganese and Total Mercury	Urine	EHL	In development
Creatinine	Urine	EHL	March 2010
Chlorpyrifos and Pyrethroid metabolites [Chlorpyrifos metabolite is 3,5,6-trichloro-2-pyridinol (TCPy)] [Pyrethroid metabolite is 3-phenoxy benzoic acid (3-PBA)]	Urine	EHL	February 2010
Phthalate metabolites [monoethyl phthalate (MeP), monobutyl phthalate (MbP),monopentyl phthalate(MPP)]	Urine	EHL	May 2010
Polycyclic Aromatic Hydrocarbon (PAH) metabolite [3-hydroxy-phenanthrene (3-Phen)]	Urine	EHL	June 2010
12 Perfluorinated Compounds (PFCs)	Serum	ECL	June 2010
Major Polychlorinated Biphenyls (PCBs)^	Serum	ECL	March 2011
Major Organochlorine Pesticides (OCPs)^	Serum	ECL	March 2011
Polybrominated Diphenyl Ethers (PBDEs)^	Serum	ECL	March 2011

* EHL = Environmental Health Laboratory (CDPH)
ECL = Environmental Chemistry Laboratory (DTSC)
^ = new laboratory method using High Resolution-Gas Chromatography Tandem Mass Spectrometry (HRGC-MS/MS)

F. CDC Site Visit

The Project Officer for the CDC Cooperative Agreement visited the Biomonitoring California Program in Richmond and Berkeley in March 2011. This site visit allowed staff to provide more detailed information on Program accomplishments, including collaborations with scientists and community groups, progress made toward laboratory methods development, and expansion of laboratory capacity and capability. Staff is now implementing changes to improve the program based on specific suggestions the Project Officer made following her visit.

G. Analyses of Archived Biospecimens

In 2010 and 2011, EHL analyzed the following chemicals in archived biospecimens:

- 3,5,6-trichloro-2-pyridinol (TCPy), a breakdown product of chlorpyrifos, an organophosphate pesticide widely used in California was collected for a California Environmental Health Tracking Program (CEHTP) project in Tulare County. CEHTP is a program within the CDPH funded by the CDC as part of a national network of state environmental health tracking programs. These programs work to integrate environmental and health data, producing information that is accessible to the public to drive improvements in the health of communities.
- TCPy and breakdown products of phthalates collected by the UC Davis Childhood Autism Risks from Genetics and the Environment (CHARGE) study. CHARGE is a study of 1,100 children and their families in 22 California counties. UC researchers will examine whether selected environmental factors are associated with child development, specifically with regard to autism and developmental delay.
- Breakdown products of phthalates collected by the UC Berkeley Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS). CHAMACOS is a study examining environmental exposures and the health of low-income children in the Salinas Valley. EHL also conducted quality control studies to ensure that samples were not contaminated during collection or processing.
- Metals (lead, cadmium and mercury) in blood were analyzed for 500 participants in CYGNET (Cohort study of Young Girls' Nutrition, Environment, and Transitions), a collaboration with KNPC staff and other researchers looking at early environmental exposures and pubertal maturation in girls.

VI. Public Participation Activities

H&SC Section 105451 directs Biomonitoring California to “provide opportunities for public participation and community capacity building” to allow for “meaningful stakeholder input” and to “develop a strategy and plan … to establish the framework for integrating public participation in this program.”

In accordance with the directive of H&SC Section 105451 “to establish the framework for integrating public participation”, a draft of the Public Involvement Plan was posted on the Program website in September 2010 for public review. The Plan was presented to the SGP in November 2010. Biomonitoring California solicited public comment on the draft Plan via multiple avenues, including two teleconferences and an on-line survey. The Plan includes goals and objectives to guide Biomonitoring California’s efforts, as well as specific activities to be carried out as resources allow. More than 200 comments on the Plan were received by the January 25, 2011 deadline. The comments were reviewed in detail and used to refine and improve the Plan. The finalized Plan, available online at http://www.oehha.ca.gov/multimedia/biomon/biomonpublic.html, provides an overview of the broad range of public involvement efforts being carried out by Biomonitoring California.

As outlined in the Public Involvement Plan, Program staff has begun planning ways to expand stakeholder involvement in Biomonitoring California and to explore building collaborative partnerships to enhance Program activities. Staff developed a brochure titled "What is Biomonitoring? Measuring Chemicals in Our Bodies" that describes basic information about the Program. The brochure is available in both English and Spanish as part of this document (see Appendix F) and on the Program website (English version: http://www.oehha.ca.gov/multimedia/biomon/pdf/2011BiomonBrochure_English.pdf , Spanish version: http://www.oehha.ca.gov/multimedia/biomon/pdf/2011BiomonBrochure_Spanish.pdf).

As an initial step, Biomonitoring California conducted an online needs-assessment survey to determine stakeholder preference for different ways of participating in Program meetings. Survey results indicated a regional clustering of current stakeholders in Northern California and a preference for meetings via teleconference and webinars rather than in-person venues.

Biomonitoring California maintains and updates a Program-specific website (http://www.biomonitoring.ca.gov) and listserv (electronic mailing list). The website provides general information about the Program and gives the public access to materials from past and upcoming public workshops, SGP meetings, and other opportunities to participate. Individuals interested in staying informed about the Program are invited to join the listserv via a link on the website. The listserv included approximately 760 active subscribers as of August 2011. The Program sends notes to listserv subscribers about upcoming events, new materials posted on the website, and other activities of potential interest. The public can communicate with the Program through our email address, biomonitoring@oehha.ca.gov.

Efforts are underway to make the website more user-friendly and accessible. In 2010, UC Berkeley SPH Health Research for Action (HRA) conducted a structured analysis of the Biomonitoring California website to improve its usability. HRA also carried out a discovery process with internal stakeholders regarding the needs of the Program and specific requirements affecting design of this site. Program staff has worked with HRA to develop a detailed design plan for revising the website. The website revision will improve navigation, ease of use, accessibility, and relevance of the site for a general audience.

To allow for remote access to SGP meetings and Biomonitoring California workshops during 2010-11, Program staff used a range of technologies, including video- and audio-webcasting, videotaping, and use of a webinar format. Individuals participating remotely can comment on the agenda items via email. The Program provided webinar access to the SGP meeting and workshop held in March 2011. A workshop on manganese held in June 2011 also used a webinar format. The March 2011 workshop on understanding and interpreting biomonitoring results was videotaped, to capture the presentations and discussions for viewing by those unable to attend the workshop and others who may have an interest in the material in the future.

VII. Conclusions and Recommendations

During the last two years (January 2010-December 2011), Biomonitoring California has made considerable progress. Specifically, the program has:

(i) significantly increased laboratory capability to analyze priority environmental chemicals;
(ii) collaborated with University of California partners on analyses of archived biospecimens;
(iii) initiated community-based as well as regional biomonitoring surveys;
(iv) detected elevated levels of mercury in the blood of a mother and infant in one of our studies;
(v) convened six SGP meetings;
(vi) added manganese, pendimethalin and triclocarban to the designated list and four parabens and certain PCBs to the priority list, based on the SGP's recommendations; and
(vii) provided enhanced opportunities for public involvement.

The Program has also substantially advanced its efforts to expand outreach and develop materials to communicate biomonitoring results clearly, especially to study participants. Individual biomonitoring results will be returned to study participants and summarized group data will be disseminated publicly beginning in 2012.

Many of the recent accomplishments were supported by resources available through the five-year CDC Cooperative Agreement.

Listed below are Program priorities for maintaining and improving Biomonitoring California. The SGP supports these recommendations (Appendix G).

A. Program Resources – Continue to:
- pursue external funding opportunities to supplement State support.
- pursue collaborations with other researchers that leverage existing resources.

B. Laboratory Analyses – Continue to:
- Conduct activities specified in the CDC Cooperative Agreement to allow Biomonitoring California to measure additional groups of chemicals and analyze samples from a greater number of individuals.
- collect biological samples and analyze biomonitoring data.
- pursue collaborations to develop laboratory methods to screen for a broad range of chemicals in Californians. This could provide a potentially important tool in the selection of chemicals for biomonitoring studies.

C. Public Participation – Continue to:

- identify and engage additional stakeholders and encourage their involvement in program development and implementation.
- maintain and expand Biomonitoring California's electronic resources, including: website improvements and internet broadcasting or audio-casting of SGP meetings whenever possible,
- increase numbers of listserv subscribers, and conduct more surveys of subscribers to identify Program-related needs and concerns.

D. Scientific Guidance Panel – Continue to:
- convene SGP meetings three times per year to provide Panel members with information and the opportunity to make recommendations to Biomonitoring California, as well as provide the public with additional occasions to comment on program activities.
- research and develop materials to support the SGP in selecting designated and priority chemicals to include in Biomonitoring California.

E. Results Communication – Continue to:
- refine results communication methods and materials for individual participants, health-care providers, and the general population.
- develop scientifically accurate information on potential health concerns of biomonitored chemicals and likely exposure sources, as well as guidance on how to reduce exposures to harmful chemicals.

Biomonitoring California staff will continue to leverage State resources by securing cooperative agreements and other external funding to support and expand community-based and regionally representative biomonitoring studies.

Studies that focus on particular populations add value by highlighting exposures in groups at particularly high risk to possible harmful effects from exposure to environmental chemicals. Surveys that represent large areas of the state provide important information about exposures in California's diverse population. Finally, surveys that represent the entire state's population are also needed to provide the basis for evaluating the effectiveness of California's environmental regulatory programs and to help provide information about environmental chemicals that pose the greatest hazards.

APPENDICES

A. Health and Safety Code (Division 8, Part 5, Chapter 8, Section 105440, et seq. (SB1379))

B. List of SGP members and short biographies

C. Summaries of recommendations made by panel members at recent SGP meetings

D. Biomonitoring California's lists of designated and priority chemicals for biomonitoring

E. Agenda and Summary of Findings from March 2011 Biomonitoring California Workshop on Understanding and Interpreting Biomonitoring Results

F. Biomonitoring brochure (English and Spanish versions)

G. Letter from the Scientific Guidance Panel Chair supporting Biomonitoring California priorities.

H. List of acronyms used in this report

IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM: 2010-2012

Appendix A

California Health and Safety Code establishing Biomonitoring California

California Department of Public Health
in collaboration with
California Environmental Protection Agency's
Office of Environmental Health Hazard Assessment and
Department of Toxic Substances Control

January 2013

Edmund G. Brown, Jr.
Governor
State of California

Diana Dooley
Secretary
California Health and Human Services Agency

Ron Chapman, MD, MPH
Director & State Health Officer
California Department of Public Health

Senate Bill No. 1379

CHAPTER 599

An act to add Chapter 8 (commencing with Section 105440) to Part 5 of Division 103 of the Health and Safety Code, relating to public health.

[Approved by Governor September 29, 2006. Filed with Secretary of State September 29, 2006.]

LEGISLATIVE COUNSEL'S DIGEST

SB 1379, Perata. Biomonitoring.

Existing law establishes various programs for the protection of the public from exposure to toxins, including, but not limited to, the Childhood Lead Poisoning Prevention Act, administered by the State Department of Health Services, which imposes a fee upon manufacturers or persons who are responsible for lead contamination and applies the proceeds of the fee to reduction or elimination of the harm caused by the lead contamination.

This bill would require the department in collaboration with the California Environmental Protection Agency to establish the California Environmental Contaminant Biomonitoring Program to monitor the presence and concentration of designated chemicals, as defined, in Californians.

This bill would require the department and the agency to establish a Scientific Guidance Panel to assist the department and the agency. The bill would require the department to provide public access to information, and to report to the Legislature and the public.

The people of the State of California do enact as follows:

SECTION 1. The Legislature finds and declares all of the following:

(a) An estimated 100,000 chemicals are registered for use today in the United States. Another 2,000 chemicals are added each year. Some toxicological screening data exists for only 7 to 10 percent of these chemicals. More than 90 percent of these chemicals have never been tested for their effects on human health. Large numbers of these chemicals are found in cosmetics, personal care products, pesticides, food dyes, cleaning products, fuels, and plastics. Because of their ubiquity in modern life, Californians are commonly exposed to multiple chemicals every day. Many of these chemicals persist in the environment, and accumulate and remain in body fat, and have been shown to be toxic.

(b) Biomonitoring studies have scientifically demonstrated that human exposure to a multitude of chemicals is widespread. The federal Centers for Disease Control and Prevention has documented the presence of 148 environmental chemicals in the blood and urine of Americans of all ages and races.

(c) Biomonitoring studies will provide data that will help California scientists, researchers, public health personnel, and community members explore linkages between chemical exposures and health.

(d) Biomonitoring data supports public health by establishing trends in chemical exposures, validating modeling and survey methods, supporting epidemiological studies, identifying highly exposed communities, addressing the data gaps between chemical exposures and specific health outcomes, informing health responses to unanticipated emergency exposures, assessing the effectiveness of current regulations, and helping to set priorities for reform.

(e) In September 2001, the Legislature passed Senate Bill 702 (Chapter 538, Statutes of 2001), making California the first state in the nation to begin planning a statewide environmental health tracking network for chronic diseases and environmental hazards and exposures. To help implement the program, the Senate Bill 702 Expert Working Group has recommended the establishment of a statewide biomonitoring program.

(f) In September 2003, the Legislature passed Assembly Bill 1360 (Chapter 664, Statutes of 2003), that requires the development and use in California of a comprehensive system of environmental measurements known as environmental indicators. The basis for the bill was the April 2002 report, "Environmental Protection Indicators for California," by the California Environmental Protection Agency and the Resources Agency. This report identifies biomonitoring as part of an overall system of, environmental indicators that California should develop to guide policy and budgetary decisions.

(g) The Legislature, therefore, finds and declares that the establishment of a statewide biomonitoring program will assist in the evaluation of the presence of toxic chemicals in a representative sample of Californians, establish trends in the levels of these chemicals in Californians' bodies over time, and assess effectiveness of public health efforts and regulatory programs to decrease exposures of Californians to specific chemical contaminants. A statewide and community-based biomonitoring program will expand biomedical, epidemiological, and behavioral public health research. California, an established leader in health promotion, health policy, and health care delivery and response, should encourage and fund this research, which will contribute to the health and well-being of millions of people.

SEC. 2. Chapter 8 (commencing with Section 105440) is added to Part 5 of Division 103 of the Health and Safety Code, to read:

Chapter 8. California Environmental Contaminant Biomonitoring Program

Article 1. General

105440. (a) This chapter shall be known, and may be cited, as the California Environmental Contaminant Biomonitoring Program.

(b) For the purposes of this chapter, the following terms have the following meanings:

(1) "Agency" means the California Environmental Protection Agency.

(2) "Biomonitoring" means the process by which chemicals and their metabolites are identified and measured within different biological specimens.

(3) "Biological specimen" means a sample taken from a biophysical substance, that is reasonably available within a human body, for use as a medium to measure the presence and concentration of toxic chemicals.

(4) "Community" means geographically or nongeographically based populations that may participate in the community-based biomonitoring program. A "nongeographical community" includes, but is not limited to, populations that may share a common chemical exposure through similar occupations, populations experiencing a common health outcome that may be linked to chemical exposures, or populations that may experience similar chemical exposures because of comparable consumption, lifestyle, product use, or subpopulations that share ethnicity, age, or gender.

(5) "Department" means the State Department of Health Services.

(6) "Designated chemicals" means those chemicals that are known to, or strongly suspected of, adversely impacting human health or development, based upon scientific, peer-reviewed animal,

human, or in vitro studies, and consist of only those substances including chemical families or metabolites that are included in the federal Centers for Disease Control and Prevention studies that are known collectively as the National
Reports on Human Exposure to Environmental Chemicals program and any substances as specified pursuant to subdivision (c) of Section 105449.

(7) "Director" means the Director of Health Services.

(8) "DTSC" means the Department of Toxic Substances Control within the agency.

(9) "Office" means the Office of Environmental Health Hazard Assessment within the agency.

(10) "Panel" means the Scientific Guidance Panel established pursuant to Article 2 (commencing with Section 105448).

(11) "Program" or "biomonitoring program" means the California Environmental Contaminant Biomonitoring Program, which shall be established and operated by the department, in collaboration with the agency, the office, and DTSC.

(12) "Secretary" means the Secretary of the California Environmental Protection Agency.

105441. The department, in collaboration with the agency, shall establish the California Environmental Contaminant Biomonitoring Program. The department is the lead entity for the program unless otherwise specified in this chapter. The program shall utilize biological specimens, as appropriate, to identify designated chemicals that are present in the bodies of Californians. Biomonitoring shall utilize scientifically based statewide surveys. Additional community-based surveys shall be contingent on funding and shall be statistically valid and scientifically based. Biomonitoring shall take place on a strictly voluntary and confidential basis. Results reported pursuant to this chapter shall not disclose individual confidential information of participants. Appropriate biological specimens shall be used to monitor and assess the presence and concentration of designated chemicals. Biological specimens shall be analyzed by laboratories operated by the department, DTSC, or their contractors.

105443. (a) All participants shall be evaluated for the presence of designated chemicals as a component of the biomonitoring process. Participants shall be provided with information and fact sheets about the program's activities and its findings. Individual participants may request and shall receive their complete results. Any results provided to participants shall be subject to the Institutional Review Board protocols and guidelines. When either physiological or chemical data obtained from a participant indicate a significant known health risk, program staff experienced in communicating biomonitoring results shall consult with the individual and recommend follow-up steps, as appropriate. Program administrators shall receive training in administering the program in an ethical, culturally sensitive, participatory, and community-based manner.

(b) Individuals selected to participate in the biomonitoring program shall reflect the age, economic, racial, and ethnic composition of the state. Other selection criteria may be applied, as appropriate, for studies of specific populations.

(c) Informational materials and outreach activities directed to program participants and communities shall, to the extent possible, be culturally appropriate and translated as needed. Educational materials shall be adapted to the biological specimens being used.

105444. (a) The program shall develop guidelines and model protocols that address the science and practice of biomonitoring to implement this chapter, including, but not limited to, study design, subject recruitment, and data collection and management, and that accomplish all of the following:

(1) Ensure confidentiality and informed consent.

(2) Communicate findings to participants, communities, and the general public.

(3) Emphasize all aspects of the program in a culturally sensitive manner.

(4) Serve as a guide for other biomonitoring programs supported by state funds.

(b) The program shall incorporate, as appropriate, the methods utilized by the federal Centers for Disease Control and Prevention for the studies known collectively as the National Report on Human Exposure to Environmental Chemicals.

(c) The program shall be implemented in collaboration with the California Environmental Health Tracking Program and the environmental indicators system maintained by the office pursuant to Section 71081 of the Public Resources Code.

(d) The department, office, and DTSC shall collaborate on the development of fact sheets and other informational and outreach materials for the biomonitoring program.

(e) The department, in collaboration with the office and DTSC, shall conduct statistical and epidemiological analyses of the biomonitoring results.

(f) Personal information as defined in Section 1798.3 of the Civil Code, shall not be shared without the written and informed consent of the individual to whom it pertains.

(g) No governmental agency or private person or entity shall discriminate against a person or community based upon the biomonitoring results.

Article 2. The Scientific Guidance Panel

105448. (a) In implementing the program, the department and the agency shall establish a Scientific Guidance Panel. The panel shall be composed of nine members, whose expertise shall encompass the disciplines of public health, epidemiology, biostatistics, environmental medicine, risk analysis, exposure assessment, developmental biology, laboratory sciences, bioethics, maternal and child health with a specialty in breastfeeding, and toxicology.

(b) The Governor shall appoint five members to the panel, the Senate Committee on Rules shall appoint two members, and the Speaker of the Assembly shall appoint two members. The appointments shall be made after soliciting recommendations of the Office of the President of the University of California.

(c) All members shall be appointed to the panel by September 1, 2007. Members shall be appointed for three-year terms, except that, with respect to the initial appointees each appointing power shall appoint one member for a one-year term and one member for a two-year term. Members may be reappointed for additional terms without limitation.

(d) The panel shall meet as often as it deems necessary, with consideration of available resources, but at a minimum, three times per year. The office shall be responsible for staffing and administration of the panel.

(e) The panel meetings shall be open to the public and be subject to the Bagley-Keene Open Meetings Act (Article 9 (commencing with Section 11120) of Part 1 of Division 3 of Title 2 of the Government Code).

(f) Members of the panel shall be reimbursed for travel and other necessary expenses incurred in the performance of their duties under this chapter, but shall not receive a salary or compensation.

105449. (a) The panel shall provide scientific peer review and make recommendations regarding the design and implementation of the program, including specific recommendations for chemicals that

are priorities for biomonitoring in California, as specified in subdivisions (b) and (c), with the program retaining final decision making authority.

(b) The panel shall recommend priority chemicals for inclusion in the program using the following criteria:

(1) The degree of potential exposure to the public or specific subgroups, including, but not limited to, occupational.

(2) The likelihood of a chemical being a carcinogen or toxicant based on peer-reviewed health data, the chemical structure, or the toxicology of chemically related compounds.

(3) The limits of laboratory detection for the chemical, including the ability to detect the chemical at low enough levels that could be expected in the general population.

(4) Other criteria that the panel may agree to.

(c) The panel may recommend additional designated chemicals not included in the CDC report, for inclusion in the program using the following criteria:

(1) Exposure or potential exposure to the public or specific subgroups.

(2) The known or suspected health effects resulting from some level of exposure based on peer-reviewed scientific studies.

(3) The need to assess the efficacy of public health actions to reduce exposure to a chemical.

(4) The availability of a biomonitoring analytical method with adequate accuracy, precision, sensitivity, specificity, and speed.

(5) The availability of adequate biospecimen samples.

(6) The incremental analytical cost to perform the biomonitoring analysis for the chemical.

105451. (a) As appropriate, the program shall utilize the principles of the agency's Environmental Justice Strategy and Environmental Justice Action Plan developed pursuant to Sections 71110 to 71113, inclusive, of the Public Resources Code, so that the activities of the panel and the implementation of the program provide opportunities for public participation and community capacity building with meaningful stakeholder input. This strategy and plan shall accord the highest respect and value to every individual and community by developing and conducting public health and environmental protection programs, policies, and activities in a manner that promotes equity and affords fair treatment, accessibility, and protection for all Californians, regardless of race, age, culture, income, or geographic location.

(b) (1) To carry out this section, the program shall develop a strategy and plan that are to be followed in the implementation of the program. This strategy and plan shall be used to establish the framework for integrating public participation in this program. The department may utilize models used by boards, departments, and offices at the agency for community outreach pursuant to this section.

(2) Public participation shall include, but need not be limited to, conducting stakeholder meetings and workshops to solicit relevant information, data, suggestions, and feedback for the development and implementation of the program.

Article 3. Fiscal Provisions

105453. Implementation of this chapter shall be contingent on a specific appropriation being provided for this purpose in the annual Budget Act or other measure.

Article 4. Reporting

105459. (a) By January 1, 2010, and every two years thereafter, the department, in collaboration with the agency, the office, and DTSC, shall submit a report to the Legislature containing the findings of the program, and shall include in the report additional activities and recommendations for improving the program based upon activities and findings to date. Copies of the report shall be made available via appropriate media to the public within 30 calendar days following its submission to the Legislature.

(b) The department shall provide the public access to information which they are required to release pursuant to the California Public Records Act (Chapter 3.5 (commencing with Section 6250) of Division 7 of Title 1 of the Government Code).

(c) The department and the office shall disseminate biomonitoring findings to the general public via appropriate media, including governmental and other Web sites in a manner that is understandable to the average person.

(d) Any health and environmental exposure data made available to the general public shall be provided in a summary format to protect the confidentiality of program participants. The data shall be made available, after appropriate quality assurance and quality control, by July 1, 2010, and at least every two years thereafter.

IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM: 2010-2012

Appendix B

Scientific Guidance Panel Members

California Department of Public Health
in collaboration with
California Environmental Protection Agency's
Office of Environmental Health Hazard Assessment and
Department of Toxic Substances Control

January 2013

Edmund G. Brown, Jr.
Governor
State of California

Diana Dooley
Secretary
California Health and Human Services Agency

Ron Chapman, MD, MPH
Director & State Health Officer
California Department of Public Health

SCIENTIFIC GUIDANCE PANEL

The Scientific Guidance Panel, a panel of expert scientists from outside of state government, will play a major role in the California Biomonitoring Program.

Role of the Panel

The role of the Panel is to:

1. Make recommendations regarding the program's design and implementation. This includes making specific recommendations regarding chemicals that are priorities for biomonitoring in California.
2. Provide scientific peer review for the California Biomonitoring Program

Appointment of Panel members

The Panel has a total of nine members. Appointment to the Panel is by the Governor (5 members) and the California Legislature (Speaker of the Assembly, 2 members; Senate Committee on Rules, 2 members). The current Panel has only eight members due to a recent retirement. The Program is developing a list of candidates from which the Governor will select a new Panel member.

As required by SB 1379, persons appointed to the Scientific Guidance Panel must have expertise in one or more of the following areas: Public health, epidemiology, biostatistics, environmental medicine, risk analysis, exposure assessment, developmental biology, laboratory science, bioethics, maternal and child health (specialty in breastfeeding), and toxicology.

They will oversee and make recommendations on how the program is developed and carried out.

Panel meetings are open to the public.

Scientific Guidance Panel Members

Name	Affiliations	Appointed by
Asa Bradman, M.S., Ph.D.	Associate Director, Center for Children's Environmental Health Research, School of Public Health, UC Berkeley and Co-Principal Investigator, Center for Health Assessment of Mothers and Children of Salinas (CHAMACOS)	Governor Schwarzenegger

B. Dwight Culver, M.D.	Clinical Professor of Medicine (Epidemiology) UC Irvine	Governor Schwarzenegger
Marion Kavanaugh-Lynch, M.D., M.P.H.	Director, California Breast Cancer Research Program University of California, Office of the President	Speaker of the Assembly, Fabian Nuñez
Ulrike Luderer, M.D., Ph.D.	Associate Professor, Center for Occupational and Environmental Health, School of Medicine UC Irvine	Governor Schwarzenegger
Thomas McKone, Ph.D.	Adjunct Professor, School of Public Health, UC Berkeley and Senior Scientist, Environmental Technologies Division Lawrence Berkeley National Laboratory	Governor Schwarzenegger
Gina Solomon, M.D., M.P.H.	Associate Clinical Professor of Medicine, and Associate Director, Pediatric Environmental Health Specialty Unit, UC San Francisco and Senior Scientist, Natural Resources Defense Council	Senate Committee on Rules
Julia Quint, Ph.D.	Research Scientist Supervisor II and Chief (Retired), Hazard Evaluation System and Information Service (HESIS), Occupational Health Branch, California Department of Health Services (renamed California Department of Public Health).	Senate Committee on Rules
Michael P. Wilson, Ph.D., M.P.H	Assistant Research Scientist, Center for Environmental and Occupational Health, School of Public Health, UC Berkeley	Speaker of the Assembly, Fabian Nuñez

Scientific Guidance Panel Member Biographies

Asa Bradman, M.S., Ph.D.
Dr. Asa Bradman is an Environmental Health Scientist who focuses on environmental exposures to pregnant women and young children. In 1997, he helped create, and is now Associate Director of, the Center for Children's Environmental Health Research in the School

of Public Health at the University of California, Berkeley. In this capacity he helps direct multiple biomonitoring and exposure studies investigating the relationship of environmental exposures and health in children living in the Salinas Valley, California. Dr. Bradman is also Co-Principal Investigator of the National Children's Study in Kern County and leads an initiative to improve environmental quality in California child care centers. Between 1987 and 1997, Dr. Bradman participated in studies of lead exposure, iron deficiency, pesticide exposure, and childhood cancer with the California Department of Health Services. He has served on a number of advisory bodies, including the Science Advisory Council for the National Center for Healthy Homes (current), California Childcare Health Program Advisory Committee (current), and the Exposures to Chemical Agents Working Group for the National Children's Study.

B. Dwight Culver, M.D.
Dr. B. Dwight Culver has worked for the University of California, Irvine (UCI) School of Medicine since 1972 and currently holds the position of Clinical Professor in the epidemiology department. Culver previously held several positions with the University including co-director of the cancer surveillance program in the division of epidemiology in the department of medicine from 1988 to 2004; director of the residency training program in occupational medicine in the department of community and environmental medicine and the department of medicine from 1976 to 1991. Prior to joining UCI, he was president and chair of the Systemed Corporation from 1967 to 1972 and medical director of the Azusa facility of Aerojet General Corporation from 1958 to 1967. He also served as a physician for the California State Health Department from 1953 to 1956.

Marion H. E. Kavanaugh-Lynch, M.D., M.P.H.
Dr. Marion Kavanaugh-Lynch is the Director of the California Breast Cancer Research Program in the Office of the President at the University of California. Her work includes setting priorities and developing strategies for the state of California's research efforts designed to bring an end to breast cancer. She recently led a national panel that developed research strategies to explore the role of environmental contaminants in breast cancer and disparities in breast cancer. She is now overseeing implementation of the selected projects while planning a second phase, which will add breast cancer prevention. She is also involved in developing the science of community-based participatory research (CBPR) and is leading a grant from the National Institute of Environmental Health Sciences to develop new infrastructure for CBPR. She has served on peer review and advisory panels for the National Institutes of Health, the Centers for Disease Control and Prevention, and the California Department of Health Services, as well as for The Breast Cancer Fund, the Gay and Lesbian Medical Association, and the American Cancer Society.

Ulrike Luderer, M.D., Ph.D., M.P.H.
Dr. Ulrike Luderer is Associate Professor of Medicine in the Division of Occupational and Environmental Medicine in the Department of Medicine at the University of California at Irvine. She also holds secondary appointments in the Department of Developmental and Cell Biology and the Program in Public Health and is the Director of the Environmental Toxicology Graduate Program. Dr. Luderer's research focuses on mechanisms of action of reproductive toxicants and on the roles of antioxidants and oxidative stress in reproductive toxicity and

reproductive aging. She served on several National Toxicology Program/NIEHS Center for the Evaluation of Risks to Human Reproduction Expert Panels, was a member of National Research Council and World Health Organization advisory committees, and served on the U.S. EPA Science Advisory Board Environmental Health Committee.

Thomas McKone, Ph.D.
Dr. Thomas E. McKone is a Senior Staff Scientist and Deputy Head of the Indoor Environment Department at the Lawrence Berkeley National Laboratory and an Adjunct Professor with the School of Public Health at the University of California, Berkeley. His research interests include the development, use, and evaluation of models and data for human and ecological exposure assessments and risk assessments; chemical transport and transformation in the environment; and the health and environmental impacts of energy, industrial, and agricultural systems. He has been a member of several National Academy of Sciences Committees, has served on the EPA Science Advisory Board, as well as a member of advisory committees for the Organization for Economic Cooperation and Development, the World Health Organization, the International Atomic Energy Agency, and the Food and Agriculture Organization.

Julia Quint, Ph.D.
Dr. Julia Quint is retired from the California Department of Public Health (CDPH) where she was a Research Scientist and Chief of the Hazard Evaluation System and Information Service (HESIS), an occupational health program. She has a Ph.D. in Biochemistry from the University of Southern California and conducted laboratory-based research at UCSF and the Lawrence Berkeley Laboratory prior to joining CDPH in 1981. Dr. Quint has significant experience as a toxicologist, researcher, and public health scientist. Her work in public health has focused on protecting workers, communities, and the environment from toxic chemicals, and on promoting the development and use of safer alternatives to toxic chemicals. She has served on a number of scientific advisory committees, including committees of the National Academy of Sciences on tetrachloroethylene and health impact assessment. She is a member of the California Environmental Protection Agency's Green Ribbon Science Panel. Dr. Quint has received several awards for her work in public health.

Gina Solomon, M.D., M.P.H.
Gina Solomon is a Senior Scientist at the Natural Resources Defense Council (NRDC) and an Associate Clinical Professor of Medicine at the University of California at San Francisco (UCSF) where she is also the Director of the Occupational and Environmental Medicine Residency Program and the Associate Director of the UCSF Pediatric Environmental Health Specialty Unit. Her work has included over 40 scientific papers, book chapters, and reports on air pollution, pesticides, global warming, and other environmental and occupational threats to health. Dr. Solomon serves on the National Toxicology Program's Board of Scientific Counselors, a National Academy of Sciences committee on Exposure Assessment in the 21st Century, and the California Biomonitoring Scientific Guidance Panel. Dr. Solomon attended college at Brown University, medical school at Yale and did her postgraduate training in internal medicine, public health, and occupational and environmental medicine at Harvard.

Michael P. Wilson, Ph.D., M.P.H.
Michael P. Wilson is the Director of UC Berkeley's Labor Occupational Health Program (LOHP) and Associate Director for Integrative Sciences of the Berkeley Center for Green Chemistry (http://bcgc.berkeley.edu/). Dr. Wilson earned his BA in Biology with Thesis Honors (1984) from University of California, Santa Cruz, and a Master of Public Health (1998) and PhD (2003) in Environmental Health Sciences from UC Berkeley. He is also a graduate of the Trade Union Program at Harvard University, the Proyecto Linguistico Francisco Marroquin in Antigua, Guatemala, and the Pre-Hospital Care Program at Stanford University. In addition to his service on the California Biomonitoring Scientific Guidance Panel, Dr. Wilson serves on the Department of Toxic Substances Control Green Ribbon Science Panel. Dr. Wilson's recent papers in *Environmental Health Perspectives* (http://coeh.berkeley.edu/docs/news/2009-ehp.pdf) and *Science* (http://coeh.berkeley.edu/docs/news/science_policy_forum_112009.pdf) explore the role of chemicals policy and the environmental health sciences in advancing green chemistry and occupational and environmental health. From 1981—1996, Dr. Wilson worked in the Central Coast area of California as an EMT, paramedic, firefighter-paramedic, and U.S. Coast Guard reserve crewman and helmsman. He presently serves as a Hazardous Materials Specialist for FEMA Urban Search and Rescue (USAR) California Task Force 4 in Oakland, California (http://www.catf-4.us/index.cfm?section=1).

IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM: 2010-2012

Appendix C

Summaries of Recommendations Made by Panel Members at Recent Scientific Guidance Panel Meetings

California Department of Public Health
in collaboration with
California Environmental Protection Agency's
Office of Environmental Health Hazard Assessment and
Department of Toxic Substances Control

January 2013

October 9, 2009 Meeting of the Scientific Guidance Panel of the California Environmental Contaminant Biomonitoring Program

Panel Recommendations and Meeting Conclusions

The Scientific Guidance Panel (SGP) of the California Environmental Contaminant Biomonitoring Program (CECBP) met on October 9, 2009 in Sacramento. The SGP discussed and provided input on priority chemicals. The Panel also heard presentations on and provided recommendations related to the cooperative agreement with the Centers for Disease Control and Prevention (CDC), the Maternal Infant Environmental Exposure Project (MIEEP), CECBP's collaboration with the Kaiser Permanente Research Program on Genes, Environment, and Health (RPGEH), and future directions for the CECBP. The SGP's recommendations and suggestions on various topics are summarized below. Meeting materials, including an agenda and the transcript, are available on the biomonitoring website (http://www.oehha.ca.gov/multimedia/biomon/cecbp100609.html).

CDC Cooperative Agreement

Program staff gave an overview of the cooperative agreement with CDC and explained its objectives. The CDC funding is primarily for the purpose of expanding the state laboratory capability and capacity for biomonitoring studies. Ninety percent of the CDC funding will go to support laboratory activities. The CDC funding is meant to supplement state funding and not supplant it.

One of the objectives of the CDC grant is to assess and track trends for selected chemicals among targeted populations. CECBP will work on this objective primarily through three specific collaborations: Environmental Health Tracking's Imperial County Study, the Cohort of Young Girls' Nutrition, Environment and Transitions (CYGNET) and the Maternal and Infant Environmental Exposure Project (MIEEP). Program staff requested specific input on the chemicals to be included in MIEEP, which is discussed further below.

Potential issues related to sample collection and storage were raised by the Panel. The Panel suggested that Program staff review quality control guidelines and standard protocols and procedures for collecting and storing samples, such as those developed by the International Society for Biological and Exposure Repositories. Program staff indicated that a Sample Management Officer will be hired in order to set up appropriate storage protocols, and that possible storage issues can be discussed again by the Panel once the officer has been hired.

Priority Chemicals

Because the CECBP laboratories do not have the resources to develop methods for all priority chemicals, Program staff requested the Panel's recommendations on which chemicals should be considered for methods development in the near future. The discussion focused on priority chemicals for which the laboratories do not have an existing method and for which methods development is not yet planned.

Diesel Exhaust

The Panel unanimously recommended that Program staff take steps to identify a biomarker of exposure to diesel exhaust and develop a laboratory method for its identification in biomonitoring studies. Following the adoption of the recommendation, there was additional discussion with Program staff about the feasibility of carrying out this recommendation. Challenges include: identifying an appropriate chemical, which is a major research project; expected changes in the composition of diesel exhaust, which make previously considered biomarkers potentially less relevant; and lack of adequate Program funding to take on this research project. Program staff agreed to look into the latest status of research on biomarkers for diesel exhaust and provide an update to the SGP.

Alternative to dialkyl phosphate (DAP) metabolites

The Panel noted that DAP metabolites are nonspecific and recommended considering more specific metabolites of organophosphate pesticides.

Cotinine

The Panel expressed interest in measuring cotinine as a way to quantify tobacco smoke exposure. Program staff noted that measuring cotinine would require a dedicated machine and current resources do not allow for that.

Brominated or chlorinated flame retardants currently not planned for methods development

The Panel expressed interest in measuring more brominated or chlorinated flame retardants for which the Department of Toxic Substances Control (DTSC) laboratory does not currently have methods. Program staff noted that these compounds are not all members of the same chemical class, and many would require completely different methods. The Panel highlighted the tris phosphate type flame retardants and short chain chlorinated paraffins as being of particular interest for future methods development.

Open scan for unknown chemicals

The Panel supported the Program's proposal to screen blood for currently unidentified chemicals, attempt to identify those chemicals, and develop analytic methods to measure them. This analysis for unknowns could be carried out in the future, possibly beginning during the fifth year of funding from the CDC cooperative agreement.

Other emerging chemicals in California

The Panel noted that other chemical hazards may become important in California because of particular programs that will lead to chemical substitution or new chemicals being used. For example, the drive to reduce the use of volatile organic compounds may result in new chemicals being introduced in California. In addition, the increased use of clean energy technologies in the state will potentially introduce new toxic hazards. Program staff encouraged the Panel or any member of the public to bring these emerging chemicals to the attention of the Program.

Maternal Infant Environmental Exposure Project (MIEEP)

Program staff provided an overview of the objectives of MIEEP and the proposed chemicals to be analyzed. Program staff also described the trade-offs of using the State laboratory versus the CDC laboratory. The Panel suggested that the analyses for this project be conducted using the State labs because there would be more value for the Program if the data came from the state labs. This would also allow the state laboratories to demonstratè capacity and capability for these analyses. PAHs were suggested as a measure of exposure to tobacco smoke, since State labs do not have the capability to analyze cotinine. Due to the fact that those sampled in the project are expected to be composed of a majority of Latinas, DDT was also suggested as a possible chemical of interest. The Panel recommended that, since the population sampled will be pregnant women and their infants, estrogenic chemicals, thyroid disrupting chemicals, and neurotoxicants should be included. A home survey was suggested as a possible part of the questionnaire process in order to get a larger quantity *of* exposure *data* that would be *of* high quality. The Panel *also* suggested administering dietary intake instruments to measure exposures to lead and pesticides.

CECBP Collaboration with Kaiser Permanente Research Program on Genes, Environment, and Health (RPGEH)

Dr. Stephen Van Den Eeden, senior investigator in the Division of Research at Kaiser Permanente presented an overview of Kaiser's Research Program on Genes, Environment and Health. Opportunities for collaboration between Kaiser and CECBP were discussed. The Panel unanimously endorsed collaboration with Kaiser and recommended that the Program continue to explore ways to expand the collaboration.

February 9, 2010 Meeting of the Scientific Guidance Panel for Biomonitoring California

The Scientific Guidance Panel (SGP) for the California Environmental Contaminant Biomonitoring Program (also known as Biomonitoring California) met on February 9, 2010 in Sacramento. The SGP's recommendations and suggestions on various topics are summarized below. Meeting materials, including the agenda, presentations and the transcript, are available on the biomonitoring website (http://oehha.ca.gov/multimedia/biomon/feb2010agenda.html).

Program and Laboratory Updates

The new public name for the California Environmental Contaminant Biomonitoring Program (CECBP) was presented to the Panel. "Biomonitoring California" was chosen as being simpler and more accessible to study participants and other interested parties:

Program staff gave an update on progress toward meeting the objectives of the Cooperative Agreement with the Centers for Disease Control and Prevention (CDC). The Panel expressed its support and encouragement for the Program's collaborative efforts with Environmental Health Tracking Program in Tulare and Imperial counties; the Cohort of Young Girls' Nutrition, Environment, and Transitions (CYGNET); the Maternal and Infant Environmental Exposure Project (MIEEP); and Kaiser's Research Program on Genes, Environment, and Health. Panel members encouraged Program staff to continue efforts to study exposures in firefighters. Panel members Luderer and Wilson offered assistance in identifying and accessing firefighter cohorts.

The Panel noted excellent progress made by the laboratories in developing analytical methods and encouraged continued development of methods to analyze new brominated flame retardants. The Panel reiterated the need for a biomarker for diesel exhaust exposure. The SGP also provided some input on the quality assessment and quality control efforts of the laboratories.

Designated and Priority Chemicals

The Panel voted unanimously to recommend adding pendimethalin (and its metabolites, biomarkers, and/or relevant indicator chemicals) to the designated chemical list.

The panel voted 6 to 2 to recommend adding the already designated polychlorinated biphenyls (PCBs) (and metabolites, biomarkers, and/or relevant indicator chemicals) to the priority list.

Panel members postponed a decision on benzophenone-3 as a potential priority chemical. They requested that the Program provide additional information on benzophenone-3, consider chemicals in sunscreen as a general category, and also

investigate the possibility of using total estrogenic load as a measure for biomonitoring.

Updated designated and priority chemical lists with the above additions have been posted (see http://www.oehha.ca.gov/multimedia/biomon/index.html).

Proposed New Format for Designated and Priority Chemical Lists

The Program proposed a simpler format for the designated and priority list. The new format would more closely mirror the approach taken by CDC in its Fourth National Report on Human Exposure to Environmental Chemicals. Panel members agreed that the new format improved the readability and accessibility of the lists. Any substantive changes to the lists that are required by the new format will be discussed with the Panel during the May 24, 2010 meeting. The new format will be implemented after the May meeting.

Maternal and Infant Environmental Exposure Project

Program staff presented an update on the Maternal and Infant Environmental Exposure Project (MIEEP; also known as Chemicals in Our Bodies Project), which included an overview of the project design, information participants would receive about the study, excerpts from the questionnaire, and an educational handout to be provided to participants. Panel members gave a variety of suggestions for improving the questionnaire, including evaluating the length of the questionnaire, addressing some design issues (e.g., questions that are likely to elicit a response of "no"), and including more questions on dietary history. Panel members appreciated that the Program developed an educational handout for participants. Suggestions on the handout included adding an overview for context, providing information on remodeling, and clarifying statements about ceramic ware. The Program will take the Panel's input into consideration in modifying the questionnaire and other study materials as much as possible.

May 24, 2010 Meeting of the Scientific Guidance Panel for Biomonitoring California

The Scientific Guidance Panel (SGP) for the California Environmental Contaminant Biomonitoring Program (also known as Biomonitoring California) met on May 24, 2010 in Sacramento. The SGP's recommendations and suggestions on various topics are summarized below. Meeting materials, including the agenda, presentations and the transcript, are available here: http://oehha.ca.gov/multimedia/biomon/sgp052410.html.

Program and Laboratory Updates

Program staff gave an update on progress toward meeting the objectives of the Cooperative Agreement with the Centers for Disease Control and Prevention (CDC). This included an update on the Program's collaborative efforts with the Environmental Health Tracking Program in Tulare and Imperial counties; the Cohort of Young Girls' Nutrition, Environment, and Transitions (CYGNET); and the Maternal and Infant Environmental Exposure Project (MIEEP). The new Firefighter Occupational Exposures Project (FOX) was also briefly introduced. The Program's efforts to obtain outside funding and the continuing progress on the pilot projects were acknowledged.

Laboratory staff gave an update on activities since the last SGP meeting. Panel members noted the progress made by the laboratories in developing and validating new analytical methods and were complimentary on the level of precision and accuracy achieved by the laboratories.

Designated Chemical

The Panel voted unanimously to recommend adding triclocarban (and its metabolites, biomarkers, and/or relevant indicator chemicals) to the designated chemical list. Panel members requested additional detailed toxicology, persistence, and exposure information for use in any future discussions on triclocarban.

Priority Chemicals

The Panel voted unanimously to recommend adding parabens that were already designated (butylparaben, ethylparaben, methylparaben, propylparaben) to the priority list.

New Format for Designated and Priority Chemical Lists

Program staff gave an overview of the new format for the designated and priority chemical lists and asked for the Panel's input on specific issues, such as formatting details, revised and new footnotes, and updating information on the lists based on CDC.

The Panel provided the following comments and recommendations:

- Because different isomers can have different toxicities (e.g., cis- and trans-permethrin), it was suggested that the specific isomers be retained on the list.
- There was an inquiry if CAS numbers would be included on the list. Program staff explained that a full technical list that will include the CAS numbers is planned for the future.
- The Panel reviewed and agreed to the revised footnote on diesel exhaust and a new footnote for polycyclic aromatic hydrocarbons (PAHs).
- The Panel approved the Program's proposal to add parent chemicals newly identified by the CDC for a particular metabolite to the priority list in cases when that metabolite is already on the priority list.

Other Panel Input on Chemical Selection

It was requested that the Program include the broad class of disinfection byproducts, especially byproducts of chloramination, in the queue of chemicals being considered for the Panel to review as potential designated chemicals.

Firefighter Occupational Exposures (FOX) Project

Program staff presented an overview of the FOX project. The Panel congratulated the Program on developing this study during the time since the last meeting. Panel members made a number of specific comments:

- Suggestions were made regarding refining the exposure assessment and the questionnaire, such as by obtaining information on pesticide applications at the fire stations and adding questions on exposures at home or at a second job.
- The Program should measure phthalates, which are likely to be found in personal protective equipment worn by firefighters.
- The Program could consider expanding the questionnaire to longer than 15 minutes, if needed, and work with the union and management to encourage rank and file firefighters to take the time to complete it.
- GPS coordinates of the fire stations should be obtained to look at nearby traffic density, truck traffic and other sources for PAH exposures. This pilot project would be a good opportunity to measure a biomarker for diesel exposure, if one were available.

Overview of Draft Public Integration Plan

Program staff presented an overview of the Draft Public Integration Plan and asked for input on specific discussion questions:

- Aspects of our public integration efforts that should be priorities.
- Methods and practices that might be effective for increasing the number and diversity of Program stakeholders.

- Ideas about achieving high participation rates in biomonitoring studies.
- Suggestions of individuals or organizations we might interview to gain insight into effective communication of biomonitoring results.

Panel members recommended that the Program make contact with a range of groups and individuals for insight and ideas on involving the public, including:

- Participants in earlier Program meetings to find out why they are not currently participating in Program activities and how the Program could better engage with them;
- Those who have had success working with environmental justice (EJ) advocates;
- The leadership of community and/or EJ groups; and
- Labor organizations, which represent a diverse cross-section of Californians, and have a commitment to chemicals policy reform. Findings of contaminants in umbilical cord blood are of concern to many occupational groups, especially those heavily exposed to chemicals (e.g., refinery workers).

Panel members also recommended that the Program:

- Inform participants that they need to request their results if they want to receive them;
- Work to ensure that results are understandable to the study participants;
- Be clear with community groups regarding the Program's limited capacity to conduct studies in their communities, to avoid raising unrealistic expectations; and
- Create a Facebook page in order to connect with the public.

Mr. Davis Baltz of Commonweal suggested using the results from the pilot study on cord blood as an opportunity to re-engage individuals who expressed interest in the Program early on but have not attended SGP meetings recently.

Selection of SGP Chair

The Panel nominated and unanimously confirmed Dr. Ulrike Luderer as Panel chair.

November 2, 2010 Meeting of the Scientific Guidance Panel for Biomonitoring California

Summary of Panel Recommendations

The Scientific Guidance Panel (SGP) for the California Environmental Contaminant Biomonitoring Program (also known as Biomonitoring California) met on November 2, 2010 in Sacramento. The SGP's recommendations and suggestions on various topics are summarized below. Meeting materials, including the agenda, presentations and transcript, are available here:
http://www.oehha.ca.gov/multimedia/biomon/sgp092110.html.

Program and Laboratory Updates

Program staff gave an update on progress toward meeting the objectives of the Cooperative Agreement with the Centers for Disease Control and Prevention (CDC). This included updates on the Maternal and Infant Environmental Exposure Project (MIEEP) and the Firefighter Occupational Exposures (FOX) Project. The Program's efforts to establish a collaboration with the Kaiser Research Program on Genes, Environment, and Health were also briefly introduced. Other items of interest were the new Biomonitoring California logo, the completion of a draft brochure on Biomonitoring California in English and Spanish, and participation of Program staff in an effort spearheaded by the Association of Public Health Laboratories to develop national biomonitoring guidelines.

A Panel member recommended carrying out a power calculation for MIEEP to see if the size of the Project is sufficient to answer the question, "Is this population of women systematically different in their exposures compared to the national NHANES survey population?" The availability of adequate funding was discussed. A Panel member commended the Program's progress on the smaller projects being conducted in the absence of funding for a statewide survey.

Laboratory staff gave an update on activities since the last SGP meeting and a preview of upcoming work. The California Department of Public Health Environmental Health Laboratory is expanding existing methods (such as increasing the number of phthalates that can be analyzed), continuing work on methods in progress (such as environmental phenols), and increasing laboratory capacity. The Department of Toxic Substances Control Environmental Chemistry Laboratory reviewed already validated methods and results obtained using these methods, reported on methods under development (new or alternative brominated flame retardants, such as polybrominated ethylbenzene) and previewed future work (such as developing methods for phenolic compounds). The Panel commended the laboratories for the continued progress.

Designated Chemical

The Panel voted unanimously to recommend adding manganese to the designated chemical list. Panel members noted that before considering manganese as a potential priority chemical, the Program should research the pharmacokinetics and laboratory methods for manganese.

Draft Public Involvement Plan

Program staff presented the key elements of the draft Public Involvement Plan that has been released for public comment, the approaches being undertaken to solicit comments, and the timeline for finalizing the Plan. The Panel discussed the Plan and provided input. Individual Panel members suggested that the Program:

- Consider developing a media strategy or other method to amplify the message.
- Partner with community organizations to reach people we would otherwise miss by our use of online tools.
- Do outreach to various groups (e.g., labor groups, professional associations, medical providers) to involve them in the Program.
- Keep a focus on the statewide survey in designing public involvement efforts.
- Convey to the public the importance of biomonitoring by making a connection to green chemistry.
- Seek wide input on the subject of biomonitoring reference levels from a variety of groups and individuals with relevant interests, such as those in the role of talking to patients and others about biomonitoring results.

Introductory Discussion of Biomonitoring Reference Levels

Program staff gave a presentation introducing the concept of "biomonitoring reference levels" - concentrations in biological media (e.g., blood or urine) that would be useful to compare with biomonitoring results. The Program is using the term broadly to include things like measured levels in relevant populations (e.g., NHANES) and levels used to derive guidance values or standards (e.g., blood lead level used to derive drinking water standard). The Program sought the Panel's perspectives on the use of biomonitoring reference levels and their suggestions for the March workshop on this topic. Individual Panel members (not necessarily the entire Panel) expressed their opinions and recommended that the Program:

- Consult with experts on nutrient loadings, radioactivity, and pharmaceuticals as part of researching biomonitoring reference levels.
- Be aware of the large uncertainties in attempting to develop reference levels. Don't assume that simple translations between biological levels and health effects will exist in all cases. Reference levels for a single chemical may differ between groups of people because of genetic variation, for example.

- Recognize that there will not be information on health-based levels of concern for many of the chemicals of great interest to the Program, because the Panel has focused on "staying ahead of the curve" and recommending that emerging chemicals be biomonitored.
- Be very cautious in taking a poor toxicity data set and attempting to extrapolate to obtain a biological equivalent. Consider carefully if we should attempt to include chemicals with sparse or no data on health effects or pharmacokinetics. Distinguish between a screening level assessment and a full risk assessment.
- Be aware that developing biomonitoring reference levels could subject the Program to controversy or even derail the Program.
- There is a need to provide a health context for biomonitoring results, particularly when returning results to individuals. People will ask questions about the meaning of their results in terms of their health and we have a responsibility to respond.
- Provide proper guidance on how any levels developed by the Program should be viewed (i.e., not as a standard or a regulatory level).
- Discuss a probability or risk-based interpretation for noncancer health effects versus the reference dose approach.
- Look at mixed exposures particularly for chemicals that have similar mechanisms. Even if chemicals do not act in the same way, cumulative exposures to multiple chemicals should be considered and evaluated.
- Be clear about the difference between exposure assessment and health risk assessment. Biomonitoring is a measure of exposure. CDC has reported results and avoided health-based interpretations. The Program has been on a path of identifying the presence of chemicals in the body; developing reference levels goes down a different path of attempting to determine how much harm is acceptable.
- Do not attempt to say that a particular level of a chemical in the body is okay. The uncertainties are too great to make those kinds of conclusions.
- Recognize that developing reference levels sets the Program on a very different path than simply identifying the presence of chemicals in blood or urine. Others have chosen not to go down this path. For example, the Royal Commission on Environmental Pollution took the position that rather than embarking on a risk assessment strategy around chemicals identified in people, they simply stated that steps should be taken to reduce the use of substances that appear in humans and in higher mammals. The European REACH regulation classifies substances that are very persistent and very bioaccumulative as chemicals of a high concern, regardless of questions of risk.
- Understand that there is value in a simple translation between a blood level and an intake level, without considering health risks.

- Make the focus of the workshop broader than just reference levels. Frame the workshop as a discussion of ways to provide context for biomonitoring results, with biomonitoring reference levels as one way to do that. Consider how to interpret biomonitoring results for individuals and groups. For example, the Program might consider providing context by using measured levels in relevant populations (e.g., NHANES), calculating levels for certain chemicals, or declining to provide context in some cases and figuring out a good way to explain to people why no context is given.

Chemical Selection Planning

Program staff gave an overview of selected chemicals and groups of chemical that are being tracked as possible candidates for consideration as potential designated chemicals, including: plasticizers, a non-halogenated flame retardant (triphenyl phosphate), emerging disinfection byproducts, two organotins (tributyltin and dibutyltin), nonylphenols and nonylphenol ethoxylates, and pesticides. Panel members expressed particular interest in triphenyl phosphate and non-halogenated flame retardants in general. Other categories of interest were pesticides, emerging disinfection byproducts and organotins,.

The Panel recommended that the Program briefly summarize the following information when reviewing possible candidates for designation: the extent and type of use, indicators of environmental persistence and/or bioaccumulation, existing data from biomonitoring studies or studies of dust levels, and evidence of toxicity. A further recommendation was to consider looking at the hazard traits that OEHHA recently defined as part of their green chemistry work.

One technical listing proposal was also considered: Should the Program automatically add to the priority list chemicals that are newly being measured by CDC and are part of a group that the Panel already recommended as priority? For example, the Panel moved the entire group of phthalates that were already designated to the priority list. CDC has recently begun measuring isodecyl phthalate. Under the proposed approach, this new phthalate would be automatically added to the priority list under phthalates, instead of being brought to the Panel for approval. The Panel unanimously agreed to the proposal.

Firefighter Occupational Exposures (FOX) Project

Dr. Leslie Israel of the University of California Irvine gave an update on the FOX Project. As of November 1, 18 participants had been recruited, with a goal of 100 participants. The Program does not anticipate any difficulties in reaching that goal. The Panel inquired about other aspects of the project, including the questionnaire, the firefighters' chemical exposures, the results return process and approaches being considered to provide context for the results. For the complete discussion, refer to the full transcript available here:
http://www.oehha.ca.gov/multimedia/biomon/sgp092110.html.

March 16, 2011 Meeting of the Scientific Guidance Panel for Biomonitoring California

Summary of Panel Recommendations

The Scientific Guidance Panel (SGP) for the California Environmental Contaminant Biomonitoring Program (also known as Biomonitoring California) met on March 16, 2011 in Oakland. The SGP's recommendations and suggestions on various topics are summarized below. Meeting materials, including the agenda, presentations and the full transcript, are available here:
http://www.oehha.ca.gov/multimedia/biomon/sgp031611.html.

Program Update

Program staff gave an update on funding status and staffing changes. A timeline highlighting Program accomplishments since its inception was presented. Various possible strategies for approximating a statewide representative sample were also reviewed. Updates were given on the Program's ongoing projects: the Maternal and Infant Environmental Exposure Project (MIEEP), the Firefighter Occupational Exposures Project (FOX) and the Biomonitoring Exposures Study (BEST). Public involvement activities were briefly described. The release of the Program brochure in English and Spanish was also announced, with hard copies of the brochure distributed at the meeting.

Panel member Dr. Julia Quint suggested developing a formal dissemination plan for the brochure. A public commenter, Carl D. Ruiz, a research fellow at Henkel Consumer Goods, asked that a disclaimer used by the Centers for Disease Control and Prevention be added to the brochure to clarify that biomonitoring measurements are an indication of exposure, not of health effect.

A public commenter, Davis Baltz from Commonweal, commended the program on its considerable achievements to date and reminded the audience that his organization was one of the sponsors of the enabling legislation. He stated that the requests the program is receiving from other parties to analyze samples, marked a significant achievement.

A public commenter, Tony Stefani of the San Francisco Firefighters Cancer Prevention Foundation, expressed interest in the Program broadening the FOX project to include other firefighters from other areas in the state, such as San Francisco. Panel members seconded that suggestion.

Laboratory Update

Laboratory staff gave an update on activities since the last SGP meeting, including staffing changes and newly acquired equipment. Progress in sample analyses and the

development and validation of new methods was also outlined. The California Department of Public Health (CDPH) Environmental Health Laboratory (EHL) described its preliminary success in the challenging analysis of dried blood spots and low-volume specimens for persistent organic chemicals (e.g., polybrominated diphenyl ethers or PBDEs). The Department of Toxic Substances Control (DTSC) Environmental Chemistry Laboratory (ECL) discussed methods development for newer brominated flame retardants (BFRs). ECL also described the testing of different types of tubes for collecting blood samples.

In the discussion with laboratory staff, Panel members:

- Commended the laboratories on their progress.

  The critical support of the CDC in helping develop the laboratory capability, including training Biomonitoring California laboratory staff, was also acknowledged. The fact that outside researchers are requesting that Biomonitoring California laboratories conduct analyses for them was noted as an indication of the importance and success of the Program.

- Supported the Program's intention to develop criteria for which outside projects to accept, to ensure that new projects fit into the overall Program goals.

  These criteria will be important to avoid the laboratories being used simply as service laboratories. Panel members also emphasized the importance of ensuring that the Program has access to the data generated through outside collaborations.

- Suggested that the quality of the filter paper used to collect the newborn dried blood spots might be improved to help reduce background contamination.

- Recommended that the laboratories present summary information on quality assurance/quality control (QA/QC) as part of their presentations.

- Reiterated an earlier recommendation that the Program consider developing methods to screen for unknown chemicals.

  The usefulness of such a method in elucidating complex exposures, such as those experienced by firefighters from a mixture of combustion products, was noted. The increasing number of substitutes for phthalates and plasticizers for which we have very little information on level of use, exposure or toxicity was highlighted as further support for screening unknowns. Having a state reporting system for chemical ingredients in products and the volumes of those chemicals would be another resource for identifying emerging chemicals.

A public commenter, Dr. Dale Hattis of Clark University, suggested the Program also consider analyzing for DNA adducts, for example, as a way of detecting DNA reactive chemicals that have not been previously identified.

Chemical Selection Planning

Program staff presented a proposed screening approach for possible candidate chemicals for designation, based on recommendations by the Panel from the November 2010 SGP meeting. The purpose of doing this screening would be to allow the Panel to weigh in early on chemicals that might be brought forward as potential designated chemicals. The screening approach included elements highlighted by the Panel previously: extent and type of use, indicators of environmental persistence, bioaccumulation and toxicity, and information from past environmental sampling and biomonitoring studies. The approach was illustrated using the example of nonhalogenated organophosphate flame retardants.

Panel members gave a number of comments on the proposed screening approach and suggestions for refining and expanding the approach:

- The screen is useful for gathering information on multiple chemicals in a readable format for easy comparison.
- Production volume alone can be misleading: Some low volume chemicals have significant toxicity concerns or concerns for persistence or bioaccumulation. Production volumes can change rapidly once a chemical gets on to the market. A chemical that starts off at a low volume may dramatically increase shortly after being introduced.
- Include information about whether the chemical is a substitute for an existing designated chemical or other chemical of concern.
- Include information on the types and numbers of products in which the chemical is found.
- Indicate some indication of the potential for exposure and likely routes of exposure (e.g., via inhalation, food).
- Overall persistence is a good indicator of exposure potential for a broad range of chemicals.
- Expand the toxicity screen to include some indication of the toxicity concern and extent of information. For example, toxicity concerns could be based on results from many conducted studies, minimal toxicity information or structure activity information. A toxicity concern could also exist because there is absolutely no information. An in-depth evaluation of data quality is not needed, but some indication of what is available would be useful.
- Consider adding reference doses (RfDs), if available.
- It would be helpful to know what chemicals are used in California and in products sold in California.
- Consider adding a notation for very persistent, very bioaccumulative chemicals, which can be a concern regardless of toxicity.
- Using laboratory-based identification of unknowns as a possible screening tool will likely generate long lists of chemicals on each participant studied. Use informatics to identify chemicals that show up most frequently and at the highest concentrations, which could help narrow down the list.
- Add more physical chemical properties to the screen, such as vapor pressure.

- Do not exclude chemicals that are not persistent. We are exposed to many nonpersistent compounds on a regular basis, and even with short half-lives in the body, exposure is still substantial: think about exposure potential.

A public commenter, Dale Hattis of Clark University, recommended the Program consider looking at intake fraction, which better describes exposure potential than volume of use. Intake fraction varies over orders of magnitude, in the same way that persistence varies over orders of magnitude, making it a good screening tool.

The Panel also recommended that the Program prepare a document on aromatic non-halogenated organophosphate flame retardants as potential designated chemicals.

"Biomonitoring Literacy:" Developing Report-Back Materials with Input from Study Participants

Dr. Rachel Morello-Frosch and Holly Brown-Williams of UC Berkeley's School of Public Health presented the work they did on developing a report-back template for the Maternal and Infant Environmental Exposure Project (MIEEP, or Chemicals in Our Bodies Project). Their findings from usability testing with some MIEEP participants were summarized and the improvements to the report back template based on the testing were explained. The primary aim of the report back materials is to address in a readable and accessible way the major questions that participants typically ask: "What did you find? How much? Is it high? Is it safe? Where does it come from? And what should I do?"

Panel member Dr. Dwight Culver inquired about how the "level of health concern" would be chosen and noted the importance of determining appropriate follow up action if high levels are found. Program staff responded that the Program will be deciding on whether a level of health concern has been established and noted that a follow up protocol is already determined for lead and is being developed for certain other chemicals such as mercury.

The Panel commended the extensive work that was done in developing a clear template. They also noted issues that should be considered in using the template and further refining it:

- Providing more information and more resources for participants who want it.
- Looking at ways to indicate that some chemicals vary considerably from measurement to measurement and that a single measurement may not be representative, particularly for non-persistent chemicals.
- Conveying the meaning of finding a metabolite, which could indicate exposure to the parent compound or to pre-formed metabolites.
- Developing information for health care providers on how to interpret the results.

There were three public commenters on this agenda item. Davis Baltz of Commonweal,

noted that in many cases we will need to be prepared to say that we do not know whether a chemical level is high or whether it is safe. He also emphasized that he does not think it's the role of Biomonitoring California to try to decide what is safe. He noted that the main goal of the Program, established in the legislation, is to regularly provide information on chemicals in Californians, both to establish a baseline and to look at trends over time, and that this should remain the focus.

Dr. Lesa Aylward of Summitt Toxicology recommended that the Program include information on breast-feeding when returning results to mothers and also consider providing reference values from NHANES beyond just the average, such as the 95th percentile. Levels can vary widely and this would not be illustrated by the average only.

Caroline Silveira, of Government Affairs at DuPont, suggested clarifying which chemicals have established levels of health concern and where those levels come from.

Kaiser Permanente Collaboration: Biomonitoring Exposures Study (BEST)

Program staff gave an overview of the Program's newest collaboration with Kaiser Permanente Northern California, Division of Research, Research Program on Genes, Environment, and Health (RPGEH). The Biomonitoring Exposures Study (BEST) is a pilot biomonitoring project in the Central Valley, with a recruitment goal of 100 English-speaking male and female adults. Collaborating with Kaiser offers an opportunity to approximate a representative sample, because of the very similar demographics of the Kaiser membership compared to the overall demographics of California. This initial pilot in the Central Valley also expands the Program's projects into a new geographic area.

Panel members' comments and recommendations included:

- Give the Panel the opportunity to comment on the exposure questionnaire to be used in BEST.
- Consider doing some pilot samples to test the integrity of the samples during the overnight shipping.
- Consider collecting blood samples at a patient's regular blood draw, rather than a home visit, to save resources.
- In addition to sending a phlebotomist to the home, consider also conducting a home environmental assessment to look for potential sources of chemicals.

Looking Forward for Biomonitoring California - Program Planning

The Program posed a series of discussion questions (full set of questions are here: http://www.oehha.ca.gov/multimedia/biomon/pdf/032011Discussion.pdf) to the Panel to assist with Program planning, focusing on:

- Identifying populations for community studies;
- Approaches for approximating a statewide representative sample;

- Approaches for investigating environmental exposure sources; and
- Additional input on Program planning.

The Panel's suggestions and recommendations are summarized below, organized by topic area.

Identifying populations for community studies

- Pay attention to children, particularly from birth to kindergarten age. The lowest age in NHANES is age 6.
- Focus initially on building on the two existing successful collaborations - mothers
- and infants; firefighters - and consider new projects as resources allow.
- Consider populations that might be particularly impacted by toxic exposures,
- which could pose environmental justice concerns. These could be urban or rural
- populations.
- Publicize the availability of our laboratory capability and see if external researchers might have resources to collaborate with the Program.
- Conduct outreach to additional occupational groups.
- Consider veterans returning from Iraq and Afghanistan as a population with potentially unique exposures.
- Some Panel members liked the idea of testing incoming medical students, while others raised some concerns. Incoming medical students are not likely to be a vulnerable population and may be less representative of California. However testing this population would offer an excellent opportunity to educate future physicians about environmental health.
- With regard to health care workers as a possible group, it was recommended that this group be broadly defined to include all types of health care workers (e.g., janitorial staff in addition to doctors, nurses, etc.). It was noted that a key exposure for health care workers, particularly nurses, is antineoplastic agents and other drugs. These drugs are not on the designated or priority lists, but if this group were studied, these exposures should be considered.
- Consider major ethnic groups in California not adequately represented in NHANES- such as Asian Americans.

Approaches for approximating a statewide representative sample

- Kaiser is the most promising collaboration for this purpose.
- Consider expanding to the Kaiser population in Southern California.
- Consider adding partnerships with community-based hospitals or clinics that could help fill in the lower income, uninsured portion of the population that would be missed in Kaiser.

- Consider collaborating with the California centers of the National Children's Study. The centers are distributed across the state in rural and urban counties and would capture children as a key group. Some challenges in this possible collaboration were that field work will not start until 2012 or 2013 and there may be difficulties in adding a collaboration with Biomonitoring California to the protocol.

Approaches for investigating environmental exposure sources

- If this is undertaken, the Program should use both environmental sampling and modeling together. The sampling results can help constrain the modeling.
- Measuring environmental samples is not the focus of the legislation, so the funding would need to come from an outside source.
- Community studies could offer good opportunities to identify environmental exposure sources but that effort should not distract from biomonitoring as the main purpose of the studies.
- Look at existing environmental sampling already being done by other researchers (e.g., the National Children's Study) and the state (e.g., the Air Resources Board).

Additional input on Program planning

- Two Panel members, Dr. Gina Solomon and Dr. Tom McKone, talked about the importance of considering how Biomonitoring California should respond in emergency situations that could arise in California, similar to the Gulf oil spill and the Japanese nuclear accident that followed the recent tsunami. The Program could play a role in developing scientifically accurate information in those situations and be a resource for the public. The Program could help address fears and counter misleading information that might be spread during emergencies like these. This would require having plans in place to get out in the field quickly.

The Acting Director of OEHHA, Dr. George Alexeeff, noted that the state has fairly well developed emergency procedures and suggested that staff involved with these emergency programs could give a presentation to the Panel. This could be a first step in developing a "biomonitoring emergency response plan."

There were three public commenters on the Looking Forward agenda item. Rachel Washburn from Loyola Marymount University in Los Angeles suggested considering nail salon workers as a group to study. This group tends to be Asian urban women of reproductive age, another population which has not been studied well.

Davis Baltz of Commonweal seconded the comment on nail salon workers, pointing to the California Healthy Nail Salon Collaborative as a good point of contact for this group of workers. Mr. Baltz also suggested that the Program consider people who work with cleaning chemicals and agricultural workers. He also agreed with the concept of building on and expanding the mother and infant and firefighter projects as a first step, considering the Program's limited resources. He raised the idea of trying to monitor cord blood on a regular basis. He named a number of fence-line communities who may be appropriate to study: West Oakland and Richmond in northern California, and in Southern California, the cities of Vernon, Commerce,

and areas around the Port of Los Angeles. Mr. Baltz thought some environmental sampling would be useful, such as taking samples of couches since dust that is coming off older sofas is going to be more laden with flame retardants. However, he also emphasized the importance of focusing on biomonitoring. He noted that Camp Lejeune in North Carolina had a spike of breast cancer cases among men, so military bases might be of interest as a follow-on to the idea of looking at returning veterans. Mr. Baltz thought it would be worth offering to biomonitor County Health Officers or the Legislature, as a way to raise the profile of the Program. He also noted an example where the CDC did an emergency biomonitoring study when a pesticide was illegally applied in Mississippi, which helped identify those who were actually exposed and needed to be evacuated versus homes that were not contaminated. So Biomonitoring California could play an important role in emergency response, though there is no funding for that.

Sharyle Patton of the Commonweal Biomonitoring Resource Center brought up the idea of having a way for communities to apply to be biomonitored, instead of taking only a top down approach in choosing them.

IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM: 2010-2012

Appendix D

Biomonitoring California Designated and Priority Chemical Lists

California Department of Public Health
in collaboration with
California Environmental Protection Agency's
Office of Environmental Health Hazard Assessment and
Department of Toxic Substances Control

January 2013

Edmund G. Brown, Jr.
Governor
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Secretary
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Biomonitoring California
Designated Chemicals
February 2011

The designated chemicals for Biomonitoring California[a] are provided in this list. Designated chemicals consist of those substances that are included in the Centers for Disease Control and Prevention's (CDC's) biomonitoring studies[b] and additional chemicals that are recommended by the Scientific Guidance Panel (SGP) for Biomonitoring California. Designated chemicals are the pool of chemicals from which the SGP can recommend priority chemicals for biomonitoring.

Targets for measurement in biomonitoring studies could include the parent chemical, metabolites and other chemical products formed in the body or the environment (e.g., hemoglobin adduct; environmental degradation product). The approach for biomonitoring a chemical may change as methods development proceeds. The parent chemical is provided in the list below, with other targets for biomonitoring shown indented underneath for some parent chemicals. Biomonitoring California determines the chemicals that are actually biomonitored and the appropriate targets for measurement.

Acrylamide
- Acrylamide hemoglobin adducts
- Glycidamide hemoglobin adducts

Antimicrobials used in Food Production[1]

Brominated and Chlorinated Organic Compounds used as Flame Retardants[1]
- 2,2-Bis(bromomethyl)-1,3-propanediol
- 2,2-Bis(chloromethyl)trimethylene bis[bis(2-chloroethyl)phosphate]
- Bis(2-ethyl-1-hexyl)tetrabromophthalate (TBPH)
- Bis(hexachlorocyclopentadieno)cyclooctane (Dechlorane Plus)
- 1,2-Bis(2,4,6-tribromophenoxy)ethane (BTBPE)
- 1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane
- 2,3-Dibromopropyl-2,4,6-tribromophenyl ether (DPTE)
- 2-Ethyl-1-hexyl-2,3,4,5-tetrabromobenzoate (TBB)
- Chlorendic acid
- Decabromodiphenylethane (DBDPE)
- Hexabromobenzene
- 2,2',4,4',5,5'-Hexabromobiphenyl (BB 153)
- Hexabromocyclododecane (HBCD)
- Hexachlorocyclopentadienyl-dibromocyclooctane
- N,N'-Ethylenebis(tetrabromophthalimide)
- Pentabromoethylbenzene
- Pentabromotoluene
- Short-chain chlorinated paraffins
- Tetrabromobisphenol A (TBBPA)
- Tetrabromobisphenol A bis(2,3-dibromopropyl) ether
- Tetrabromobisphenol A bis(2-hydroxyethyl) ether
- Tetrabromophthalic anhydride
- Tetrakis(2-chloroethyl)dichloroisopentyl diphosphate
- 2,4,6-Tribromophenol
- Tris(2-chloroethyl)phosphate (TCEP)
- Tris(1-chloro-2-propyl)phosphate (TCPP)
- Tris(1,3-dichloro-2-propyl)phosphate (TDCPP)
- Tris(2,3-dichloro-1-propyl)phosphate

Polybrominated diphenyl ethers (PBDEs)
- 2,2',4-Tribromodiphenyl ether (BDE 17)
- 2,4,4'-Tribromodiphenyl ether (BDE 28)
- 2,2',4,4'-Tetrabromodiphenyl ether (BDE 47)
- 2,3',4,4'-Tetrabromodiphenyl ether (BDE 66)
- 2,2',3,4,4'-Pentabromodiphenyl ether (BDE 85)
- 2,2',4,4',5-Pentabromodiphenyl ether (BDE 99)
- 2,2',4,4',6-Pentabromodiphenyl ether (BDE 100)
- 2,2',4,4',5,5'-Hexabromodiphenyl ether (BDE 153)
- 2,2',4,4',5,6'-Hexabromodiphenyl ether (BDE 154)
- 2,2',3,4,4',5',6-Heptabromodiphenyl ether (BDE 183)
- 2,2',3,3',4,4',5,5',6,6'-Decabromodiphenyl ether (BDE 209)

Cyclosiloxanes[1]
- Decamethylcyclopentasiloxane (D5)
- Dodecamethylcyclohexasiloxane (D6)
- Octamethylcyclotetrasiloxane (D4)

Diesel Exhaust[2]

a. California Environmental Contaminant Biomonitoring Program (also known as Biomonitoring California), codified at Health and Safety Code section 105440 et seq.
b. Known collectively as the National Reports on Human Exposure to Environmental Chemicals program.

Disinfection By-Products (Trihalomethanes)[3]

Bromodichloromethane
Dibromochloromethane
Tribromomethane (Bromoform)
Trichloromethane (Chloroform)

Environmental Phenols[3]

Benzophenone-3
Bisphenol A
4-*tert*-Octylphenol
Triclocarban[4]
Triclosan

Parabens[3]

Butylparaben[5]
Ethylparaben
Methylparaben
n-Propylparaben

Metals[3]

Antimony
Arsenic
- Arsenic (V) acid
- Arsenobetaine
- Arsenocholine
- Arsenous (III) acid
- Dimethylarsinic acid
- Monomethylarsonic acid
- Trimethylarsine oxide

Barium
Beryllium
Cadmium
Cesium
Cobalt
Lead
Manganese
Mercury
Molybdenum
Platinum
Thallium
Tungsten
Uranium

Perchlorate

Perfluorochemicals[3]

2-(N-Ethyl-perfluorooctane sulfonamido) acetic acid
2-(N-Methyl-perfluorooctane sulfonamido) acetic acid
Perfluorobutane sulfonic acid
Perfluorodecanoic acid
Perfluorododecanoic acid
Perfluoroheptanoic acid
Perfluorohexane sulfonic acid
Perfluorononanoic acid
Perfluorooctane sulfonamide
Perfluorooctane sulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluoroundecanoic acid

Pesticides[3, 6]

Carbamate Insecticides[3]

Benfuracarb
- Carbofuranphenol

Carbaryl
- 1-Hydroxynaphthalene[7]
- 2-Hydroxynaphthalene[7]

Carbofuran
- Carbofuranphenol

Carbosulfan
- Carbofuranphenol

Furathiocarb
- Carbofuranphenol

Propoxur
- 2-Isopropoxyphenol

Fungicides[3]

Captafol
- Tetrahydrophthalimide

Captan
- Phthalimide
- Tetrahydrophthalimide

Chlorothalonil
Dichloran
Folpet
- Phthalimide

Iprodione
Mancozeb
- Ethylene thiourea

Maneb
- Ethylene thiourea

Metalaxyl
Metiram
- Ethylene thiourea

Nabam
- Ethylene thiourea

Pentachlorophenol
o-Phenylphenol
Propineb
- Propylene thiourea

Thiram
- Ethylene thiourea

Ziram
- Ethylene thiourea

Herbicides - Substituted Ureas[3]

Bensulfuron-methyl
Chlorimuron-ethyl
Chlorsulfuron
Diuron
Ethametsulfuron-methyl
Foramsulfuron
Halosulfuron
Iodosulfuron
Linuron
Metsulfuron-methyl
Nicosulfuron
Primisulfuron-methyl
Prosulfuron
Rimsulfuron
Sulfometuron-methyl
Sulfosulfuron
Thifensulfuron-methyl
Triasulfuron
Triflusulfuron-methyl
Non-specific metabolites
- Dimethoxy pyrimidine
- Dimethyl pyrimidine
- Methyl methoxytriazine

Organochlorine Pesticides[3]

Aldrin
- Dieldrin

Chlordane
- *trans*-Nonachlor
- Oxychlordane

Dichlorodiphenyltrichloroethane (DDT) (including p,p'-DDT and o,p'-DDT)
- *p,p'*-Dichlorodiphenyldichloroethene (DDE)

Dieldrin
Endosulfan
- Endosulfan-ether
- Endosulfan-lactone
- Endosulfan-sulfate

Endrin
Heptachlor
- Heptachlor epoxide

Hexachlorobenzene
- Pentachlorophenol
- 2,4,5-Trichlorophenol
- 2,4,6-Trichlorophenol

Hexachlorocyclohexanes (HCH) (including beta-HCH and gamma-HCH [lindane])
- Pentachlorophenol
- 2,4,5-Trichlorophenol
- 2,4,6-Trichlorophenol

Methoxychlor
- Dihydroxy methoxychlor
- Monohydroxy methoxychlor

Mirex
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Organophosphate Insecticides[3]

Acephate
Azinphos methyl
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate

Chlorethoxyphos
- Diethylphosphate
- Diethylthiophosphate

Chlorpyrifos
- Diethylphosphate
- Diethylthiophosphate
- 3,5,6-Trichloro-2-pyridinol

Chlorpyrifos methyl
- Dimethylphosphate
- Dimethylthiophosphate
- 3,5,6-Trichloro-2-pyridinol

Coumaphos
- 3-Chloro-7-hydroxy-4-methyl-2H-chromen-2-one/ol
- Diethylphosphate
- Diethylthiophosphate

Diazinon
- Diethylphosphate
- Diethylthiophosphate
- 2-Isopropyl-4-methyl-6-hydroxypyrimidine

Dichlorvos (DDVP)
- Dimethylphosphate

Dicrotophos
- Dimethylphosphate

Dimethoate
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate

Disulfoton
- Diethyldithiophosphate
- Diethylphosphate
- Diethylthiophosphate

Ethion
- Diethyldithiophosphate
- Diethylphosphate
- Diethylthiophosphate

Fenitrothion
- Dimethylphosphate
- Dimethylthiophosphate

Fenthion
- Dimethylphosphate
- Dimethylthiophosphate

Isazophos-methyl

- 5-Chloro-1,2-dihydro-1-isopropyl-[3H]-1,2,4-triazol-3-one
- Dimethylphosphate
- Dimethylthiophosphate

Malathion
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate
- Malathion dicarboxylic acid

Methamidophos

Methidathion
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate

Methyl parathion
- Dimethylphosphate
- Dimethylthiophosphate
- *p*-Nitrophenol

Naled
- Dimethylphosphate

Oxydemeton-methyl
- Dimethylphosphate
- Dimethylthiophosphate

Parathion (Ethyl parathion)
- Diethylphosphate
- Diethylthiophosphate
- *p*-Nitrophenol

Phorate
- Diethyldithiophosphate
- Diethylphosphate
- Diethylthiophosphate

Phosmet (Imidan)
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate

Pirimiphos-methyl
- 2-(Diethylamino)-6-methylpyrimidin-4-ol/one
- Dimethylphosphate
- Dimethylthiophosphate

Sulfotepp
- Diethylphosphate
- Diethylthiophosphate

Temephos
- Dimethylphosphate
- Dimethylthiophosphate

Terbufos
- Diethyldithiophosphate
- Diethylphosphate
- Diethylthiophosphate

Tetrachlorvinphos
- Dimethylphosphate

Pyrethroid Pesticides[1]

Allethrin
- *cis/trans*-Dimethylvinylcyclopropane carboxylic diacid

Bifenthrin

Cyfluthrin
- *cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- *trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- 4-Fluoro-3-phenoxybenzoic acid

Cyhalothrin (including *lamba*- and *gamma*-)
- 3-Phenoxybenzoic acid

Cypermethrin (including *cis*- and *trans*-)
- *cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- *trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- 3-Phenoxybenzoic acid

Cyphenothrin

Deltamethrin
- *cis*-3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid
- 3-Phenoxybenzoic acid

Esbiothrin

Esfenvalerate

Etofenprox

Fenpropathrin
- 3-Phenoxybenzoic acid

Fenvalerate

Imiprothrin

Metofluthrin

Permethrin (including *cis*- and *trans*-)
- *cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- *trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- 3-Phenoxybenzoic acid

Phenothrin (sumithrin)

Prallethrin

Pyrethrin 1
- *cis/trans*-Dimethylvinylcyclopropane carboxylic diacid

Resmethrin
- *cis/trans*-Dimethylvinylcyclopropane carboxylic diacid

Tetramethrin

Tralomethrin
- 3-Phenoxybenzoic acid

Other Herbicides

Acetochlor
- Acetochlor mercapturate

Alachlor
- Alachlor mercapturate

Atrazine
- Atrazine mercapturate
- Diaminochlorotriazine
- Desethylatrazine
- Desisopropylatrazine
- Hydroxyatrazine

Dacthal

2,4-Dichlorophenoxyacetic acid (2,4-D), salts and esters
- 2,4-Dichlorophenoxyacetic acid
- 2,4-Dichlorophenol

Metolachlor
- Metolachlor mercapturate

Pendimethalin

2,4,5-Trichlorophenoxyacetic acid (2,4,5-T), salts and esters
- 2,4,5-Trichlorophenoxyacetic acid

Trifluralin

Other Pesticides

1,4-Dichlorobenzene (*p*-Dichlorobenzene)
- 2,5 Dichlorophenol

N,N-Diethyl-3-methylbenzamide (DEET)

Fipronil

Octhilinone

Phthalates[3]

Benzylbutyl phthalate (BzBP)
- Mono-benzyl phthalate
- Mono-*n*-butyl phthalate

Dibutyl phthalate (DBP)[8]
- Mono-*n*-butyl phthalate
- Mono-isobutyl phthalate

Dicyclohexyl phthalate (DCHP)
- Mono-cyclohexyl phthalate

Diethyl phthalate (DEP)
- Mono-ethyl phthalate

Di-2-ethylhexyl phthalate (DEHP)
- Mono-(2-ethyl-5-carboxypentyl) phthalate
- Mono-2-ethylhexyl phthalate
- Mono-(2-ethyl-5-hydroxyhexyl) phthalate
- Mono-(2-ethyl-5-oxohexyl) phthalate

Di-isodecyl phthalate (DiDP)
- Mono-(carboxynonyl) phthalate

Di-isononyl phthalate (DiNP)
- Mono-(carboxyisooctyl) phthalate
- Mono-(hydroxyisononyl) phthalate
- Mono-isononyl phthalate
- Mono-(oxoisononyl) phthalate

Dimethyl phthalate (DMP)
- Mono-methyl phthalate

Di-*n*-octyl phthalate (DOP)
- Mono-(3-carboxypropyl) phthalate
- Mono-*n*-octyl phthalate

Phytoestrogens[3]

Daidzein
O-Desmethylangolensin
Enterodiol
Enterolactone
Equol
Genistein

Polychlorinated Biphenyls (PCBs), Dioxin-Like[3]

Coplanar PCBs[3]

3,4,4',5-Tetrachlorobiphenyl (PCB 81)
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)

Mono-*ortho*-Substituted PCBs[3]

2,3,3',4,4'-Pentachlorobiphenyl (PCB 105)
2,3',4,4',5-Pentachlorobiphenyl (PCB 118)
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)

Polychlorinated Biphenyls (PCBs), Non-Dioxin-Like[3]

2,2',5-Trichlorobiphenyl (PCB 18)
2,4,4'-Trichlorobiphenyl (PCB 28)
2,2',3,5'-Tetrachlorobiphenyl (PCB 44)
2,2',4,5'-Tetrachlorobiphenyl (PCB 49)
2,2',5,5'-Tetrachlorobiphenyl (PCB 52)
2,3',4,4'-Tetrachlorobiphenyl (PCB 66)
2,4,4',5-Tetrachlorobiphenyl (PCB 74)
2,2',3,4,5'-Pentachlorobiphenyl (PCB 87)
2,2',4,4',5-Pentachlorobiphenyl (PCB 99)
2,2',4,5,5'-Pentachlorobiphenyl (PCB 101)
2,3,3',4',6-Pentachlorobiphenyl (PCB 110)
2,2',3,3',4,4'-Hexachlorobiphenyl (PCB 128)
2,2',3,4,4',5' and 2,3,3',4,4',6-Hexachlorobiphenyl (PCB 138 & 158)
2,2',3,4',5,5'-Hexachlorobiphenyl (PCB 146)
2,2',3,4',5',6-Hexachlorobiphenyl (PCB 149)
2,2',3,5,5',6-Hexachlorobiphenyl (PCB 151)
2,2',4,4',5,5'-Hexachlorobiphenyl (PCB 153)
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)
2,2',3,3',4,5,5'-Heptachlorobiphenyl (PCB 172)
2,2',3,3',4,5',6'-Heptachlorobiphenyl (PCB 177)
2,2',3,3',5,5',6-Heptachlorobiphenyl (PCB 178)
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)
2,2',3,4,4',5',6-Heptachlorobiphenyl (PCB 183)
2,2',3,4',5,5',6-Heptachlorobiphenyl (PCB 187)
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (PCB 194)

2,2',3,3',4,4',5,6-Octachlorobiphenyl (PCB 195)
2,2',3,3',4,4',5,6' and 2,2',3,4,4',5,5',6-Octa-chlorobiphenyl (PCB 196 & 203)
2,2',3,3',4,5,5',6-Octachlorobiphenyl (PCB 199)
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (PCB 206)
2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl (PCB 209)

Polychlorinated Dibenzo-*p*-dioxins[3]

1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin
1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD)

Polychlorinated Dibenzofurans[3]

1,2,3,4,6,7,8-Heptachlorodibenzofuran
1,2,3,4,7,8,9-Heptachlorodibenzofuran
1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,6,7,8-Hexachlorodibenzofuran
1,2,3,7,8,9-Hexachlorodibenzofuran
2,3,4,6,7,8-Hexachlorodibenzofuran
1,2,3,4,6,7,8,9-Octachlorodibenzofuran
1,2,3,7,8-Pentachlorodibenzofuran
2,3,4,7,8-Pentachlorodibenzofuran
2,3,7,8-Tetrachlorodibenzofuran

Polycyclic Aromatic Hydrocarbons (PAHs)[3]

Benz[a]anthracene
- 1-Hydroxybenz[a]anthracene
- 3-Hydroxybenz[a]anthracene
- 9-Hydroxybenz[a]anthracene

Benzo[a]pyrene
- 3-Hydroxybenzo[a]pyrene

Benzo[c]phenanthrene
- 1-Hydroxybenzo[c]phenanthrene
- 2-Hydroxybenzo[c]phenanthrene
- 3-Hydroxybenzo[c]phenanthrene

Chrysene
- 1-Hydroxychrysene
- 2-Hydroxychrysene
- 3-Hydroxychrysene
- 4-Hydroxychrysene
- 6-Hydroxychrysene

Fluoranthene
- 3-Hydroxyfluoranthene

Fluorene
- 2-Hydroxyfluorene
- 3-Hydroxyfluorene
- 9-Hydroxyfluorene

Naphthalene
- 1-Hydroxynaphthalene
- 2-Hydroxynaphthalene

Phenanthrene
- 1-Hydroxyphenanthrene
- 2-Hydroxyphenanthrene
- 3-Hydroxyphenanthrene
- 4-Hydroxyphenanthrene
- 9-Hydroxyphenanthrene

Pyrene
- 1-Hydroxypyrene

Synthetic Hormones used in Food Production[1]

Melengestrol acetate
Trenbolone acetate
Zeranol

Tobacco Smoke

Nicotine
- Cotinine

Volatile Organic Compounds[3]

Benzene
Carbon tetrachloride
Chlorobenzene
Dibromomethane
1,2-Dibromo-3-chloropropane (DBCP)
1,2-Dichlorobenzene (*o*-Dichlorobenzene)
1,3-Dichlorobenzene (*m*-Dichlorobenzene)
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
cis-1,2-Dichloroethene
trans-1,2-Dichloroethene
Dichloromethane (Methylene chloride)
1,2-Dichloropropane
2,5-Dimethylfuran
Ethylbenzene
Hexachloroethane
Methyl-*t*-butyl ether (MTBE)
Nitrobenzene
Styrene
1,1,2,2-Tetrachloroethane
Tetrachloroethylene (Perchloroethylene)
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Toluene
m-Xylene
o-Xylene
p-Xylene

Notes

[1] All members of the chemical class are designated chemicals, including, but not limited to, the chemicals shown.

[2] Diesel exhaust is a complex mixture that contains many components, one or more of which may be useful as an indicator for biomonitoring.

[3] All members of the chemical class are not designated chemicals; only the specific chemicals listed are designated chemicals.

[4] Triclocarban is not a phenol but can be analytically measured with environmental phenols. When it is released into the environment, it is commonly found in the same environmental media as triclosan.

[5] Includes n-butylparaben and isobutylparaben.

[6] Fungicides, herbicides, and insecticides are grouped under the general heading of "Pesticides."

[7] 1-Hydroxynaphthalene is the metabolite of both carbaryl and naphthalene. To determine the percent of 1-hydroxynaphthalene attributable to carbaryl alone, 2-hydroxynaphthalene (which is only a metabolite of naphthalene) must also be measured.

[8] Includes di-n-butyl phthalate and di-isobutyl phthalate.

Biomonitoring California
Priority Chemicals
February 2011

The following is a list of priority chemicals for Biomonitoring California.[a] The Scientific Guidance Panel (SGP) recommends priority chemicals from the designated chemical list. Targets for measurement in biomonitoring studies could include the parent chemical, metabolites and other chemical products formed in the body or the environment (e.g., hemoglobin adduct; environmental degradation product). The approach for biomonitoring a chemical may change as methods development proceeds. The parent chemical is provided in the list below and, for some parent chemicals, other targets for biomonitoring are shown indented underneath. Biomonitoring California determines the chemicals that are actually biomonitored and the appropriate targets for measurement.

Brominated and Chlorinated Organic Compounds used as Flame Retardants[1]

2,2-Bis(bromomethyl)-1,3-propanediol
2,2-Bis(chloromethyl)trimethylene bis[bis(2-chloroethyl)phosphate]
Bis(2-ethyl-1-hexyl)tetrabromophthalate (TBPH)
Bis(hexachlorocyclopentadieno)cyclooctane (Dechlorane Plus)
1,2-Bis(2,4,6-tribromophenoxy)ethane (BTBPE)
1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane
2,3-Dibromopropyl-2,4,6-tribromophenyl ether (DPTE)
2-Ethyl-1-hexyl-2,3,4,5-tetrabromobenzoate (TBB)
Chlorendic acid
Decabromodiphenylethane (DBDPE)
Hexabromobenzene
2,2',4,4',5,5'-Hexabromobiphenyl (BB 153)
Hexabromocyclododecane (HBCD)
Hexachlorocyclopentadienyl-dibromocyclooctane
N,N'-Ethylenebis(tetrabromophthalimide)
Pentabromoethylbenzene
Pentabromotoluene
Short-chain chlorinated paraffins
Tetrabromobisphenol A (TBBPA)
Tetrabromobisphenol A bis(2,3-dibromopropyl) ether
Tetrabromobisphenol A bis(2-hydroxyethyl) ether
Tetrabromophthalic anhydride
Tetrakis(2-chloroethyl)dichloroisopentyl diphosphate
2,4,6-Tribromophenol
Tris(2-chloroethyl)phosphate (TCEP)
Tris(1-chloro-2-propyl)phosphate (TCPP)
Tris(1,3-dichloro-2-propyl)phosphate (TDCPP)
Tris(2,3-dichloro-1-propyl)phosphate

<u>Polybrominated diphenyl ethers (PBDEs)</u>

2,2',4-Tribromodiphenyl ether (BDE 17)
2,4,4'-Tribromodiphenyl ether (BDE 28)
2,2',4,4'-Tetrabromodiphenyl ether (BDE 47)
2,3',4,4'-Tetrabromodiphenyl ether (BDE 66)
2,2',3,4,4'-Pentabromodiphenyl ether (BDE 85)
2,2',4,4',5-Pentabromodiphenyl ether (BDE 99)
2,2',4,4',6-Pentabromodiphenyl ether (BDE 100)
2,2',4,4',5,5'-Hexabromodiphenyl ether (BDE 153)
2,2',4,4',5,6'-Hexabromodiphenyl ether (BDE 154)
2,2',3,4,4',5',6-Heptabromodiphenyl ether (BDE 183)
2,2',3,3',4,4',5,5',6,6'-Decabromodiphenyl ether (BDE 209)

Cyclosiloxanes[1]

Decamethylcyclopentasiloxane (D5)
Dodecamethylcyclohexasiloxane (D6)
Octamethylcyclotetrasiloxane (D4)

Diesel Exhaust[2]

Environmental Phenols[3]

Bisphenol A
Triclosan

<u>Parabens[3]</u>

Butylparaben[4]
Ethylparaben
Methylparaben
n-Propylparaben

Metals[3]

Arsenic
- Arsenic (V) acid
- Arsenobetaine
- Arsenocholine
- Arsenous (III) acid
- Dimethylarsinic acid
- Monomethylarsonic acid
- Trimethylarsine oxide

Cadmium

a. California Environmental Contaminant Biomonitoring Program, codified at Health and Safety Code section 105440 et seq.

Lead
Mercury

Perchlorate

Perfluorochemicals[3]

2-(N-Ethylperfluorooctanesulfonamido) acetic acid
2-(N-Methylperfluorooctanesulfonamido) acetic acid
Perfluorobutane sulfonic acid
Perfluorodecanoic acid
Perfluorododecanoic acid
Perfluoroheptanoic acid
Perfluorohexane sulfonic acid
Perfluorononanoic acid
Perfluorooctane sulfonamide
Perfluorooctane sulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluoroundecanoic acid

Pesticides[3, 5]

Herbicides[3]

2,4-Dichlorophenoxyacetic acid (2,4-D), salts and esters
- 2,4-Dichlorophenoxyacetic acid
- 2,4-Dichlorophenol

Organochlorine Pesticides[3]

Dichlorodiphenyltrichloroethane (DDT) (including p,p'-DDT and o,p'-DDT)
- p,p'-Dichlorodiphenyldichloroethene (DDE)

Organophosphorus Insecticides[3]

Acephate
Azinphos methyl
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate

Chlorethoxyphos
- Diethylphosphate
- Diethylthiophosphate

Chlorpyrifos
- Diethylphosphate
- Diethylthiophosphate
- 3,5,6-Trichloro-2-pyridinol

Chlorpyrifos methyl
- Dimethylphosphate
- Dimethylthiophosphate
- 3,5,6-Trichloro-2-pyridinol

Coumaphos
- 3-Chloro-7-hydroxy-4-methyl-2H-chromen-2-one/ol
- Diethylphosphate
- Diethylthiophosphate

Diazinon
- Diethylphosphate
- Diethylthiophosphate
- 2-Isopropyl-4-methyl-6-hydroxypyrimidine

Dichlorvos (DDVP)
- Dimethylphosphate

Dicrotophos
- Dimethylphosphate

Dimethoate
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate

Disulfoton
- Diethyldithiophosphate
- Diethylphosphate
- Diethylthiophosphate

Ethion
- Diethyldithiophosphate
- Diethylphosphate
- Diethylthiophosphate

Fenitrothion
- Dimethylphosphate
- Dimethylthiophosphate

Fenthion
- Dimethylphosphate
- Dimethylthiophosphate

Isazophos-methyl
- 5-Chloro-1,2-dihydro-1-isopropyl-[3H]-1,2,4-triazol-3-one
- Dimethylphosphate
- Dimethylthiophosphate

Malathion
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate
- Malathion dicarboxylic acid

Methamidophos
Methidathion
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate

Methyl parathion
- Dimethylphosphate
- Dimethylthiophosphate
- *p*-Nitrophenol

Naled
- Dimethylphosphate

Oxydemeton-methyl
- Dimethylphosphate
- Dimethylthiophosphate

Parathion (Ethyl parathion)
- Diethylphosphate
- Diethylthiophosphate
- *p*-Nitrophenol

Phorate
- Diethyldithiophosphate
- Diethylphosphate
- Diethylthiophosphate

Phosmet (Imidan)
- Dimethyldithiophosphate
- Dimethylphosphate
- Dimethylthiophosphate

Pirimiphos-methyl
- 2-(Diethylamino)-6-methylpyrimidin-4-ol/one
- Dimethylphosphate
- Dimethylthiophosphate

Sulfotepp
- Diethylphosphate
- Diethylthiophosphate

Temephos
- Dimethylphosphate
- Dimethylthiophosphate

Terbufos
- Diethyldithiophosphate
- Diethylphosphate
- Diethylthiophosphate

Tetrachlorvinphos
- Dimethylphosphate

Pyrethroid Pesticides[3]

Allethrin
- *cis/trans*-Dimethylvinylcyclopropane carboxylic diacid

Cyfluthrin
- *cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- *trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- 4-Fluoro-3-phenoxybenzoic acid

Cyhalothrin (including *lamba*- and *gamma*-)
- 3-Phenoxybenzoic acid

Cypermethrin (including *cis*- and *trans*-)
- *cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- *trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- 3-Phenoxybenzoic acid

Deltamethrin
- *cis*-3-(2,2-Dibromovinyl)-2,2-dimethylcyclopropane carboxylic acid
- 3-Phenoxybenzoic acid

Fenpropathrin
- 3-Phenoxybenzoic acid

Permethrin (including *cis*- and *trans*-)
- *cis*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- *trans*-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid
- 3-Phenoxybenzoic acid

Pyrethrin 1
- *cis/trans*-Dimethylvinylcyclopropane carboxylic diacid

Resmethrin
- *cis/trans*-Dimethylvinylcyclopropane carboxylic diacid

Tralomethrin
- 3-Phenoxybenzoic acid

Other Pesticides

1,4-Dichlorobenzene (*p*-Dichlorobenzene)
- 2,5 Dichlorophenol

Phthalates[3]

Benzylbutyl phthalate (BzBP)
- Mono-benzyl phthalate

Dibutyl phthalate (DBP)[6]
- Mono-*n*-butyl phthalate
- Mono-isobutyl phthalate

Dicyclohexyl phthalate (DCHP)
- Mono-cyclohexyl phthalate

Diethyl phthalate (DEP)
- Mono-ethyl phthalate

Di-2-ethylhexyl phthalate (DEHP)
- Mono-(2-ethyl-5-carboxypentyl) phthalate
- Mono-2-ethylhexyl phthalate
- Mono-(2-ethyl-5-hydroxyhexyl) phthalate
- Mono-(2-ethyl-5-oxohexyl) phthalate

Di-isodecyl phthalate (DiDP)
- Mono-(carboxynonyl) phthalate

Di-isononyl phthalate (DiNP)
- Mono(carboxyisononyl) phthalate
- Mono(hydroxyisononyl) phthalate
- Mono-isononyl phthalate
- Mono(oxoisononyl) phthalate

Dimethyl phthalate (DMP)
- Mono-methyl phthalate

Di-*n*-octyl phthalate (DOP)
- Mono-(3-carboxypropyl) phthalate
- Mono-*n*-octyl phthalate

Polychlorinated Biphenyls (PCBs), Dioxin-Like[3]

Coplanar PCBs[3]

3,4,4',5-Tetrachlorobiphenyl (PCB 81)
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)

Mono-*ortho*-Substituted PCBs[3]

2,3,3',4,4'-Pentachlorobiphenyl (PCB 105)
2,3',4,4',5-Pentachlorobiphenyl (PCB 118)
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)

2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)

Polychlorinated Biphenyls (PCBs), Non-Dioxin-Like[3]

2,2',5-Trichlorobiphenyl (PCB 18)
2,4,4'-Trichlorobiphenyl (PCB 28)
2,2',3,5'-Tetrachlorobiphenyl (PCB 44)
2,2',4,5'-Tetrachlorobiphenyl (PCB 49)
2,2',5,5'-Tetrachlorobiphenyl (PCB 52)
2,3',4,4'-Tetrachlorobiphenyl (PCB 66)
2,4,4',5-Tetrachlorobiphenyl (PCB 74)
2,2',3,4,5'-Pentachlorobiphenyl (PCB 87)
2,2',4,4',5-Pentachlorobiphenyl (PCB 99)
2,2',4,5,5'-Pentachlorobiphenyl (PCB 101)
2,3,3',4',6-Pentachlorobiphenyl (PCB 110)
2,2',3,3',4,4'-Hexachlorobiphenyl (PCB 128)
2,2',3,4,4',5' and 2,3,3',4,4',6-Hexachlorobiphenyl (PCB 138 & 158)
2,2',3,4',5,5'-Hexachlorobiphenyl (PCB 146)
2,2',3,4',5',6'-Hexachlorobiphenyl (PCB 149)
2,2',3,5,5',6-Hexachlorobiphenyl (PCB 151)
2,2',4,4',5,5'-Hexachlorobiphenyl (PCB 153)
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)
2,2',3,3',4,5,5'-Heptachlorobiphenyl (PCB 172)
2,2',3,3',4,5',6'-Heptachlorobiphenyl (PCB 177)
2,2',3,3',5,5',6-Heptachlorobiphenyl (PCB 178)
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)
2,2',3,4,4',5',6-Heptachlorobiphenyl (PCB 183)
2,2',3,4',5,5',6-Heptachlorobiphenyl (PCB 187)
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (PCB 194)
2,2',3,3',4,4',5,6-Octachlorobiphenyl (PCB 195)
2,2',3,3',4,4',5,6' and 2,2',3,4,4',5,5',6-Octachlorobiphenyl (PCB 196 & 203)
2,2',3,3',4,5,5',6-Octachlorobiphenyl (PCB 199)
2,2',3,3',4,4',5,5',6'-Nonachlorobiphenyl (PCB 206)
2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl (PCB 209)

Polycyclic Aromatic Hydrocarbons (PAHs)[3,7]

3-Hydroxybenzo[a]pyrene
6-Hydroxychrysene
3-Hydroxyphenanthrene

Tobacco Smoke

Nicotine
Cotinine

Notes

[1] All members of the chemical class are priority chemicals, including, but not limited to, the chemicals listed.

[2] Diesel exhaust is a complex mixture that contains many components, one or more of which may be useful as an indicator for biomonitoring.

[3] All members of the chemical class are not priority chemicals; only the specific chemicals listed are priority chemicals.

[4] Includes n-butylparaben and isobutylparaben.

[5] Fungicides, herbicides, and insecticides are grouped under the general heading of "Pesticides."

[6] Includes di-n-butyl phthalate and di-isobutyl phthalate.

[7] The SGP recommended the three hydroxy-PAHs listed as priority chemicals. These three hydroxy-PAHs are metabolites of benzo[a]pyrene, chrysene and phenanthrene, respectively.

IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM: 2010-2012

Appendix E

Agenda and Summary of Findings from March 2011 Biomonitoring California Workshop on Understanding and Interpreting Biomonitoring Results

California Department of Public Health
in collaboration with
California Environmental Protection Agency's
Office of Environmental Health Hazard Assessment and
Department of Toxic Substances Control

January 2013

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Diana Dooley
Secretary
California Health and Human Services Agency

Ron Chapman, MD, MPH
Director & State Health Officer
California Department of Public Health

Biomonitoring California Workshop
Understanding and Interpreting Biomonitoring Results
Elihu M. Harris State Office Building, Auditorium
1515 Clay Street, Oakland, California
March 17, 2011, 9 am to 5 pm

9:00 Welcome
George Alexeeff, Acting Director, Office of Environmental Health Hazard Assessment

9:10 Overview of workshop goals and introduction of morning speakers

9:25 Biomonitoring of Exposure to Environmental Chemicals: Complexities in Interpreting Data
Dana Barr, Emory University

9:55 "Is It Safe?": New Ethics for Reporting Personal Exposures to Environmental Chemicals
Ruthann Rudel, Silent Spring Institute

10:25 Break

10:45 Making Sense of Human Biomonitoring Data
Tina Bahadori, American Chemistry Council

11:15 Morning questions and discussion

11:45 Lunch

1:00 Introduction of afternoon speakers

1:10 Interpreting Biomonitoring Data in a Risk Assessment Context Using Biomonitoring Equivalents
Lesa Aylward, Summit Toxicology

1:40 Importance of Pharmacokinetics and Distributional Analysis for Understanding Biomonitoring Results
Dale Hattis, Clark University

2:10 Understanding and Interpreting Biomonitoring Results in the Context of Sustainable Communities
Amy Kyle, UC Berkeley

2:40 Break

3:00 Afternoon questions and discussion

3:30 Panel discussion (all speakers) with audience participation

4:45 Wrap up

5:00 Adjourn

For questions on the workshop, contact:
biomonitoring@oehha.ca.gov

Highlights of Discussion at the

March 17, 2011 Workshop on Understanding and Interpreting Biomonitoring Results

On March 17, 2011 Biomonitoring California held a public workshop in Oakland on "Understanding and Interpreting Biomonitoring Results." The objectives of the workshop were to:

- Discuss approaches for understanding and interpreting biomonitoring results, including strengths and weaknesses;
- Discuss methods for developing comparison levels in blood or urine;
- Discuss scientific challenges with interpreting biomonitoring results, including how to address multiple chemical exposures and sensitive sub-populations; and
- Provide guidance to Biomonitoring California on approaches for understanding and interpreting biomonitoring results.

The workshop included presentations and panel discussions by six national experts and interactive sessions with the audience. Workshop materials, including the agenda, the workshop description, the presentations, and the full transcript, are available online: http://www.oehha.ca.gov/multimedia/biomon/sgpwrkshp031711.html.

Highlights of Workshop Discussion

There was a rich discussion of many issues at the workshop, which is captured in the full transcript (http://www.oehha.ca.gov/multimedia/biomon/pdf/March172011Wrkshptranscript.pdf). Below are some highlights of the discussion, focused on issues most relevant to what the Program is currently working on and grouped into general topic areas. These points were drawn mainly from the discussion periods and reflect ideas from the speakers and members of the audience. They do not necessarily reflect the views of the Program.

Returning individual results: context and uncertainty
This section includes paraphrased comments from the speakers and audience related to returning results to individual participants and how to provide context for those results, especially in the face of uncertainty.

- Most people want to receive their results. The main questions that people want answers to when they get their results are: What did you find? How much? Is it high? Is it safe? Where did it come from? What should I do?

- The Program can use the consent process as a conversation, to let people know what to expect when they receive their individual results - i.e., that the Program will tell participants what is known, and that for many chemicals, the health implications are uncertain.

- Communicating uncertain science is challenging and it is important to find a balance between creating unnecessary worry and providing false reassurance.

- People are familiar with dealing with uncertainty and with decision-making in the face of uncertainty. We do it all the time in many contexts in our lives.
- Putting individual results in context with respect to study population values and NHANES or other relevant comparison populations is valuable.
- By including both the range of values observed in the study population as well as the 5th to 95th percentiles from the NHANES program, individuals could see whether the exposures occurring in the population the study they participated in are unusual.
- Using NHANES levels alone as a baseline for comparisons has some limitations because the demographics in California are different than those in the U.S. as a whole.
- Conveying the variability of measurements of the same chemical in the same person, especially for non-persistent compounds, is important and challenging.

Information on chemical health effects and exposure sources for report back *This section includes paraphrased comments from the speakers and audience related to providing information to participants on potential health effects and exposure sources of biomonitored chemicals.*

- If people are provided with information about exposure sources for a biomonitored chemical, some will be interested in deciding whether or not to use a particular product or participate in an activity that may lead to exposure. This may be true even in the absence of information describing possible health effects related to their biomonitoring results. By providing information on exposure sources and ways to reduce exposures, the Program can support this decision making.
- To provide for informed decision-making, it is important that that information about exposure sources be accurate. Commonly used sources of information, such as those on the Internet, can be inaccurate and out-dated.
- It would be helpful if consumer product manufacturers would provide more information on what chemicals are in their products.
- How much is known about a chemical's health effects and exposure can guide communication. When there is a good understanding of exposure sources and health effects, the message can involve a clear action message (e.g., lead, mercury). When there is some information about the health effects but very little about how to reduce exposure, precautionary action and more research (e.g., flame retardants) can be recommended.
- Describing the history of when a chemical was first introduced and how it is used is one way to provide context for understanding individual results. For example, if a population had been measured 20 or 30 years ago, the reference range for many chemicals would have been much different. Certain chemicals would not have been detected at all because they hadn't been synthesized yet.
- In explaining the presence of chemicals that have long been biomonitored (lead,

dioxins, PCB compounds), the Program could include a description of these as success stories, in which biomonitoring data was used to spur actions which led to declining exposures to these chemicals.

Developing levels of health concern or other health comparison levels

This section includes paraphrased comments from the speakers and audience related to the possibility that the Program would develop health-based values to guide interpretation of individual participants' results.

- The Program can provide advice on follow up actions to participants where there is some certainty (e.g., lead, mercury). Follow up action on these well-known hazards is most simply guided by setting a specific level and talking with anyone who exceeds that level.

- An argument against setting a "bright line" level of health concern for most chemical exposures is that this approach does not account for an exposure that may shift the whole population lower on a distribution of a health outcome. For example, lead exposures can affect intelligence across the whole population by moving some of the population who are already on the lower end of the distribution into the "retarded" range, and some on the higher end out of the "gifted" range. It is not only those who are above a certain threshold level who are impacted by this overall shift in the distribution.

- Biomonitoring equivalents (BEs) are not intended for interpreting individual participants' results. They are most useful for population level interpretation of biomonitoring results. BEs are a translation of existing risk assessments, so are limited by the quality of those risk assessments.

- The Program should not spend time developing risk interpretations for individual participants for most biomonitored chemicals, as attempting to do so could delay progress of the Program.

Evaluating exposures and studying early effect markers

This section includes paraphrased comments from the speakers and audience related to-possible approaches for using biomonitoring studies to identify exposure sources and investigate early markers of possible health effects.

- Conducting follow-up with people who have exposures at the upper end of the distribution for the study population can help identify highly exposed populations ("Who's high and why?"), find undocumented exposure sources, and explain aspects of population exposure variability.

- The "exposome" attempts to conceptually incorporate many different factors that

interplay to impact health, including stress, diet, exercise, as well as chemical exposures. It

is limited by the data inputs, which may not include any info on exposures during sensitive time periods (e.g., puberty, infancy).

- Intervention studies are one way to identify exposure sources and can provide information about how people might reduce their exposures. Potential exposure sources are removed, with samples (e.g., blood or urine) taken before and after the removal. In some studies, potential sources may be re-introduced (e.g., known dietary sources of pesticide exposure) and samples taken again. These intervention studies may allow researchers to document and track changes in the levels of biomonitored chemicals attributed to the changes in exposure sources.

- Correlational studies analyzing which chemicals occur together in biomonitoring data can provide insights to sources of exposure. Such analyses might also point to new directions, in terms of health effects to look for that might be caused by those co-occurrences.

- It would be valuable to relate biomonitoring data to "natural integrator" outcomes like birth weight, which can be influenced by multiple chemical exposures as well as many other factors.

- Biomonitoring studies can be an opportunity to look for early effect markers (e.g., thyroid hormone levels), which could be done most efficiently by focusing on people who have high exposures to particular compounds. One way to do this would be to use an `omics' approach to evaluate hundreds or thousands of chemicals in samples collected over time, measure markers, such as changes in enzyme levels or protein production, and observe how changes in exposure sources affect these early markers.

Aspects of biomonitoring measurements
This section includes paraphrased comments from the speakers and audience related to analytical and measurement issues that could impact interpretation of results.

- The level of detection (LOD) is not a static number, but can change over time, as well as for different runs of the same machine testing samples for the same chemical.

- Methodology improvements that have led to very low LODs for some chemicals but not others mean simple "detection" of a chemical as a signal of interest is problematic. Detection is very much driven by our analytical capabilities.

- The Program should consider taking multiple measurements in each person in a study rather than having a larger total study size with only one data point per person. This would provide a better estimate of the variability of levels seen in an individual, especially for non-persistent chemicals.

Informing public health and regulatory actions
This section includes paraphrased comments from the speakers and audience related to using biomonitoring results to help guide Program priorities and public health and regulatory policies.

- Biomonitoring California was created partly to address a strong interest of certain subpopulations (for example, communities living in highly industrialized areas) to gain information that would help them to understand what they perceive as their increased risks

  from chemical exposures. For the Program to be able to give subpopulations that kind of information, it needs data that could establish baseline exposures for the general population of California.

- The Program should focus on generating biomonitoring data that can be used to set population-based priorities and inform policies on which chemical exposures warrant action.

- The desire to look at emerging chemicals was an important driver in the Program's beginning. That effort should not be slowed down in any way, for example, because of a need to figure out a context for communicating the results before the Program studies emerging chemicals.

- For the Program as a whole, it is important to think strategically about the questions that can be answered with the kind of results that will be generated, and how these questions relate to the responsibilities of Cal/EPA and CDPH.

- The legislative provision to return results to participants was about people having a right to know, and was not intended to be a primary goal of the Program.

- Learning about biomonitoring results can lead to an increase in environmental health literacy. Information gives a person or a community the power to make choices, including individual and policy level actions that could reduce exposures.

- Both manufacturers and people who use products tend to reduce use of the substance or product that is identified as posing exposure or health concerns. The pattern is that well-studied chemicals tend to get replaced with alternative substances that are typically less well studied than the substances that are being replaced. This issue is an ongoing challenge.

- The design of chemistries for consumer products should take into account biopersistence and other characteristics that lead to chemicals being human health concerns. Design characteristics that make a chemical commercially valuable (e.g., really stable, flame retardant) may often be the exact same properties that make them undesirable for the environment and human health.

Next Steps

The Scientific Guidance Panel (SGP) for Biomonitoring California will discuss the March 17 workshop at their meeting on July 14, 2011 in Sacramento (for meeting details visit: http://www.oehha.ca.gov/multimedia/biomon/07142011agenda.html). The Panel will provide their comments and recommendations on topics related to the workshop.

IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM: 2010-2012

Appendix F

Biomonitoring California Brochure (English and Spanish versions)

California Department of Public Health
in collaboration with
California Environmental Protection Agency's
Office of Environmental Health Hazard Assessment and
Department of Toxic Substances Control

January 2013

Edmund G. Brown, Jr.
Governor
State of California

Diana Dooley
Secretary
California Health and Human Services Agency

Ron Chapman, MD, MPH
Director & State Health Officer
California Department of Public Health

Which Chemicals Are Measured?

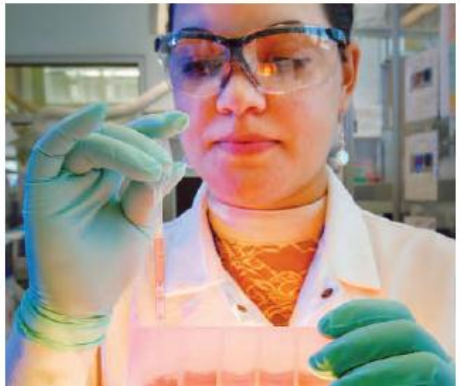
Scientists can measure many chemicals in the body. Usually, they measure chemicals that can be harmful, are widely used, and stay in the body or the environment for a long time. For example,

Pesticides are used to kill insects in homes, yards, farms, parks, and on pets.

Flame retardants are in the foam in furniture and in cars, electronics, and many other products. They get into the air, dust, and food.

Mercury comes from coal-fired power plants and mines. It pollutes our air and water. It gets into fish that we eat. It is also in some skin lightening creams.

Phthalates (THAL-ates) are in many plastic products. They are also in nail polish and products with added "fragrance," such as shampoos, air fresheners, and candles.



Biomonitoring California

Biomonitoring California was created to help protect the people of California from harmful chemicals.

Biomonitoring California *measures levels of certain chemicals in Californians and how the levels change over time.*

Biomonitoring California *helps evaluate how well government programs protect the public from harmful chemicals.*

To find out more about *Biomonitoring California*, or for more information about biomonitoring,

email: **biomonitoring@oehha.ca.gov**

visit: **www.biomonitoring.ca.gov**

BIOMONITORING CALIFORNIA

A joint program of the California Department of Public Health, Office of Environmental Health Hazard Assessment, and Department of Toxic Substances Control.

What Is Biomonitoring?

Measuring chemicals in our bodies

BIOMONITORING CALIFORNIA

Chemicals in Everyday Life

We come into contact with many chemicals each day. They are used in industry and agriculture. They are in common products, such as cosmetics, toys, and plastics.

Some of these chemicals get into our air, water, soil, dust, and food. As a result, all of us have chemicals in our bodies. We may have more or fewer chemicals—depending on the products we use, the jobs we do, and the places we live.

Chemicals and Our Health

Some chemicals can harm our health. They can cause birth defects, learning problems, weight gain, cancer, asthma, and other illnesses. However, many chemicals have not been well studied, so we do not know if they affect our health.

What is Biomonitoring?

Biomonitoring (bi-o-MON-i-tor-ing) is a way to measure the chemicals in a person's body. It can tell us which chemicals are there and how much.

Scientists usually test for chemicals in samples of blood and urine. There are only a few labs that can do this testing.

Like other parents, Tony wants to protect his son's health. "We need to learn which chemicals our kids are exposed to."

Why is Biomonitoring Important?

Biomonitoring helps us learn which chemicals get into our bodies.

This information can be used to:

- Learn more about how chemicals affect our health.
- Help keep harmful chemicals out of our environment and the products we buy.

Taking Part in a Biomonitoring Project

Biomonitoring California is a state government program. You may be asked to take part in one of the *Biomonitoring California* projects. If you agree to participate:

- You will be asked to provide blood, urine, or other samples for testing.
- You can see your results.
- Your results will be confidential.
- You will learn if you have chemicals in your body that might be harmful. However, safe amounts for most chemicals are not known.
- You will learn ways to help keep some chemicals out of your body.

Anna was asked to be part of a biomonitoring project with other pregnant women.

¿Qué químicos se miden?

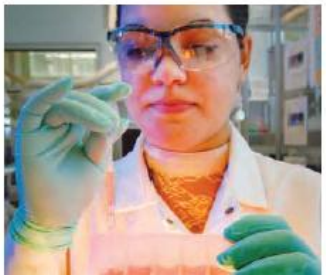
Los científicos pueden medir muchos químicos en el cuerpo. Generalmente, miden químicos que pueden ser perjudiciales, que se usan mucho y que permanecen en el cuerpo o en el medioambiente durante un largo tiempo. Por ejemplo,

Los pesticidas se usan para matar insectos en los hogares, jardines, granjas, parques y en las mascotas.

Los productos que retrasan el fuego se encuentran en la esponja en los muebles y en los coches, en los aparatos electrónicos y en muchos otros productos. Se filtran en el aire, en el polvo y en los alimentos.

El mercurio proviene de las plantas que funcionan con carbón y de las minas, contamina nuestro aire y agua, y se introduce en el pescado que comemos. Además, se encuentra en algunas cremas para aclarar la piel.

Los ftalatos se encuentran en muchos productos de plástico. También están en los esmaltes de uñas y en los productos con "fragancias" agregadas, como los champús, refrescantes del aire y velas.



Programa de Biomonitoring California

Biomonitoring California se creó para ayudar a proteger a la gente de California contra químicos perjudiciales.

***Biomonitoring California** mide las concentraciones de ciertos químicos en los californianos, y cómo las concentraciones cambian con el tiempo.*

***Biomonitoring California** ayuda evaluar qué tan bien los programas gubernamentales protegen al público contra químicos perjudiciales.*

Para más información sobre *Biomonitoring California*, o para obtener más información acerca del biomonitoreo,

email: **biomonitoring@oehha.ca.gov**
visite: **www.biomonitoring.ca.gov**

BIOMONITORING CALIFORNIA

Un programa conjunto del Departamento de Salud Pública de California, de la Oficina para la Evaluación de los Peligros a la Salud Ambiental y del Departamento para el Control de Substancias Tóxicas.

¿Qué es el biomonitoreo?

Cómo medir los químicos en el cuerpo

BIOMONITORING CALIFORNIA

Los químicos en la vida cotidiana

Todos los días, estamos en contacto con muchos químicos. Éstos se usan en la industria y en la agricultura. Están en los productos comunes, como los cosméticos, juguetes y plásticos.

Algunos de estos químicos se filtran en nuestro aire, agua, tierra, polvo y los alimentos. Como resultado, todos nosotros tenemos químicos en el cuerpo. Posiblemente tengamos más o menos químicos—dependiendo de los productos que usamos, los empleos que desempeñamos y los lugares en que vivimos.

Los químicos y nuestra salud

Algunos químicos pueden dañar nuestra salud y causar defectos congénitos, problemas de aprendizaje, aumento de peso, cáncer, asma y otras enfermedades. Sin embargo, muchos químicos no se han estudiado bien, así que no sabemos si afectan nuestra salud.

¿Qué es el biomonitoreo?

El biomonitoreo es una manera de medir los químicos en el cuerpo. Puede indicarnos qué químicos hay y en qué cantidad.

Generalmente, los científicos hacen análisis para detectar químicos en las muestras de sangre y de orina. Sólo hay unos cuantos laboratorios que pueden hacer estas pruebas.

Como otros padres, Tony quiere proteger la salud de su hijo. "Necesitamos averiguar a qué químicos están expuestos nuestros hijos."

¿Por qué es importante el biomonitoreo?

El biomonitoreo nos ayuda a averiguar qué químicos se introducen en el cuerpo.

Esta información puede usarse para:

- Aprender más acerca de cómo los químicos afectan nuestra salud.
- Ayudar a mantener los químicos perjudiciales lejos de nuestro medioambiente y los productos que compramos.

La participación en un proyecto de biomonitoreo

Biomonitoring California es un programa del gobierno estatal. Es posible que se le invite a usted a participar en uno de los proyectos de *Biomonitoring California*. Si usted decide participar:

- Se le pedirá que dé muestras de sangre, de orina u otras muestras para que se analicen.
- Usted puede ver sus resultados.
- Sus resultados serán confidenciales.
- Usted averiguará si tiene químicos en el cuerpo que podrían perdudicarle. Sin embargo, se desconocen las cantidades seguras para la mayoría de los químicos.
- Usted aprenderá maneras para ayudar a mantener algunos químicos fuera del cuerpo.

A Anna se le pidió que participara en un proyecto de biomonitoreo con otras mujeres embarazadas.

IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM: 2010-2012

Appendix G

Letter from the Chair of the Scientific Guidance Panel Supporting Biomonitoring California Priorities

California Department of Public Health
in collaboration with
California Environmental Protection Agency's
Office of Environmental Health Hazard Assessment and
Department of Toxic Substances Control

January 2013

Edmund G. Brown, Jr.
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Occupational and Environmental Medicine
Department of Medicine
5201 California Avenue, Suite 100
Irvine, CA 92617

August 18, 2011

Ron Chapman, MD, MPH
Director, California Department of Public Health
1615 Capitol Avenue
P.O. Box 997377, MS 0500
Sacramento, CA 95899-7377

Dear Dr. Chapman:

I am writing on behalf of the Scientific Guidance Panel (SGP) for the California Environmental Contaminant Biomonitoring Program (CECBP, also called Biomonitoring California) with our recommendations regarding the ongoing and future efforts of the Program. As you may know, the CECBP was established by legislation (Senate Bill 1379, Perata and Ortiz, Chapter 599, Statutes of 2006) to monitor the presence and concentration of selected chemicals in Californians. This legislation also established the SGP and stipulated that it be composed of nine members, five appointed by the Governor, two appointed by the Senate Committee on Rules, and two appointed by the Speaker of the Assembly. The SGP meets three times yearly to review progress and advise the Program. We met most recently on July 14, 2011.

Since the last report to the Legislature in 2010, the staff of the California Department of Public Health (CDPH), the Office of Environmental Health Hazard Assessment (OEHHA), and the Department of Toxic Substances Control (DTSC) have continued to do a truly outstanding job growing and developing the program and ensuring transparency and high quality participation across stakeholders and the general public. Moreover, they have accomplished this despite limited resources in very difficult fiscal times. During the past two years, the Program has identified new collaborators and initiated several exciting collaborative pilot projects, built laboratory capability and capacity, successfully obtained external funding, and actively engaged the public.

The SGP strongly endorses the efforts of the CECBP staff to obtain external resources to supplement State funding. We were extremely pleased that the cooperative agreement between the CECBP and the U.S. Centers for Disease Control and Prevention (CDC) was renewed at $2.6 million for 2010-11, the second year of a five-year agreement. Together with the $1.9 million in State funding for the CECBP, this cooperative agreement has enabled the Program to expand laboratory capability and capacity and to undertake targeted biomonitoring studies. The SGP

applauds the excellent progress made by both the CDPH Environmental Health Laboratory and the DTSC Environmental Chemistry Laboratory to develop new methods for the measurement of priority chemicals identified by the SGP, such as methods for the measurement of brominated organic flame retardants and of hydroxylated polycyclic aromatic hydrocarbons, as well as methods to measure chemicals in dried blood spots. The SGP commends the CECBP for their outreach efforts to form partnerships with other State programs and with academic researchers to conduct innovative and informative targeted studies. Examples of these successful ongoing and completed collaborations include:

- Maternal and Infant Environmental Exposure Project (MIEEP), a collaboration between CECBP and researchers at the University of California San Francisco and University of California Berkeley to conduct a pilot biomonitoring study to measure and compare levels of chemicals in pregnant women and their infants, for which enrollment of 92 participants, sample collection, and analyses of blood metals have been completed. A key early finding of MIEEP was the detection of elevated blood mercury in one mother-infant pair. The source of mercury exposure was identified as a face cream, and a Health Alert about mercury-adulterated creams from Mexico was distributed. This case is an excellent illustration of the benefits of biomonitoring. Additional biomonitoring analyses and development of report back materials for MIEEP are ongoing.
- Firefighter Occupational Exposures (FOX) Project, a collaboration between CECBP, researchers at the University of California Irvine, and the Orange County Fire Authority for which enrollment of 101 participants, sample collection, and biomonitoring analyses of metals and perfluorinated chemicals have been completed. Additional biological sample analyses and usability testing for results return materials are in progress.
- Biomonitoring Exposures Study (BEST), a collaboration between CECBP and the Kaiser Research Program on Genes, Environment, and Health of Kaiser Permanente Northern California (KPNC) to assess chemical exposures in a stratified random sample of KPNC members in seven Central Valley counties. Participant recruitment and sample collection have started for this project. BEST is an important first step in obtaining a regionally representative sample of Californians.
- CECBP collaborations with the CDPH Environmental Health Tracking Program to conduct biomonitoring for organophosphate insecticides in Tulare County and for perchlorate and metals in Imperial County. These studies have been successfully completed.

The SGP fully supports the Program priorities identified by CECBP staff for the coming fiscal year:

- Continue to pursue opportunities and collaborations to leverage existing resources.
- Continue conducting activities specified in the CDC cooperative agreement to increase laboratory capability and capacity.
- Continue outreach efforts to identify and engage additional stakeholders.
- Continue efforts to improve the biomonitoring website.
- Continue efforts to identify emerging chemicals of concern for possible biomonitoring.
- Refine methods and materials used for results communication.
- Begin to return the results of biomonitoring tests to participants.
- Meet with the SGP three times a year to obtain input and recommendations on all Program activities.

- The SGP also encourages the Program to pursue collaborations for the development of laboratory methods to screen unknown chemicals in Californians as a potentially important tool in the selection of chemicals for biomonitoring.

While the SGP strongly commends the outstanding progress the CECBP has made with limited resources, the SGP recognizes that the Program would need additional resources to fully accomplish the objectives of the law. Specifically, the law directs the State to establish a biomonitoring program that, "*will assist in the evaluation of the presence of toxic chemicals in a representative sample of Californians, establish trends in the levels of these chemicals in Californians…, and assess effectiveness of public health efforts and regulatory programs to decrease exposures….*" The funding needed to biomonitor a representative sample of California's 37 million residents would amount to an estimated $10 million annually, which is more than five times greater than the current state budget for the Program. Members of the SGP are well aware of the severe financial challenges currently facing the State and that it is not possible to increase Program funding at this time. The CECBP staff are doing a remarkable job of leveraging funding sources and of laying the groundwork for a full program in the future when additional funding becomes available. In order to continue making optimal use of current Program resources, the SGP strongly supports the maintenance of current Program staffing levels. At the earliest possible time, CDPH, OEHHA and DTSC should fill several critical vacancies that resulted from the hiring freeze and ensure that these vacant Program positions are not eliminated.

During the past two years, the CECBP has expanded laboratory capability and capacity and initiated pilot studies that are providing scientifically credible data on environmental exposures and providing insight into the public health impacts of these exposures. The CECBP is providing information on exposures that can ultimately support money-saving public health initiatives, reducing health care costs and preventing the need for costly environmental remediation. Finally, the increased capacity of California laboratories enabled by the Program will also improve the ability of our State to respond to terrorist attacks, industrial accidents, or other disasters involving human exposures and health effects.

Thank you for considering this information. We look forward to continuing our assistance to the State agencies charged with implementing this challenging and extremely important public health program. Please feel free to contact me if you would like me to provide further information about Biomonitoring California.

Respectfully,

Ulrike Luderer

Ulrike Luderer, M.D., Ph.D., M.P.H.
Chair, California Environmental Contaminant Biomonitoring Committee
Scientific Guidance Panel

IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM: 2010-2012

Appendix H

Acronyms Used in this Report

California Department of Public Health
in collaboration with the
Office of Environmental Health Hazard Assessment and
Department of Toxic Substances Control

January 2013

Acronym	Definition
BEST	Biomonitoring Exposures Study
BIG	Biomonitoring Interagency Group
BPA	Bisphenol A
CDC	U.S. Centers for Disease Control and Prevention
CDPH	California Department of Public Health
CEHTP	California Environment Health Tracking Program
CHAMACOS	Center for the Health Assessment of Mothers and Children of Salinas
CHARGE	Childhood Autism Risks from Genetics and the Environment
DBS	Dried Blood Spots
DTSC	Department of Toxic Substances Control
ECL	Environmental Chemistry Laboratory
EHL	Environmental Health Laboratory
FOX	Firefighter Occupational Exposures Project
FY	Fiscal Year
GC-MS/MS	Gas Chromatograph-Tandem Mass Spectrometer
GDSP	Genetic Disease Screening Program
HPLC-MS/MS	High Pressure Liquid Chromatograph-Tandem Mass Spectrometer
HRA	Health Research for Action
HRGC/MS	High Resolution Gas Chromatograph-Mass Spectrometer
H&SC	California Health and Safety Code
IC-MS/MS	Ion Chromatography-Tandem Mass Spectrometer
ICP-MS	Inductively Coupled Plasma-Mass Spectrometer
ISO	International Organization for Standardization
KPNC	Kaiser Permanente Northern California
LIMS	Laboratory Information Management System
MIEEP	Maternal and Infant Environmental Exposure Project
NHANES	National Health and Nutrition Examination Survey
NSP	Newborn Screening Program
OCPs	Organochlorine Pesticides
OEHHA	Office of Environmental Health Hazard Assessment
PBDEs	Polybrominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
PFCs	Perfluorinated Chemicals
PRHE	Program on Reproductive Health and the Environment
PSP	Prenatal Screening Program
RPGEH	Research Program on Genes, Environment and Health
SB	Senate Bill
SGP	Scientific Guidance Panel
SPH	School of Public Health
TCPy	Trichloropyridinol (a breakdown product of chlorpyrifos)
TCWF	The California Wellness Foundation
TSCA	Toxic Substances Control Account
UC	University of California
UCB	University of California, Berkeley
UC Irvine	University of California, Irvine
UCSF	University of California, San Francisco