# IMPLEMENTATION OF THE CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM

**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

January 2010

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## ACKNOWLEDGEMENTS

The California Environmental Contaminant Biomonitoring Program (CECBP) thanks former State Senators Don Perata and Deborah Ortiz for their tireless leadership in promoting biomonitoring in California, which resulted in the statutory foundation for this program.

We are grateful to the following people and organizations for their collaboration, advice, and support during the program's initial development and implementation:

- The chairman and members of the CECBP Scientific Guidance Panel for their individual and collective expertise, as well as their thoughtful recommendations;
- The Breast Cancer Fund and Commonweal, sponsors of the Legislation that established the CECBP, for their continuing support;
- Staff and management in both the National Center for Health Statistics and the National Center for Environmental Health (U.S. Centers for Disease Control and Prevention) for their guidance on population sampling, study design and laboratory analytical methods;
- University of California and other academic researchers for their interest in collaborative projects;
- California residents for providing information and important local perspectives; and
- Industry and manufacturing representatives for sharing technical data and commercial viewpoints.


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## Executive Summary

Biomonitoring is the science of measuring chemicals in humans. By directly measuring levels of potentially toxic environmental chemicals in blood, urine, or other biological specimens, biomonitoring can produce important public health information that cannot be provided by traditional air, water, and soil monitoring. The California Environmental Contaminant Biomonitoring Program (CECBP) was established through legislation in 2006 by Senate Bill (SB) 1379 (Perata, Chapter 599, Statutes of 2006; codified in Health & Safety Code (H&SC) Sections 105440 through 105459). Under SB 1379, the CECBP 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 provided by a distinguished Scientific Guidance Panel (SGP) and substantial opportunities for input by the public. The CECBP is the first legislatively mandated ongoing state biomonitoring program in the country.

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

- What chemicals are people exposed to?
- Which groups or populations in California have higher exposures to specific toxic chemicals?
- 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 now have 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 consumer products, diet, occupation, and other sources. 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 shape the State's nascent Green Chemistry Initiative.

The principal goals of the CECBP 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. Under SB 1379, the program is structured to identify and prioritize for analysis those chemicals of greatest potential public health concern to California residents. SB 1379 requires the program to submit progress reports every two years to the Legislature, beginning in January 2010. This document is the first of these reports.

Program Structure and Resources

CECBP is collaboratively administered by staff in three state departments. Responsibilities are broadly divided in the following manner:

- 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) processing, storage and analysis of blood and urine samples for specified priority chemicals, including metals and chemicals that are not biologically persistent; (4) communication of test results to participants who request them; (5) data analysis; (6) generation of reports to the Legislature; and (7) dissemination of information to the public.

- OEHHA has primary responsibility for: (1) administering and supporting the Scientific Guidance Panel, including scientific evaluation of information used to select chemicals for biomonitoring; (2) developing public outreach efforts, including maintenance of the program website and dissemination of information to the public; (3) carrying out data analysis; and (4) identifying levels of biomonitored chemicals in blood or urine that may be of health concern.

- DTSC has primary responsibility for analysis of blood samples for biologically persistent priority chemicals, such as flame retardants; and data analysis.

Staff members in all three departments collaborate on multiple activities within the overall division of labor, including program design, SGP meetings, and data analysis. For instance, OEHHA and DTSC staff contribute to the program design for which CDPH is the lead. Similarly, though OEHHA convenes and staffs the SGP meetings, representatives from DTSC and CDPH attend and make presentations to the Panel as well. Departmental responsibilities for analysis of data to be collected by the CECBP will be non-duplicative and will focus on different issues.

Baseline annual program funding for all three CECBP departments from FY 2007-08 to the present is $1.9 million. In FY 2008-09, the Legislature transferred CECBP's funding from the General Fund to the Toxic Substances Control Account (TSCA). The TSCA fund receives revenue primarily from environmental fees levied on businesses with 50 or more employees that handle hazardous materials and cost recovery of DTSC's work on hazardous substance release sites. TSCA annual revenues are not sufficient to cover annual expenditures. Given the current gap between TSCA annual revenues and expenditures, TSCA cannot indefinitely cover both the current CECBP allocation and other DTSC program activities intended to be funded from TSCA. Moreover, current state support for the CECBP is only a fraction of the amount needed to operate the full program mandated by SB 1379, including statewide surveys (estimated between $9M and $10M/year).

The CECBP was envisioned in SB 1379 to include a large-scale statewide survey, in which the program would measure levels of environmental chemicals in the blood, urine and possibly other biological specimens obtained from a representative sample of

California residents. However, because program funding has remained at baseline levels, implementation of the statewide program has had to be suspended. Nevertheless, considerable progress has been made on other aspects of program implementation, as described below.

CECBP staff has successfully sought supplemental extramural support. In collaboration with the nonprofit Sequoia Foundation, the CECBP submitted an application to the U.S. Centers for Disease Control and Prevention (CDC) in response to a competitive Request for Applications. CDC awarded California, New York and Washington states 5-year cooperative agreements to increase state biomonitoring laboratory capability and capacity. The CDC has indicated that this funding is to be used to supplement, not replace, existing state biomonitoring program support. The cooperative agreement's first year of funding ($2.6 million) began on September 1, 2009. Some of the CDC cooperative agreement resources will be used to support smaller-scale community-based studies. CECBP staff members are seeking funding from other organizations to supplement both state and CDC resources.

Scientific Guidance Panel and Chemical Selection

A nine-member Scientific Guidance Panel (SGP) appointed by the Governor and the Legislature provides scientific peer review for the CECBP. As required by SB 1379, the SGP has met three times per year for a total of seven meetings since the program began. These meetings provide opportunities for CECBP staff to update the SGP and the public on program activities, request feedback and recommendations from the SGP members, and receive public comment. The SGP has played a critical role in identifying and recommending for biomonitoring those priority chemicals of greatest potential public health importance for California's population.

Selection of chemicals that may be included in CECBP surveys involves a two-step process. Only substances identified as "designated chemicals" may be biomonitored under SB 1379. These are defined as chemicals included in CDC national exposure studies or added by the SGP according to a process described in the legislation. From the designated chemicals list, the SGP recommends "priority chemicals." Examples of priority chemicals recommended by the Panel include brominated and chlorinated compounds used as flame retardants, mercury and other heavy metals, perchlorate, bisphenol A, some organophosphate and pyrethroid pesticides, some perfluorinated chemicals, and some phthalates.

Study and Sample Design

CECBP disseminated a request to researchers throughout the United States to identify those who had recently collected blood or urine specimens from Californian residents. Researchers at three universities will be providing CECBP laboratories specimens to be analyzed for selected priority chemicals starting in 2010. This information will assist CECBP to determine the types and levels of environmental chemicals present in Californians. Additionally, under the CDC cooperative agreement, CECBP and staff in the University of California (UC) San Francisco Program on Reproductive Health and

the Environment (PRHE) have designed a pilot project to assess chemical exposures in 100 pregnant women and infants in San Francisco. Finally, CECBP is also working with the California Environmental Health Tracking Program (CEHTP) on two community biomonitoring studies in Tulare and Imperial Counties.

To comply with the mandate of SB 1379, CECBP staff initially developed a five-year plan, in consultation with the CDC National Center for Health Statistics, to implement a statewide biomonitoring program, which was to be modeled after an ongoing federal government survey known as the National Health and Nutrition Examination Survey (NHANES). Under a contract initiated in 2007, the CDC National Center for Health Statistics worked with CECBP staff to develop a program plan for a statewide survey in California that would result in biomonitoring participants from 48 counties over a six-year period beginning in 2011. However, as noted, subsequent funding limitations have limited further development of the statewide survey.

A distinctive feature of the CECBP is the legislative requirement that biomonitoring results be returned to study participants who request them, even though the health implications of these results may be uncertain or unknown. CECBP is collaborating with researchers at UC Berkeley to develop best practices and materials for returning individual test results to participants. CECBP staff is also beginning work to identify levels of biomonitored chemicals in blood or urine that may be of health concern.

Laboratory Status

CDPH's Environmental Health Laboratory (EHL) and DTSC's Environmental Chemistry Laboratory (ECL) conduct laboratory analyses of environmental chemicals in biological specimens. EHL has primary responsibility for the development of methods for analysis of toxic metals in blood and non-persistent chemical contaminants in blood and urine. ECL primarily focuses on biologically persistent chemicals in blood. CECBP funding has allowed both EHL and ECL to hire initial staff and to procure and install state-of-the-art analytical equipment. The laboratories have focused on developing testing methods, instrument standard operating procedures, and quality assurance measures for chemicals to be analyzed. In the coming year, both laboratories will analyze blood and urine samples from California residents collected through the CEHTP and university researchers. Although baseline funding limits the number of tests that can be completed, as well as the number of chemicals that can be analyzed, supplemental funding through the CDC cooperative agreement will allow for substantial augmentation of laboratory capacity.

The CECBP laboratories have also executed a Memorandum of Understanding (MOU) with the Division of Laboratory Sciences (DLS) of CDC's National Center for Environmental Health. Under the MOU, DLS will train CECBP laboratory staff and assist CECBP laboratories with quality assurance and quality control protocols.

## Public Participation Activities

Initial activities to promote public participation included setting up a CECBP listserv, a dedicated email address, and a website. CECBP staff conducted public workshops in three regions of California and several statewide teleconferences in March and April 2008, to introduce the program to the public and stakeholders and to solicit input on program implementation. An online survey was also conducted in 2008 to obtain additional input. Members of public have participated in SGP meetings, which have been webcast when possible to expand access. CECBP staff has also developed a draft public participation strategy and plan, embodying the legislative directive "to establish the framework for integrating public participation." The strategy and plan include goals and objectives to guide CECBP efforts, as well as specific activities to be carried out as resources allow, and will create additional opportunities for stakeholders to help shape the program's future. Future activities designed to meet SB 1379's public participation objectives include expanding electronic resources and generating opportunities to increase the number and diversity of stakeholders engaged in CECBP implementation.

## Conclusions and Recommendations

With currently available baseline resources, CECBP has made significant progress in planning for community biomonitoring surveys, identifying designated and priority chemicals, building laboratory capability and capacity to analyze selected environmental chemicals, and providing opportunities for public participation. A recently awarded CDC cooperative agreement will allow CECBP laboratories to continue building capability and capacity.

Although staff originally estimated that the CECBP would be fully implemented over five years (by 2011), insufficient resources have limited the full implementation of a statewide sampling program representative of California's diverse population. Consequently, the CECBP has modified its implementation plans and activities to focus on smaller community and pilot studies. Additionally, CECBP has leveraged its existing baseline state resources to obtain external funding and to collaborate with other programs and researchers.

The CECBP's external Scientific Guidance Panel has commended staff for program accomplishments in light of limited resources and strongly supports the continuation of current efforts. In addition, the SGP has recommended that worker groups be included in targeted biomonitoring studies. Finally, the SGP recommends that stable long-term funding be identified to allow implementation of both statewide and community biomonitoring studies, as envisioned and mandated by the Legislature in SB 1379.

# I. Introduction and Background

## A. Introduction

Biomonitoring is the science of measuring chemicals in humans. By directly measuring levels of potentially toxic environmental chemicals in blood, urine, or other biological specimens, biomonitoring can produce important public health information that cannot be provided by traditional air, water, and soil monitoring. The California Environmental Contaminant Biomonitoring Program (CECBP) was established through legislation in 2006 by Senate Bill (SB) 1379 (Perata, Chapter 599, Statutes of 2006; codified in Health & Safety Code (H&SC) Sections 105440 through 105459 – see Appendix A). Under SB 1379, the CECBP 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 distinguished Scientific Guidance Panel (SGP), and substantial opportunities for input by the public.

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

- What chemicals are people exposed to?
- Which groups or populations in California have higher exposures to specific toxic chemicals?
- 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 now have 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 consumer products, diet, occupation, and other sources. 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 shape the state's nascent Green Chemistry Initiative.

The CECBP'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 the CECBP and includes information about its activities and findings through calendar year 2009.

### B. Background

California residents experience widespread exposures to a multitude of environmental chemicals, such as flame retardants, pesticides, mercury, and plasticizers, 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 the tri-departmental CECBP. The CECBP is the first legislatively mandated, ongoing state biomonitoring program in the country.

The principal goals of the CECBP 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. When fully implemented, the CECBP will:

1. Produce information on the levels of environmental chemicals in Californians and whether those levels are increasing or decreasing over time.

2. 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 in the environment.

3. Produce data that researchers could use in studying relationships between levels of chemicals in Californians and health effects.

4. Facilitate the identification of emerging environmental health issues.

Resources available to the program are insufficient to undertake statewide surveys for the foreseeable future. Nonetheless, as described in the following sections, the CECBP is undertaking a number of smaller-scale projects that will provide valuable information in themselves and will also lay a strong foundation for statewide surveys in the future.

## II. Program Structure and Resources

### A. Program Structure

SB 1379 requires that the CECBP be collaboratively developed and implemented 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 are listed in Figure 1.

**Figure 1. CECBP Departmental Roles and Lead Responsibilities**

| |
|---|
| CDPH (lead entity) – (1) overall design of the biomonitoring program, including both statewide and community surveys; (2) participant recruitment and sample collection; (3) communication of test results to participants who request them; (4) data management and analysis; (5) generation of reports to the Legislature; and (6) dissemination of information to the public.<br><br>DTSC, CDPH laboratories – Laboratory methods development, processing and analyzing biological samples for environmental contaminants, and data analysis<br><br>OEHHA – (1) administering and supporting the Scientific Guidance Panel, including scientific evaluation of information used to select chemicals for biomonitoring; (2) developing public outreach efforts, including maintenance of the program website and dissemination of information to the public; (3) carrying out data analysis; and (4) identifying levels of biomonitored chemicals in blood or urine that may be of health concern. |

Staff members in all three departments collaborate on multiple activities within the overall division of labor, including program design, SGP meetings, and data analysis. For instance, OEHHA and DTSC staff contribute to the program design for which CDPH is the lead. Similarly, though OEHHA convenes and staffs the SGP meetings, representatives from DTSC and CDPH attend and make presentations to the Panel as well. Departmental responsibilities for analysis of data to be collected by the CECBP will be non-duplicative and will focus on different issues.

CECBP activities and issues 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.

## B. CECBP Budget

At the present time, CECBP does not have sufficient resources to implement the statewide biomonitoring program mandated in SB 1379 (H&SC Section 105441). The legislation stated that program implementation would be contingent upon appropriations provided through the annual Budget Act or other measures, but did not include any dedicated funding (H&SC Section 105453). The three departments initially developed a five-year implementation plan aimed at beginning operations of the full program (collecting data and biological specimens from approximately 2000 participants per two-year sampling cycle) in Fiscal Year (FY) 2011-12.

The 2007 Budget Act provided an appropriation of $5.2 million for CECBP planning and initial program implementation, $3.2 million allocated to CDPH, $380,000 allocated to OEHHA and $1,600,000 allocated to DTSC. Much of this allocation consisted of one-

time funding for the acquisition of dedicated equipment for the CDPH and DTSC laboratories. Due to the state's fiscal crisis, the Legislature transferred the source of CECBP's funding from the General Fund to the Toxic Substances Control Account (TSCA) in FY 2008-09. TSCA was established to finance state Superfund cleanup and pollution prevention activities, but trailer-bill legislation (AB 1338, Chapter 760, Statutes of 2008) specifically amended H&SC Section 25173.6(b)(16) to allow funding of the CECBP from TSCA. The TSCA fund receives revenue primarily from environmental fees levied on businesses with 50 or more employees that handle hazardous materials and cost recovery of DTSC's work on hazardous substance release sites. Currently, TSCA annual revenues do not cover annual expenditures.

CECBP's baseline TSCA funding of approximately $1.9 million per year supports 13 core staff. Table 1 presents the allocation of funding and staff among the three departments.

**Table 1. CECBP Budgets for FY 2007-2009**

| | CDPH | | OEHHA | | DTSC | | **Total** | |
|---|---|---|---|---|---|---|---|---|
| | Budget | Staff | Budget | Staff | Budget | Staff | Budget | Staff |
| **FY 2007-08**[1] Initial budget with 2007 legislative augmentation | | | | | | | | |
| Baseline | $954,000 | 8 | $380,000 | 3 | $368,000 | 2 | $1,702,000 | 13 |
| One-time only costs | $2,246,000 | | $0 | | $1,232,000 | | $3,478,000 | |
| Total | **$3,200,000** | **8** | **$380,000** | **3** | **$1,600,000** | **2** | **$5,180,000** | **13** |
| **FY 2008-09**[2] | | | | | | | | |
| Baseline & Total | **$1,029,000** | **8** | **$558,000** | **3** | **$344,000** | **2** | **$1,931,000** | **13** |
| **FY 2009-10** | | | | | | | | |
| Baseline[2] | **$1,062,000** | **8** | **$558,000** | **3** | **$344,000** | **2** | **$1,964,000** | **13** |
| CDC[3] | **$2,600,000** | **9** | **0** | **0** | **0** | **0** | **$2,600,000** | **9** |
| Total | **$3,662,000** | **17** | **$558,000** | **3** | **$344,000** | **2** | **$4,564,000** | **22** |

[1] General Fund
[2] Toxic Substances Control Account
[3] 5-year Cooperative Agreement with U.S. Centers for Disease Control and Prevention

While the 2008 trailer-bill legislation authorized use of TSCA funds for CECBP, it did not authorize new fees or an increase in existing fees to cover the program's costs. It also did not specify any amount of funding that should be allocated to CECBP. Given the current gap between TSCA annual revenues and expenditures, TSCA cannot indefinitely cover both the current CECBP allocation and other DTSC program activities intended to be funded from TSCA. Moreover, current state support for the CECBP is only a fraction of the amount needed to operate the full program mandated by SB 1379, including statewide surveys (estimated between $9M and $10M/year). It appears that TSCA, as currently constituted, is at best only a temporary funding source for CECBP and does not represent a stable, long-term funding source for the program.

CDPH, OEHHA, and DTSC are attempting to identify a stable, long-term funding mechanism that will both sustain current CECBP functions and allow the program to grow and fulfill its legislative mandates. Such a funding mechanism, once identified, will likely require legislation.

In light of the state's current fiscal difficulties, CECBP staff have sought and obtained extramural financing to conduct smaller-scale biomonitoring activities. In a competitive application process, CECBP worked with the non-profit organization Sequoia Foundation, which resulted in the award of a five-year cooperative agreement with the U.S. Centers for Disease Control and Prevention (CDC), beginning September 1, 2009. The other states awarded cooperative agreements are New York and Washington. The purpose of the cooperative agreement is to increase state biomonitoring laboratory capability and capacity. The CDC has indicated that this funding is intended to supplement, not replace, existing state biomonitoring program support. This funding ($2.6 million for federal FY 2009-10) will be used primarily to hire Sequoia Foundation staff at the CDPH Richmond campus, purchase laboratory equipment and supplies, and provide resources for collecting biological specimens (blood and urine) from California residents. Funding for the remaining four years of this agreement will depend upon the availability of federal resources, which is reevaluated annually. During the second through fifth years of the cooperative agreement, available funds will support the DTSC laboratory in addition to the activities identified during FY 2009-10.

Activities to be funded by the CDC cooperative agreement are described in Section IV. While the agreement will provide for needed laboratory equipment and initial biomonitoring data covering certain groups of Californians, the CDC funds will not be sufficient to operate a statewide biomonitoring program on an ongoing basis.

## 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 the CECBP is provided by a nine-member Scientific Guidance Panel (SGP) appointed by the Governor and the Legislature. The purpose of the SGP is to recommend chemicals to be included in the biomonitoring program, provide input and guidance on the design of the program, and to review the results and conclusions of biomonitoring studies. The SGP has played an indispensable role in identifying and recommending priority chemicals for biomonitoring by the CECBP. Appendix B contains a list of names and short biographies for current Panel members.

SB 1379 requires the SGP to meet three times per year. OEHHA is responsible for convening, staffing, and providing background materials for the SGP meetings. Since the inception of the CECBP, the SGP has met seven times:

- December 17, 2007;

- June 10, October 24, and December 4 - 5, 2008;
- March 2 - 3, July 28 - 29, and October 6, 2009.

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

The primary SGP actions to date have been to augment the list of "designated chemicals" (H&SC Section 105449(c)) and, from this list, to make recommendations for priority chemicals for biomonitoring in California (H&SC Section 105449(a) and (b)) (see below). The SGP has also heard progress reports and provided feedback on the overall implementation of the program, including the development of laboratory capacity and the CECBP program choices to analyze archived biological specimens and to undertake a pilot mother-infant biomonitoring study. The SGP meetings have also provided a forum for stakeholders and the public to express their views on chemical selection and the structure of the program.

**B. Chemical Selection**

Selection of chemicals for biomonitoring by the CECBP involves a two-step process, defined in the enabling legislation (H&SC Section 105449). In the first stage of the selection process, chemicals of interest are considered for inclusion in a list of "designated chemicals." Only a "designated" chemical can be biomonitored. Designated chemicals are defined in the legislation as those included in the CDC's national biomonitoring program, plus additional chemicals as recommended by the SGP and adopted by the program (H&SC Sections 105440(b)(6) and 109449(c)). These additional chemicals can be designated based on known or potential exposure to the public, known or suspected health effects, and other criteria contained in SB 1379.

SB 1379 sets out a second stage in the process, by providing for the selection of "priority chemicals" for biomonitoring from the list of designated chemicals. The SGP may recommend priority chemicals based on the degree of potential exposure, the likelihood of health effects, the limits of laboratory detection, and other criteria the panel may agree to. CECBP staff retains authority for final choices on chemicals to be biomonitored from the pool of priority chemicals.

To date, the SGP has added five classes of chemicals, one chemical mixture, and three 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 a complete list of CECBP designated and priority chemicals as of December 2009. The Panel may add other chemicals to either the designated or priority list in the future.

The list of priority chemicals includes substances in a range of chemical classes, with highlights shown below:

- Lead, cadmium, mercury, and arsenic, which are present in a variety of products and used in a number of industries. Exposure to these metals or compounds of these metals can cause many adverse health effects, including cancer and reproductive effects.

- Diesel exhaust, which has been linked to a number of ailments, including cancer.

- Cotinine, which is an indicator of recent exposure to tobacco smoke.

- Certain pesticides, including organophosphate pesticides such as chlorpyrifos, malathion, and naled, and pyrethroid pesticides, such as cyfluthrin, permethrin, and resmethrin.

- Brominated and chlorinated compounds used as flame retardants, which include polybrominated diphenyl ethers (PBDEs) and the carcinogen chlorinated tris, for example. Many flame retardants accumulate in the body and in the environment and some are suspected of causing cancer and impacting child development. California fire-safety regulations result in substantially greater use of chemical flame retardants in products sold in California than in many other states and countries.

- Environmental phenols, including bisphenol A (BPA) and triclosan. BPA is used in certain plastics and to line some food and beverage cans. Triclosan is widely used in antibacterial soaps. These chemicals are suspected of disrupting hormone systems and consequently harming health.

- Perchlorate, a component of rocket fuel that may contaminate drinking water and food. Perchlorate interferes with the proper functioning of the thyroid gland, which could affect child development.

- Phthalates, a family of chemicals used in cosmetics and plastic products. A number of phthalates have been identified as developmental and/or reproductive toxicants. The development of the male reproductive system appears to be especially sensitive to phthalate exposure *in utero*.

- Perfluorinated compounds (PFCs), used to manufacture non-stick cookware, wrinkle-free clothing, and other consumer products. One such compound, perfluorooctanoic acid, has been detected in virtually all Americans, and may cause cancer and reproductive effects.

- Cyclosiloxanes, which are used in applications such as dry cleaning and personal care products. For certain cyclosiloxanes, there are concerns for potential carcinogenicity, possible effects on the reproductive system, and effects

on other systems in the body. Cyclosiloxanes are also persistent in the environment.

- Three polycyclic aromatic hydrocarbons, a family of chemicals that are ubiquitous air pollutants and have been shown to cause cancer.

For some of the above classes, not all members of the chemical class are priority chemicals. For specific details on chemicals included on the priority list, please refer to Appendix D.

## IV. CECBP Study and Sample Design

### A. Community studies

In addition to obtaining biomonitoring data representative of the general California population, H&SC Section 105441 states that community-based studies "shall be contingent on funding." To undertake such studies, CECBP 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 further described below. Projects supported by the CDC Cooperative Agreement are marked with an asterisk (*).

1. Archived biospecimens from researchers

In September 2008, CECBP disseminated a request to researchers throughout the United States to identify those with stored blood or urine specimens collected within the past five years from Californian residents. The CECBP laboratories will use their recently purchased equipment and apply their model analytical protocols to produce biomonitoring data on Californians' chemical exposures in 2010. CECBP staff is pursuing two options for obtaining biospecimens:

a. CECBP is finalizing agreements with researchers at three academic institutions -- Columbia University, UC Davis, and UC Berkeley -- to analyze archived samples for a limited number of chemicals. More information about these investigations and the chemicals to be analyzed is presented in Section V.E.

b. CECBP has initiated discussions with CDPH's Genetic Disease Screening Program and the Kaiser Permanente Research Program on Genes, Environment and Health (RPGEH). Blood and urine specimens from Kaiser Permanente members in northern California may be available for chemical analysis.

CECBP staff will continue to assess the feasibility of obtaining biospecimens to analyze, considering such factors as the utility of the specific specimens for the analysis of selected chemicals, costs to obtain and analyze the biospecimens, and appropriate sampling strategies to allow for tracking chemical trends in California's population.

2. Maternal and Infant Environmental Exposure Project*

In response to recommendations from CECBP's SGP and members of the public, CECBP has designed a pilot project to measure selected priority chemicals in pregnant women and in umbilical cord blood during delivery. Chemicals measured in umbilical cord blood represent those in the newborn infant; cord blood can be obtained in substantial quantities just after delivery without harming the neonate. This would provide valuable information on the degree to which fetuses are exposed to environmental chemicals that could affect their development. Using funding available through the CDC cooperative agreement, CECBP plans to conduct the Maternal and Infant Environmental Exposure Project (MIEEP) collaboratively with the University of California, San Francisco (UCSF) Program on Reproductive Health and the Environment (PRHE). During the first year of the cooperative agreement, CDC funding will support participant recruitment and enrollment, collection of urine from approximately 100 pregnant women during their last trimester of pregnancy, collection of maternal and umbilical cord blood at the time of delivery, and analysis of selected priority chemicals by CECBP laboratories.

Additional funds to support the MIEEP are also expected early in 2010. UCSF PRHE and UC Berkeley, in collaboration with CECBP staff, submitted a joint proposal to The California Wellness Foundation (TCWF) in August 2009, requesting $250,000 over a two-year period. The additional resources will expand the pilot to include questionnaire administration, data analysis, and development of a best practices framework to communicate the results of chemical analyses to participants, even when the health implications may be uncertain or unknown. The results communication activity will be carried out in collaboration with researchers at UC Berkeley School of Public Health (SPH) (see Results Communication below).

3. Collaboration with the California Environmental Health Tracking Program (CEHTP) In accordance with H&SC Section 105444(c), CECBP is working with CEHTP on community studies in Tulare and Imperial Counties. In the Tulare County study*, urine samples were collected in 2009 from community residents during pesticide application periods. The samples will be analyzed by CDPH's Environmental Health Laboratory (EHL) in 2010 for chlorpyrifos, a widely used pesticide that was recommended as a priority chemical for California by the SGP.

The Imperial County study is a community assessment of perchlorate and heavy metal exposure from drinking water, soil, and locally grown produce. Perchlorate is a component of rocket fuel that can affect the proper functioning of the thyroid gland, which plays a critical role in normal growth and development (particularly of the nervous system), as well as in the maintenance of health. This chemical has also been recommended as a priority for California by the SGP. The Colorado River, which is the primary source of irrigation and drinking water for the Imperial Valley, is contaminated with perchlorate due to ongoing runoff from a now-closed facility in Nevada. Exposure to perchlorate is potentially important not just in Imperial Valley, but in the rest of the country, as the Valley produces much of the nation's winter produce. CEHTP staff collected urine specimens from Imperial Valley residents, as well as samples of drinking water and locally grown produce, in May 2009. Chemical analyses of water and

produce are being conducted by laboratories at CDC, the University of Arizona, and CDPH's Food and Drug Laboratory Branch. CDPH laboratory staff is storing the urine samples, which will be analyzed in 2010 when the laboratory has developed, implemented, and validated methods to analyze perchlorate, arsenic, and several other metals.

The CEHTP provided approximately $45,000 to the CDPH EHL for additional equipment and supplies to assist with sample collection, analysis, and storage for both the Imperial and Tulare County studies. CECBP staff will also work with the CEHTP to test methods for health communication and outreach regarding exposures by returning biomonitoring results in these two studies to participants who request them and by developing outreach and educational materials for participants, the general public, and health-care providers.

**B. Results Communication**

A distinctive feature of the CECBP is the legislative requirement that biomonitoring results be returned to study participants who request them, even though the health implications of these results may be scientifically uncertain (H&SC Section 105443). In 2008, CECBP began collaborating with Dr. Rachel Morello-Frosch, Associate Professor at the UC Berkeley SPH, in developing approaches to communicate biomonitoring results to study participants. In addition, CECBP is collaborating with Holly Brown-Williams, Director of Policy at Health Research for Action, UC Berkeley SPH, on health literacy and results communication.

Both Dr. Morello-Frosch and Ms. Brown-Williams participated in the planning process for the MIEEP and will contribute to the development of best practices for communicating results of chemical analyses to biomonitoring participants. As noted above, the biomonitoring projects conducted with CEHTP will also inform this effort. These collaborations will allow CECBP to develop best practices and appropriate materials for returning individual biomonitoring results to participants. Related to this work, OEHHA will identify levels of biomonitored chemicals in blood or urine that may be of health concern.

**C. Plans for Statewide Survey**

During FY 2007-08, to help plan the technical aspects and logistics of a five-year roll-out of a statewide biomonitoring program, CDPH entered into a contract with CDC's National Center for Health Statistics (NCHS). This contract is separate from the five-year CDC cooperative agreement described previously. This agreement was executed in part to comply with H&SC Section105444(b), which directs the CECBP to "incorporate, as appropriate, the methods utilized by the [CDC] for the studies known collectively as the National Report on Human Exposure to Environmental Chemicals." The latter is based on biomonitoring of blood and urine samples collected from participants in the NCHS-sponsored National Health and Nutrition Examination Survey (NHANES), which is designed to obtain health-related information from a representative sample of the nation's population. Data developed under NHANES are not intended to

be representative of exposures in any given state, and the CDC will not release state-specific information.

NCHS staff assisted CDPH biomonitoring staff with developing four products:

1) A statistical model for selecting a valid representative sample of Californians to be recruited in two-year sampling cycles

The recommended sampling plan drafted by NCHS calls for recruiting and enrolling approximately 4,000 California residents per two-year cycle, assuming that laboratory costs and capacity would limit the CECBP to approximately 2,000 participants per year.

2) Concept of Operations

The Concept of Operations is a framework built around tasks required to carry out a large-scale state-wide representative biomonitoring survey based on the CDC model. These tasks include the logistics and procedures for participant recruitment and enrollment, data collection (e.g., questionnaires, physiological measurements), blood and urine specimen collection and shipping, reporting individual findings, and consultations/referrals for individuals with elevated levels of environmental contaminants with known clinical effects, such as mercury. Factors considered included workflow, timelines, and staff required to carry out defined tasks.

3) Staffing Plan

The Staffing Plan developed in conjunction with the Concept of Operations defined the various types of staff needed for participant recruitment and enrollment, as well as for operating temporary field clinics in selected sites around the state. At each site participants would have their blood and urine collected and some basic physiological measurements obtained, such as height, weight, and blood pressure.

4) Cost Model

NCHS also developed a Cost Model reflecting the activities, equipment, supplies, personnel, and travel costs needed to carry out all the phases of field data collection. The Cost Model was developed under the assumptions that a statewide biomonitoring survey would include a defined number of sampling sites per year, to be determined based on statistical and financial considerations, and that California could use this cost model as a framework to estimate and adjust costs for different numbers of survey sites.

These products were scalable in nature, and could be deployed for some regional and community-based studies as well as a statewide survey.

As originally conceived, the statewide biomonitoring survey would require a substantial information technology (IT) component. An IT system to support the CECBP would include automated processes and data management essential for handling a large volume of confidential health and exposure data obtained from participants throughout

the state. The State Administrative Manual (Section 4819.35) requires preparation of a Feasibility Study Report (FSR) before IT funding can be approved. CECBP contracted with Shooting Star Solutions during FY 2007-08 to develop an FSR in conjunction with CDPH biomonitoring staff. The FSR, addressing the design, development, and implementation of the California Biomonitoring Information Technology System (CalBITS), was completed and approved by CDPH in June 2008 and submitted to the State Office of the Chief Information Officer (OCIO). However, the OCIO discontinued its review of the FSR because the Department of Finance did not support the project's use of the General Fund as its proposed funding source.

## V. CECBP Laboratory Status

### A. Laboratory Capacity and Capability

Laboratory analyses of environmental chemicals relevant to the CECBP are conducted by CDPH's EHL and DTSC's Environmental Chemistry Laboratory (ECL).

EHL provides environmental and clinical analytical services, as well as leadership in the development of laboratory methods, and serves as a reference laboratory for local and state public health agencies. It holds a Certificate of Compliance under the Clinical Laboratory Improvement Amendments (CLIA), which is a federal requirement for laboratories that conduct tests on human specimens and provide test results that could be used for diagnosis of disease or for other patient management decisions. Within the CECBP, EHL has primary responsibility for the development of novel, advanced, and improved methodologies for analysis of metals in blood and non-persistent chemicals in blood and urine. Non-persistent chemicals are rapidly metabolized and excreted, and include, for instance, many organophosphate insecticides and some plasticizers such as phthalates. In contrast, persistent chemicals, including chlorine-containing pesticides such as DDT, can remain in the environment, animals, and people for months to years.

CECBP funding has allowed EHL to procure and install one each of the following large instruments:

- High Resolution Gas Chromatograph-Mass Spectrometer (HR-GC/MS)
- High Pressure Liquid Chromatograph-Tandem Mass Spectrometer (HPLC/MS-MS)
- Inductively Coupled Plasma-Mass spectrometer (ICP/MS)
- Gilson 215 Liquid handler (for automating sample processing).

ECL serves as California's reference laboratory for analysis of toxic chemicals in the environment and consumer products. Although ECL collaborates with many researchers to measure persistent chemicals, the laboratory does not report individual results to study subjects and is not presently CLIA-certified. However, ECL staff and management are currently preparing an application for CLIA certification. Within the

CECBP, 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).

CECBP funding has allowed ECL staff to procure and install an HR-GC/MS and an HPLC/MS-MS, as well as auxiliary equipment to be used for sample preparation and extraction.

With existing budgetary resources, both laboratories have hired initial staff to install and operate the new laboratory instruments. In consideration of priorities outlined by CECBP's Scientific Guidance Panel, staff has focused on developing methods, standard operating procedures, and quality assurance and quality control measures for the chemicals listed in Table 2. In 2010, both laboratories will begin analyses of samples collected through the CEHTP and archived biospecimens collected by university researchers (see below).

Current resource constraints limit both the numbers of analyses that can be run and the total number of chemicals that can be analyzed, since both are dependent on staffing, equipment, and availability of consumable supplies, such as test reagents. For example, EHL staff must divide access time for their one HPLC/MS-MS between phthalate and pesticide tests. Furthermore, ECL is able to conduct analyses on only one chemical class (e.g., PFCs or PBDEs and other flame retardants), as they have only two CECBP-funded staff. However, supplemental resources acquired through the CDC cooperative agreement (and potentially other sources) will allow for the hiring of more staff and the purchase of additional equipment and supplies, expanding the laboratories' capacity to conduct more analyses of a larger number of chemicals. Chemicals under consideration for analytical methods development include additional pesticides and metals, perchlorate, bisphenol A, and cyclosiloxanes (see Section III.B.).

**Table 2. CECBP laboratory instruments and analytical methods***

| Laboratory | Target Chemicals | Biological Specimen | Instrument | Date Method Ready |
|---|---|---|---|---|
| | | | | |
| CDPH/ EHL | Metals (lead, mercury, cadmium) | Whole blood | ICP-MS | 12/09 |
| CDPH/ EHL | Phthalates (plasticizers) | Urine | HPLC/MS-MS** | 12/09 |
| CDPH/ EHL | 3,5,6 Trichloropyridinol (a metabolite of chlorpyrifos, an organophosphate pesticide) | Urine | HPLC/MS-MS** | 9/09 |
| CDPH/ EHL | 3-Phenoxybenzoic acid (a pyrethroid pesticide metabolite) | Urine | HPLC/MS-MS** | 12/09 |
| CDPH/ EHL | 3-hydroxyphenanthrene (a polycyclic aromatic hydrocarbon) | Urine | HRGC/MS | 12/09 |
| CDPH/ EHL | Creatinine (for standardizing urinary chemical analysis) | Urine | plate reader | 12/09 |
| DTSC/ECL | Perfluorinated chemicals (PFCs) | Serum | HPLC/MS-MS | 12/09 |
| DTSC/ECL | Polybrominated diphenyl ethers (PBDEs and other brominated flame retardants) | Serum | HRGC/MS | 12/09 |

* acronyms used in this table are defined in the text and in Appendix G
** shared machine for pesticide and phthalate analyses

The CECBP laboratories have executed a Memorandum of Understanding (MOU) with the Division of Laboratory Sciences (DLS), part of CDC's NCEH. Under the terms of the MOU, DLS will train CECBP laboratory staff in analytical methods and biospecimen collection, processing, storage, and shipping procedures, and will assist with proficiency testing to evaluate the quality of biomonitoring measurements. Additionally, DLS committed to analyze biological specimens from up to 500 participants (or mother-infant pairs) on a one-time basis, which would include analyses of up to ten chemical classes (each of which contains multiple chemicals), and to analyze samples from up to 200 participants for a single chemical. CECBP staff plan to build on the results of the pilot MIEEP by applying for external funding to support a 500-person paired maternal-infant exposure investigation.

## B. Laboratory Fellowships

The CECBP laboratories applied for and were awarded two fellowships by the Association of Public Health Laboratories (APHL). Each Fellow has a Ph.D. in chemistry. The first APHL Environmental Fellow joined ECL in October 2008 and his fellowship was renewed to June 2010. He is working alongside ECL staff to develop analytical methods for BPA and several newer bromine-containing flame retardants in serum.

The other APHL Environmental Fellow joined EHL in February 2009 and is developing analytical methods for the determination of urinary phthalate metabolites. Her fellowship is scheduled to end in June 2010, but EHL is applying for an additional extension.

## C. Instrument and Analytical Methods Training

CECBP laboratory staff received initial training on operation and maintenance of the newly installed instruments by the equipment vendors in early 2009 and advanced training in the summer after having had several months' experience in basic operations.

Through the MOU with CDC's DLS, CECBP staff attended CDC trainings in Atlanta. Four CDPH EHL staff received training in May 2009 on analytical methods for several CECBP priority chemicals (i.e., the metabolites of organophosphate pesticides, phthalate metabolites, BPA and hydroxylated polycyclic aromatic hydrocarbons (hydroxy-PAH)). In June 2009, three DTSC ECL staff received training focused on the analysis of persistent pollutants, including bromine-containing flame retardants and PFCs.

## D. Analytical Methods Development

ECL staff members are adapting their current methods for measuring persistent environmental pollutants to match the CDC methods, using their new instruments. They are also applying the CDC methodology (with some necessary adaptations) for measuring PFCs.

EHL staff have adapted and validated two analytical methods for urine specimens: heavy metals and trichloro-2-pyridinol (TCP), a metabolite of the pesticide chlorpyrifos. Methods for hydroxy-PAHs, phthalate metabolites, and pyrethroid metabolites will be developed by December 2009. EHL is developing capacity to test for creatinine in urine and expects to have this method ready by December 2009. Creatinine is a normal product of human muscle metabolism that is excreted in urine, and needs to be measured in all urinary tests of environmental chemicals to standardize the results based on how dilute or concentrated the urine is.

### E. Anticipated Analyses of Archived Biospecimens

In 2010, ECL will analyze PBDEs in archived serum samples collected by Columbia University researchers during 2005-2008 from California men. These biospecimens were collected as part of a Columbia University project examining whether environmental agents play a role in declining sperm counts in men. The Columbia researchers will investigate associations between major PBDEs and male reproduction.

EHL will analyze archived biospecimens from:

1. Tulare County for a metabolite of chlorpyrifos, an organophosphate pesticide;

2. UC Davis Childhood Autism Risks from Genetics and the Environment (CHARGE) study for phthalate metabolites and a chlorpyrifos metabolite. 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.

3. UC Berkeley Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS) for phthalate metabolites. CHAMACOS is a study examining environmental exposures and the health of low-income children from birth to five years of age in the Salinas Valley. EHL will also perform quality control studies to ensure the samples were not contaminated during collection or processing.

## VI. Public Participation Activities

H&SC Section 105451 directs the CECBP 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.”

Initial public outreach activities in 2007 included setting up a CECBP listserv to facilitate electronic communication, a dedicated e-mail address, and a website. As of August 2009, the listserv had approximately 500 active subscribers. The CECBP website (http://www.oehha.ca.gov/multimedia/biomon/index.html), which is hosted and maintained by OEHHA, provides general information about the CECBP, including answers to frequently asked questions. In order to support public participation in SGP meetings and other CECBP activities, new materials are regularly added to the website, including meeting agendas, background documents, and presentations. While most of the website is in English, some basic program information is available in Spanish. The website was substantially reorganized in 2009 to improve accessibility. Future priorities include: (1) structured analysis of the CECBP website to improve its usability; (2) based on this analysis, development of new materials that address the need for easy-to-understand explanations of biomonitoring and the activities and findings of

CECBP; (3) translation of website materials into multiple languages; and (4) improved access to materials through website design modifications.

In order to build awareness of CECBP and engage potential stakeholders, CECBP staff held public workshops and teleconferences during April and May 2008. These forums provided information and answers to questions about biomonitoring and CECBP, and gathered public input regarding chemicals that should be priorities for biomonitoring. Three workshops were held, one each in Northern, Central, and Southern California, in which a total of 71 people participated. Simultaneous interpretation for Spanish-speaking audiences was offered for each workshop, but was requested at only one. Three publicly noticed teleconferences, with individuals participating from a total of 32 phone lines, addressed the same topics as the workshops and enabled participation from members of the public throughout the state. CECBP staff also designed and implemented a web-based survey (available in both English and Spanish) to gather suggestions on selecting chemicals for the Program. Over 300 individuals participated in the survey, including people from non-governmental and community-based organizations, state and local government agencies, universities and businesses, as well as other interested state residents. Preliminary results of these activities were presented to the SGP in June 2008. The final report summarizing these public participation activities and results is included in Appendix E and is also available online at http://oehha.ca.gov/multimedia/biomon/pdf/PublicParticipationreport021909.pdf. Appendices to the report on public participation activities can be found at http://www.oehha.ca.gov/multimedia/biomon/reports.html#state. CECBP also queried California state staff in a variety of programs in several different agencies and departments to elicit information on which chemicals these staff considered important for biomonitoring. The report summarizing state staff input was presented to the SGP in June 2008 and is included as Appendix F. It is also available online at http://oehha.ca.gov/multimedia/biomon/pdf/StateGovReport021909.pdf. Both the public participation results and the state government survey have informed the SGP deliberations on designated and priority chemicals.

CECBP staff has also developed a draft public participation strategy and plan, embodying the directive of H&SC Section 105451 “to establish the framework for integrating public participation.” The strategy and plan will create additional opportunities for stakeholders to help shape the program’s future, and include goals and objectives to guide CECBP efforts, as well as specific activities to be carried out as resources allow. The plan calls for more outreach to identify individuals and institutions interested in biomonitoring activities in California, including community-based and other non-governmental organizations; local, regional, and statewide public health professionals; members of the business community; and the general public. Additional activities to educate the public about sample collection and to share biomonitoring results are also included. Staff anticipates releasing the draft public participation strategy and plan for public comment in early 2010.

Under the CDC cooperative agreement, a field investigations coordinator was hired in October 2009 to conduct public participation activities for targeted biomonitoring investigations. These activities will include identifying stakeholders and conducting

needs assessments. Resources are also earmarked to support activities designed to enhance stakeholder participation in the CECBP. For instance, a basic informational brochure to help recruit participants and to introduce the topic of biomonitoring will be created and tested in focus groups. Key documents will be translated into languages other than English to improve CECBP's connections with California's diverse population.

## VII. Conclusions and Recommendations

During its first two years, CECBP has made significant progress in planning for statewide and community biomonitoring surveys, supporting the SGP, identifying designated and priority chemicals, building laboratory capability and capacity to analyze selected priority environmental chemicals, and providing opportunities for public participation. Data from the analysis of a limited number of biospecimens collected by other researchers will also be available in 2010.

With the additional resources available through a newly acquired federal cooperative agreement, CECBP laboratories will continue to build laboratory capability and capacity to analyze priority chemicals. Staff will also carry out targeted biomonitoring investigations, including a paired maternal-infant exposure investigation, and explore collaborations with other researchers. Public participation activities, especially those involving biomonitoring investigations, will include efforts to make information about the CECBP more accessible.

The biggest challenge facing CECBP is to identify a stable, long-term source of funding that will enable the program to implement SB 1379's mandate for a statewide biomonitoring program that will provide policymakers and the public with information on the levels of environmental chemicals in a representative sample of California residents. Until this funding source is identified, CECBP staff will continue to focus on securing grants, cooperative agreements, and other external funding to support smaller-scale biomonitoring studies. Such studies have significant value in themselves and, properly designed, their results can be generalized to larger populations, which can inform future policy decisions about some exposures to environmental chemicals in California. However, community studies cannot provide the breadth of information about exposures in California's diverse population that can be obtained with statewide surveys. The latter are needed to more thoroughly evaluate the effectiveness of California's environmental regulatory programs and make the most informed decisions on steps to protect Californians from environmental chemicals that pose the greatest hazards.

Recommendations from the SGP for improving the CECBP (please refer to Appendix G, a letter from the SGP Chair):

1. Identify and secure a stable long-term funding mechanism to allow full CECBP implementation of statewide and community based biomonitoring surveys in accordance with legislative mandates.

2. Continue to pursue external funding opportunities and collaborations with other researchers that leverage existing resources to:

    - Carry out various program components mandated by SB 1379,
    - Obtain biomonitoring data to assess Californians' exposure to chemicals, and
    - Develop targeted biomonitoring studies of individuals who are exposed to priority chemicals occupationally.

3. Conduct activities specified in the CDC cooperative agreement to increase laboratory capability and capacity, resulting in an increase in both the number of tests and types of chemicals that CECBP staff can measure.

4. Conduct outreach efforts to identify and engage additional CECBP stakeholders and encourage their involvement in program development and implementation.

5. Continue to maintain and expand CECBP electronic resources, including: website improvements (e.g., easy-to-understand materials, translation of more materials into multiple languages, and improved accessibility); internet broadcasting or audio-casting of all SGP meetings; increased numbers of listserv subscribers; and more surveys of subscribers to identify program-related needs and concerns.

6. Continue to meet with the SGP three times per year to provide Panel members with information and the opportunity to make recommendations to CECBP, as well as provide the public an opportunity to comment on program activities.

7. Continue to research and develop materials to support the SGP in selecting designated and priority chemicals to include in the CECBP.

8. Continue to develop results communication methods and materials for individual participants, health-care providers, and interested groups.

9. Identify levels of biomonitored chemicals in blood or urine that may be of health concern.

## Appendix A: Health and Safety Code Division 8, Part 5, Chapter 8, Section 105440 et seq. (SB 1379)

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**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 followup 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.

## Appendix B: Scientific Guidance Panel

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

### 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 CECBP.

### Appointment of Panel members

The SGP has a total of nine members. Appointment to the Panel is by the Governor (five members) and the California Legislature (Speaker of the Assembly, two members; Senate Committee on Rules, two members). Members are appointed for three-year terms and may be reappointed for additional terms without limitation.

As required by SB 1379, persons appointed to the SGP 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.

### Current SGP 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 |
| 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 |
| Edward Moreno, M.D., M.P.H. | Director, Department of Community Health, and Health Officer, Fresno County | 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 |

## SGP 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. 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, California Childcare Health Program Advisory Committee, Silent Spring Institute California Advisory Board, 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. Currently, she is leading a national panel that is developing research strategies to explore the role of environmental contaminants in breast cancer. She serves on the oversight group for the NIEHS/NCI Breast Cancer and Environment Research Centers. 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 Departments of Developmental and Cell Biology and Environmental Toxicology. Dr. Luderer's research focuses on mechanisms of action of reproductive toxicants and on protective

mechanisms against those toxicants. She has served on the National Toxicology Program/NIEHS Center for the Evaluation of Risks to Human Reproduction Expert Panel on 1- and 2-bromopropane and chaired the Expert Panel on styrene. She served on the National Research Council subcommittee on methyl bromide. She was a member of the U.S. EPA Science Advisory Board Environmental Health Committee from 2000-2006 and served as an ad hoc member on the EPA carcinogenicity of ethylene oxide.

**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.

**Edward Moreno, M.D., M.P.H.**
Dr. Edward Moreno is the Fresno County Health Officer and the Director of the Fresno County Health Department. He administers several county programs including Environmental Health, Public Health and Community Health, the Office of Emergency Services, the Central California Emergency Medical Services Agency and Indigent and Inmate Health Care Services. He serves on several Boards including the American Academy of Pediatrics California Chapter 1, California Conference of Local Health Officers, Health Officers Association of California, and the Fresno County First Five Commission. He was previously employed by the University of California San Francisco, Fresno Medical Education Program as Associate Professor of Pediatrics. He has prior experience as a general pediatrician working in private practice, in hospital based practice and in federally qualified health centers.

**Julia Quint, Ph.D.**
Dr. Julia Quint is a 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). Dr. Quint has significant experience as a toxicologist, researcher and public health practitioner. She recently retired from the Occupational Health Branch of the California Department of Health Services where she served as Chief of the Hazard Evaluation System and Information Service. Dr. Quint has served on a number of advisory boards and directed a number of public health projects.

**Gina Solomon, M.D., M.P.H.**
Dr. 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 Associate Director of the UCSF Pediatric Environmental Health Specialty Unit. Her work has included over 30 scientific papers, book chapters, and reports on air pollution, pesticides and other environmental and occupational threats to reproductive health and child development. Dr. Solomon serves on the U.S. EPA Science Advisory Board Drinking Water Committee, as well as on the California Scientific Guidance Panel for biomonitoring. She has previously served on a committee of the National Academy of Sciences on toxicity testing, an EPA scientific committee on endocrine disrupting chemicals, and on the California Expert Working Group on Environmental Health Tracking. Dr. Solomon is co-author of the award-winning book, Generations at Risk: Reproductive Health and the Environment, published by MIT Press in 1999. Dr. Solomon attended 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.**
Dr. Michael Wilson is a research scientist at the Center for Occupational and Environmental Health (COEH) at the School of Public Health, University of California, Berkeley, where he conducts research and practice in chemicals policy, green chemistry, exposure assessment, and sustainable production (http://coeh.berkeley.edu/people/apers_educ/wilson.htm). Dr. Wilson conducted his doctoral and masters work in environmental health sciences at the University of California, Berkeley, from 1996 to 2003. He earned a bachelor's degree in biology in 1984 from the University of California, Santa Cruz. Dr. Wilson is the chief author of a 2006 report to the California Legislature, "Green Chemistry in California: A Framework for Leadership in Chemicals Policy and Innovation", (available online at http://coeh.berkeley.edu/news/06_wilson_policy.htm), published by the California Policy Research Center under the aegis of the UC Office of the President. In addition to his appointment to the Biomonitoring Program Scientific Guidance Panel, Dr. Wilson serves on the California Environmental Protection Agency's Green Chemistry Science Advisory Panel.

# Appendix C: Recommendations from Scientific Guidance Panel Meetings

(For all of the Scientific Guidance Panel meeting agendas, presentations, handouts and more please visit: **http://www.oehha.ca.gov/multimedia/biomon/agendas.html**)

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### December 4-5, 2008 Meeting of the Scientific Guidance Panel of the California Environmental Contaminant Biomonitoring Program

### Panel Recommendations and Meeting Conclusions

At a meeting held in Sacramento, California on December 4 – 5, 2008, the Scientific Guidance Panel (SGP or Panel) of the California Environmental Contaminant Biomonitoring Program (CECBP) heard presentations by staff and comments from the public. The SGP considered several issues during its deliberations, and made several recommendations to the CECBP and decided on topics for the next meeting, as follows:

1. The SGP recommended that Program staff pursue their plan to analyze archived biological specimens from one or more researchers who responded to a Request for Information.
2. The SGP encouraged Program staff to pursue a pilot study focusing on paired maternal/child exposures, designed so that the results could be generalized to a wider California population. Panel members favored a descriptive study rather than a hypothesis-driven study. It was also suggested that such a study take advantage of the Memorandum of Understanding (MOU) between CECBP and CDC's National Center for Environmental Health Laboratory (NCEHL) whereby NCEHL will analyze a limited number of biological specimens collected by the CECBP for some selected chemicals.
3. SGP members requested that Program staff present a draft pilot study plan at the next SGP meeting.
4. The SGP recommended adding "diesel exhaust" as a designated chemical for inclusion in the CECBP.
5. The SGP recommended adding "brominated and chlorinated organic compounds used as flame retardants" as designated chemicals for inclusion in the CECBP.
6. The SGP requested additional information be provided to the Panel on cyclosiloxanes prior to the next meeting. The SGP will consider whether to recommend adding cyclosiloxanes as designated chemicals for inclusion in the CECBP.
7. The SGP postponed to a future meeting whether to recommend designated chemicals related to the use of antimicrobials and synthetic hormones in animal husbandry.
8. The SGP requested that materials be developed on pesticides for consideration as potential designated chemicals. The focus will be placed on residential and high-use agricultural pesticides.

9. The SGP will discuss at their next meeting criteria to recommend priority chemicals for inclusion in the CECBP. The SGP may add additional criteria to the list of existing criteria.
10. The SGP would like Program staff to provide information on possible priority chemicals at the next SGP meeting. At the next meeting, the SGP will consider recommending some chemicals for inclusion as priority chemicals.
11. Recommending designated and priority chemicals is an ongoing process of the SGP and will continue to be addressed at future meetings.

**March 2-3, 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 March 2-3, 2009 in Sacramento. CECBP staff made presentations on a variety of issues and the public provided comments to the Panel. The SGP deliberated on and made recommendations regarding designated and priority chemicals[1]. The Panel also provided comments on CECBP study design issues. The SGP's specific recommendations and suggested topics for the next meeting are summarized below.

***Panel recommendations regarding designated[2] and priority chemicals:***

1. The SGP recommended that the following chemical classes be added as designated chemicals for inclusion in the CECBP:
    - Antimicrobials approved for use in food animal production
    - Synthetic hormones approved for use in food animal production
    - Cyclosiloxanes

2. The SGP recommended that the following chemicals and chemical classes be added as priority chemicals for inclusion in the CECBP:
    - Cadmium
    - Lead
    - Mercury
    - Arsenic
    - Bisphenol A
    - 2,4,4'-Trichloro-2'-hydroxyphenyl ether (Triclosan)
    - Perchlorate
    - Diesel exhaust
    - Cotinine
    - Brominated and chlorinated organic compounds used as flame retardants
    - 3-Hydroxybenzo[a]pyrene
    - 6-Hydroxychrysene
    - 3-Hydroxyphenanthrene
    - Organophosphate insecticides already designated[3]

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[1] A copy of the enabling legislation, which includes the criteria for selecting designated and priority chemicals, can be found here: http://oehha.ca.gov/multimedia/biomon/pdf/sb_1379_bill_20060929.pdf

[2] For a complete list of the CECBP designated chemicals, see http://oehha.ca.gov/multimedia/biomon/pdf/CECBPDesignatedChemicals.pdf

[3] Priority chemicals in this class include only those members that are already designated.

- Polybrominated diphenyl ethers (PBDEs)[4]
- Pyrethroid pesticides already designated[3]
- Phthalates already designated[3]

***Panel input regarding CECBP study design:***

1. The SGP encouraged the CECBP to consider emphasizing thyroid disruptors in the Maternal-Infant Environmental Contaminant Biomonitoring Project.
2. SGP members encouraged CECBP staff to include chemicals in the Maternal-Infant Environmental Contaminant Biomonitoring Project that are likely to be detected in the individuals tested.
3. SGP members support CECBP efforts to report results to individuals, to the larger communities from which these participants come, and to the medical community. SGP members offered to review and provide input on draft materials that would be used for results communication, once they become available.

***Panel suggestions regarding discussion topics related to chemical selection for the next meeting:***

1. The SGP identified pesticides as a priority for discussion at the next meeting. The Panel suggested discussing pesticides as potential designated or potential priority chemicals at the next meeting, including:
    - Pesticides that are of highest use in California and/or are used on pets or for other household purposes
    - Pesticides that are not on the CDC list[5] to be considered as potential designated chemicals:
        - Classes of pesticides on the CDC list that are not fully designated (e.g., pyrethroids, organophosphates)
        - Specific pesticides of potential concern that are not on the CDC list and therefore not designated (e.g., fumigants, select organochlorines, select carbamates)
    - Pesticides on the CDC list to be considered as potential priority chemicals:
        - Carbamates already designated
        - Organochlorines already designated

2. SGP members would like to investigate the following types of chemicals and chemical classes as potential designated chemicals:
    - Plasticizers
    - Chloramine disinfection byproducts
    - Glycol ethers

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[4] PBDEs are members of the priority class "brominated and chlorinated organic compounds used as flame retardants."

[5] The CDC list of chemicals can be found here: http://www.oehha.ca.gov/multimedia/biomon/pdf/CDCChemicalsListHandout.pdf

- Linear siloxanes
- Chemical classes on the CDC list that are not fully designated:
    - Phthalates

3. SGP members would like to consider the following chemicals and chemical classes as potential priority chemicals:
    - Perfluorinated chemicals on the CDC list and already designated
    - Cyclosiloxanes
    - Antimicrobials approved for use in food animal production
    - Synthetic hormones approved for use in food animal production

4. Additional topics the SGP would like to see discussed at the next meeting include:
    - Update on laboratory capacity relevant to designated and priority chemicals.
    - Update on requesting methods development from manufacturers, or other sources, using Assembly Bill 289 (Chan, Chapter 699, Statutes of 2006) and other means.
    - Overview on portfolio of options by which the state can gather information on substances newly entering commerce and substances that are expected to increase in use.

**July 28-29, 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 July 28 and 29, 2009 in Oakland. The SGP deliberated on and made recommendations regarding designated and priority chemicals. The Panel also provided comments on issues related to reporting biomonitoring results to individuals. The SGP's specific recommendations and suggestions on various topics are summarized below. Meeting materials, including an agenda and the transcript, are available on the biomonitoring website (http://oehha.ca.gov/multimedia/biomon/cecbp071409.html).

***Panel recommendations regarding designated[6] and priority[7] chemicals:***

1. The SGP recommended that the following chemicals and chemical classes be added as "designated chemicals" for inclusion in the CECBP:
   - Pyrethrins and pyrethroids (as a chemical class)
   - Iprodione
   - Fipronil
   - Octhilinone
2. The SGP recommended that the following chemicals and chemical classes be added as "priority chemicals" for inclusion in the CECBP:
   - Cyclosiloxanes (as a chemical class)
   - Perfluorinated compounds already designated[8]
     - Dichlorodiphenyltrichloroethane (DDT)
     - para-Dichlorobenzene (1,4-dichlorobenzene)
     - 2,4-Dichlorophenoxyacetic acid (2,4-D), salts and esters
3. The SGP recommended that N,N-diethyl-3-methylbenzamide (DEET) not be added as a priority chemical for inclusion in the CECBP at this time.

***Panel suggestions regarding general strategies for selecting chemicals for discussion at future SGP meetings:***

Panel members provided CECBP staff with input on several issues related to selecting chemicals to include in the CECBP. Panel suggestions are summarized below. For full details of this discussion, consult the transcript from July 28 (available at: http://oehha.ca.gov/multimedia/biomon/pdf/SGPTranscript072809.pdf).

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[6] For a complete list of the CECBP designated chemicals, see http://oehha.ca.gov/multimedia/biomon/pdf/designatedchemaug2009.pdf

[7] For a complete list of the CECBP priority chemicals, see http://oehha.ca.gov/multimedia/biomon/pdf/prioritychemsaug2009.pdf

[8] Priority chemicals in this class include only those members that are already designated.

1. CECBP staff should not necessarily wait for biomonitoring results from the Centers for Disease Control and Prevention (CDC) to become available before bringing chemicals to SGP as potential priority chemicals. The Program should evaluate this issue on a chemical-by-chemical basis. There may be compelling reasons to bring a chemical forward for discussion in the absence of CDC biomonitoring results.
2. If CDC biomonitoring results are available, they should be evaluated by the Program in order to decide whether to bring a chemical forward for consideration as a potential priority chemical. In general, CECBP staff should focus less attention on chemicals that are rarely detected by the CDC. However, there will be exceptions to this general guidance. For example, if laboratory methods have advanced or if there are significant differences in use and/or exposure in California, the chemical may warrant consideration for inclusion in the program, and it would be important to bring the chemical forward to the SGP.
3. Chemicals that have shared metabolites with CECBP designated or priority chemicals should not necessarily be automatically be assigned the same status. This decision should be made on a chemical-by-chemical basis. CECBP should give particular attention to parent compounds that give rise to a shared metabolite that is known to be toxic and has exposure potential. In these cases, the class of parent compounds may be brought forward for consideration.
4. There may be compelling reasons for CECBP staff to bring limited/declining use or banned chemicals to the SGP for possible inclusion in the Program. These reasons could include continued use of these chemicals in other parts of the world (leading to potential exposures to Californians) or the potential for biomonitoring to evaluate the efficacy of public health actions aimed at these chemicals.
5. CECBP staff may want to consider bringing chemicals with exposure that is difficult to quantify forward for discussion at SGP meetings if biomonitoring could be a useful means of assessing exposure to these chemicals.
6. In recognition of the fact that analytical methods are constantly evolving and improving, current analytical method limitations should not preclude a chemical from being brought to the SGP for consideration for inclusion in the CECBP.

***Panel input regarding CECBP reporting biomonitoring results to participants:***

The Panel heard a number of presentations on topics related to communicating biomonitoring results to participants. The Panel recommended that Program staff keep the information provided during the presentations and discussion in mind when planning future results communication activities. Highlights of the panel comments and suggestions are provided below. For full details of this discussion, consult the transcript from July 29 (available at: http://oehha.ca.gov/multimedia/biomon/pdf/SGPTranscript072909.pdf).

1. It is important to begin dialogue with community groups early in the development of a community-based study.
2. One-on-one meetings between study researchers and study participants to

communicate results are commonly used in small studies and allow for fuller discussion and education. Given the logistics of a statewide study and limited Program resources, the Panel discussed methods other than in-person reporting. Web-based methods of reporting results were suggested as one option for disseminating a basic level of information to study participants.

3. When biomonitoring reference levels are available, they should be used as a standard for comparison for individual and group results.
4. Health care providers should be involved in biomonitoring studies and local health officers may be able to identify appropriate health care providers in the community. There was a wide-ranging discussion of many issues related to results communication. These involved community-based participatory research, clinical ethics, and comparisons between a public health model and a clinical model for results communication. The Panel expressed interest in discussing these issues further at future meetings.

***Panel suggestions regarding discussion topics for future meetings:***

1. The SGP recommended that Program staff continue to evaluate and bring forward pesticides to which the public is thought to have considerable exposure, based on volume and/or type of use.

2. In addition to chemicals and chemical classes that have been mentioned at previous SGP meetings (e.g., chloramine disinfection byproducts, glycol ethers, phthalate replacements), some new chemicals were suggested for consideration as potential designated and potential priority chemicals including:
    a. Manganese (potential designated chemical)
    b. Low-VOC (volatile organic compound) solvents (e.g., 1-bromopropane) (potential designated chemical or chemical class)
    c. Dichloroanilines (potential designated chemical class)
    d. Acrylamide (potential priority chemical)

3. Panel members believe that questionnaires and other exposure assessment methods are a critical component of any biomonitoring project and they expressed an interest in seeing the CECBP draft questionnaire for evaluating participants' exposures.

## Appendix D: CECBP Designated and Priority Chemicals List (current as of December 2009)

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DESIGNATED CHEMICALS LIST (December 2009)

Designated chemicals consist of those chemicals that are included in the Centers for Disease Control and Prevention's (CDC's) National Biomonitoring Program, as well as additional chemicals, meeting certain criteria, that are recommended by the CECBP's Scientific Guidance Panel (SGP). Designated chemicals are the pool of chemicals from which the highest priority chemicals are selected for biomonitoring. Any "target chemical" that would be measured is indented and italicized directly below its parent chemical.

**Metals[2,3]**

Antimony
Barium
Beryllium
Cadmium
Cesium
Cobalt
Lead
Mercury
Molybdenum
Platinum
Thallium
Tungsten
Uranium
Arsenic
Arsenous (III) acid
Arsenic (V) acid
Monomethylarsonic acid
Dimethylarsinic acid
Arsenobetaine
Arsenocholine
Trimethylarsine oxide

**Diesel Exhaust[4]**

**Tobacco Smoke**

Nicotine

*Cotinine*

**Phthalates[2]**

Benzylbutyl phthalate (BzBP)

*Mono-benzyl phthalate*

Di-2-ethylhexyl phthalate (DEHP)

*Mono-2-ethylhexyl phthalate*

*Mono-(2-ethyl-5-oxohexyl) phthalate*

*Mono-(2-ethyl-5-hydroxyhexyl) phthalate*

*Mono-(2-ethyl-5-carboxypentyl) phthalate*

Dibutyl phthalate (DBP)

*Mono-n-butyl phthalates*

*Mono-isobutyl phthalate*

Dicyclohexyl phthalate (DCHP)

*Mono-cyclohexyl phthalate*

Dimethyl phthalate (DMP)

*Mono-methyl phthalate*

Diethyl phthalate (DEP)

*Mono-ethyl phthalate*

Di-isononyl phthalate (DiNP)

*Monoisononyl phthalate*

*Mono(hydroxyisononyl) phthalate*

*Mono(carboxyisononyl) phthalate*

*Mono(oxoisononyl) phthalate*

Di-n-octyl phthalate (DOP)

*Mono-n-octyl phthalate*

*Mono-(3-carboxypropyl) phthalate*

**Phytoestrogens[2]**

Daidzein

Enterodiol

Enterolactone

Equol

Genistein

O-Desmethylangolensin

**Environmental Phenols**[2]

Bisphenol A
2-Hydroxy-4-methoxybenzophenone (Benzophenone-3)
4-tert-Octyl phenol
2,4,4'-Trichloro-2'-hydroxyphenyl ether (Triclosan)

**Polycyclic Aromatic Hydrocarbons**[2]

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*

**Carbamates[2]**

Benfuracarb

*Carbofuranphenol*

Carbofuran

*Carbofuranphenol*

Carbosulfan

*Carbofuranphenol*

Furathiocarb

*Carbofuranphenol*

Propoxur

*2-Isopropoxyphenol*

**Organochlorine Pesticides[2]**

Aldrin

*Aldrin*

*Dieldrin*

Chlordane

*Oxychlordane*

*trans-Nonachlor*

DDT

*p,p'-DDT*

*o,p'-DDT*

*p,p'-DDE*

Dieldrin

*Dieldrin*

Endrin

*Endrin*

Methoxychlor

*Monohydroxy methoxychlor*

*Dihydroxy methoxychlor*

Endosulfan

*Endosulfan-ether*

*Endosulfan-lactone*

*Endosulfan-sulfate*

Heptachlor

*Heptachlor epoxide*

Hexachlorobenzene

*Pentachlorophenol*

*2,4,5-Trichlorophenol*

*2,4,6-Trichlorophenol*

Hexachlorocyclohexanes

*Beta-hexachlorocyclohexane*

*Gamma-hexachlorocyclohexane*

*Pentachlorophenol*

*2,4,5-Trichlorophenol*

*2,4,6-Trichlorophenol*

Mirex

*Mirex*

Pentachlorophenol

*Pentachlorophenol*

Trichlorophenols (2,4,5-Trichlorophenol and 2,4,6-Trichlorophenol)

*2,4,5-Trichlorophenol*

*2,4,6-Trichlorophenol*

**Organophosphate Insecticides**
**Dialkyl Phosphate Metabolites and Specific Metabolites[2]**

---

Acephate

Azinphos Methyl

*Dimethylphosphate*

*Dimethylthiophosphate*

*Dimethyldithiophosphate*

Chlorethoxyphos

*Diethylphosphate*

*Diethylthiophosphate*

Chlorpyrifos

*3,5,6-Trichloro-2-pyridinol*

*Diethylphosphate*

*Diethylthiophosphate*

Chlorpyrifos Methyl

*3,5,6-Trichloro-2-pyridinol*

*Dimethylphosphate*

*Dimethylthiophosphate*

Coumaphos

*3-Chloro-7-hydroxy-4-methyl-2H-chromen-2-one/ol*

*Diethylphosphate*

*Diethylthiophosphate*

Diazinon

*2-Isopropyl-4-methyl-6-hydroxypyrimidine*

*Diethylphosphate*

*Diethylthiophosphate*

Dichlorvos (DDVP)

*Dimethylphosphate*

Dicrotophos

*Dimethylphosphate*

Dimethoate

*Dimethylphosphate*

*Dimethylthiophosphate*

*Dimethyldithiophosphate*

Disulfoton

*Diethylphosphate*

*Diethylthiophosphate*

*Diethyldithiophosphate*

Ethion

*Diethylphosphate*

*Diethylthiophosphate*

*Diethyldithiophosphate*

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

*Malathion dicarboxylic acid*

*Dimethylphosphate*

*Dimethylthiophosphate*

*Dimethyldithiophosphate*

Methamidophos
Methidathion
*Dimethylphosphate*
*Dimethylthiophosphate*
*Dimethyldithiophosphate*
Methyl parathion
*para-Nitrophenol*
*Dimethylphosphate*
*Dimethylthiophosphate*
Naled
*Dimethylphosphate*
Oxydemeton-methyl
*Dimethylphosphate*
*Dimethylthiophosphate*
Parathion
*para-Nitrophenol*
*Diethylphosphate*
*Diethylthiophosphate*
Phorate
*Diethylphosphate*
*Diethylthiophosphate*
*Diethyldithiophosphate*
Phosmet (Imidan)
*Dimethylphosphate*
*Dimethylthiophosphate*
*Dimethyldithiophosphate*
Pirimiphos-methyl
*2-(Diethylamino)-6-methylpyrimidin-4-ol/one*
*Dimethylphosphate*
*Dimethylthiophosphate*
Sulfotepp
*Diethylphosphate*
*Diethylthiophosphate*
Temephos
*Dimethylphosphate*
*Dimethylthiophosphate*

Terbufos

*Diethylphosphate*

*Diethylthiophosphate*

*Diethyldithiophosphate*

Tetrachlorvinphos

*Dimethylphosphate*

**Pyrethroid Pesticides[5]**

Allethrin

*cis/trans-Dimethylvinylcyclopropane carboxylic diacid*

Bifenthrin

Cyfluthrin

*4-Fluoro-3-phenoxybenzoic acid*

*cis-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid*

*trans-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid*

Cyhalothrin

Lambda-cyhalothrin

Gamma-cyhalothrin

Cypermethrin

*3-Phenoxybenzoic acid*

cis-Cypermethrin

*cis-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid*

trans-Cypermethrin

*trans-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid*

Cyphenothrin

Deltamethrin

*3-Phenoxybenzoic acid*

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

Esbiothrin

Esfenvalerate

Etofenprox

Fenpropathrin

Fenvalerate

Imiprothrin

Metofluthrin

Permethrin

*3-Phenoxybenzoic acid*

cis-Permethrin

*cis-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid*

trans-Permethrin

*trans-3-(2,2-Dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid*

Phenothrin (sumithrin)

Prallethrin

Pyrethrin 1

*cis/trans-Dimethylvinylcyclopropane carboxylic diacid*

Resmethrin

*cis/trans-Dimethylvinylcyclopropane carboxylic diacid*

Tetramethrin

Tralomethrin

**Fungicides[2]**

Captafol

*Tetrahydrophthalimide*

Captan

*Phthalimide*

*Tetrahydrophthalimide*

Chlorothalonil

Dichloran

Folpet

*Phthalimide*

Mancozeb

*Ethylenethio urea (ETU)*

Maneb

*Ethylenethio urea (ETU)*

Metalaxyl

Metiram

*Ethylenethio urea (ETU)*

Nabam

*Ethylenethio urea (ETU)*

Ortho-phenylphenol (OPP)

Propineb

*Propylenethio urea (PTU)*

Thiram

*Ethylenethio urea (ETU)*

Ziram

*Ethylenethio urea (ETU)*

**Herbicides: Substituted Ureas[2]**

Bensulfuron-methyl
Chloroimuron ethyl
Chlorsulfuron
Dimethoxy pyrimidine (isomers unspecified)
Dimethyl pyrimidine (isomers unspecified)
Diuron
Ethametsulfuron-methyl
Foramsulfuron
Halosulfuron
Iodosulfuron
Linuron
Methyl methoxytriazine
Metsulfuron-methyl
Nicosulfuron
Primisulfuron-methyl
Prosulfuron
Rimsulfuron
Sulfometuron-methyl
Sulfosulfuron
Thifensulfuron-methyl
Triasulfuron
Triflusulfuron-methyl

**Other Herbicides[2]**

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

*2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)*

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

*2,4-Dichlorophenoxyacetic acid*

*2,4-Dichlorophenol (minor)*

Acetochlor

*Acetochlor mercapturate*

Alachlor

*Alachlor mercapturate*

Atrazine

*Atrazine mercapturate*

*Diaminochlorotriazine*

*Desethylatrazine*

*Desisopropylatrazine*

*Hydroxyatrazine*

Dacthal

Metolachlor

*Metolachlor mercapturate*

Trifluralin

**Other Pesticides**

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

para-Dichlorobenzene (1,4-dichlorobenzene)

*2,5 Dichlorophenol*

Iprodione

Octhilinone

Fipronil

**Polychlorinated Dibenzo-p-dioxins, Dibensofurans, Coplanar and Mono-Ortho-Substituted Biphenyls[2]**

1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)

1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)

1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)

1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)

1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)

1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)

2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)

1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)

1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)

1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)

1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)

1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)

1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)

1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)

2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)

2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)

2,3,7,8-Tetrachlorodibenzofuran (TCDF)

2,4,4'-Trichlorobiphenyl (PCB 28)

2,3',4,4'-Tetrachlorobiphenyl (PCB 66)
2,4,4',5-Tetrachlorobiphenyl (PCB 74)
3,4,4',5-Tetrachlorobiphenyl (PCB 81)
2,3,3',4,4'-Pentachlorobiphenyl (PCB 105)
2,3,3',4',6-Pentachlorobiphenyl (PCB 110)
2,3',4,4',5-Pentachlorobiphenyl (PCB 118)
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)
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)
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)

**Perfluorinated Compounds[2]**

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

**Non-Dioxin-Like Polychlorinated Biphenyls[2]**

2,2',5-Trichloro biphenyl (PCB 18)
2,2'3,5'-Tetrachloro biphenyl (PCB 44)
2,2',4,5'-Tetrachloro biphenyl (PCB 49)
2,2',5,5'-Tetrachlorobiphenyl (PCB 52)
2,2',3,4,5'-Pentachlorobiphenyl (PCB 87)
2,2',4,4',5-Pentachlorobiphenyl (PCB 99)
2,2',4,5,5'-Pentachlorobiphenyl (PCB 101)
2,2',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'-Decachloro biphenyl (PCB 209)

**Brominated and Chlorinated Organic Compounds Used as Flame Retardants[5]**

1,2-Bis(2,4,6-tribromophenoxy)ethane (BTBPE)
1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane (TBECH)
2, 4, 6-Tribromophenol
2,2-Bis(bromomethyl)-1,3-propanediol
2,2-Bis(chloromethyl)trimethylene bis[bis(2-chloroethyl)phosphate]
2,3-Dibromopropyl-2,4,6-tribromophenyl ether (DPTE)
2-Ethyl-1-hexyl-2,3,4,5-tetrabromobenzoate (TBB)
Bis(2-ethyl-1-hexyl) tetrabromophthalate (TBPH)
Bis(2-hydroxyethyl ether) TBBPA
Bis(hexachlorocyclopentadieno)cyclooctane (Dechlorane Plus)
Chlorendic acid
Decabromodiphenylethane (DBDPE)
Hexabromobenzene (HBB)
Hexabromocyclododecane (HBCD)
Hexachlorocyclopentadienyl-dibromocyclooctane
N-N-Ethylene-bis(tetrabromophthalimide)
Pentabromoethylbenzene (PBEB)
Pentabromotoluene (PBT)

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)
- 2,2'4,4',5,5'-Hexabromobiphenyl (BB 153)

Short-chain chlorinated paraffins
Tetrabromobisphenol A (TBBPA)
Tetrabromobisphenol A bis(2,3)dibromopropyl ether
Tetrabromophthalic anhydride
Tetrakis(2-chloroethyl)dichloroisopentyldiphosphate
Tris(1,3-dichloro-2-propyl)phosphate
Tris(1-chloro-2-propyl)phosphate (TCPP)
Tris(2,3-dichloro-1-propyl)phosphate
Tris(2-chloroethyl)phosphate

**Volatile Organic Compounds[2]**

1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2-dibromo-3-chloropropane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2,5-Dimethylfuran
Benzene
Bromodichloromethane

Bromoform
Carbon tetrachloride
Chlorobenzene
Chloroform
cis-1,2-Dichloroethene
Dibromochloromethane
Dibromomethane
Ethylbenzene
Hexachloroethane
m-/p-Xylene
Methylene chloride
Methyl-tert-butyl ether (MTBE)
Nitrobenzene
o-Xylene
Styrene
Tetrachloroethene
Toluene
trans-1,2-Dichloroethene
Trichloroethene

## Synthetic Hormones used in Food Production[5]

Zeranol
Trenbolone acetate
Melengestrol acetate

## Antimicrobials used in Food Production[5]

## Other Chemicals

Acrylamide
Glycidamide
Perchlorate

## Notes

1 Parent chemical is measured unless otherwise noted. Target chemical for measurement may change as method development proceeds.

2 All members of the chemical class are not designated chemicals; only the specific chemicals listed are designated chemicals.

3 The Centers for Disease Control and Prevention measures various forms of metals. CECBP will determine the most appropriate way to measure levels of the target metal in individuals tested.

4 All components of diesel exhaust are designated chemicals

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

PRIORITY CHEMICALS LIST (December 2009)

The following is a list of priority chemicals for the California Environmental Contaminant Biomonitoring Program (CECBP). Priority chemicals are the subset of designated chemicals that were recommended by the Scientific Guidance Panel (SGP) as priorities for biomonitoring in California. Biomonitoring of these chemicals will involve either measuring the parent compound or a target compound, as determined by the CECBP. Per SGP recommendation, the CECBP will determine the most appropriate target compound(s) to measure in order to evaluate the priority chemical in individuals tested.

**Metals**[1]

Cadmium
Lead
Mercury
Arsenic

**Phthalates**[1]

Dimethyl phthalate (DMP)
Diethyl phthalate (DEP)
Dibutyl phthalate (DBP)
Benzylbutyl phthalate (BzBP)
Dicyclohexyl phthalate (DCHP)
Di-2-ethylhexyl phthalate (DEHP)
Di-n-octyl phthalate (DOP)
Di-isononyl phthalate (DiNP)

**Diesel Exhaust**[2]

**Tobacco Smoke**

Cotinine

**Polycyclic Aromatic Hydrocarbons**[1]

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

**Environmental Phenols**[1]

Bisphenol A
2,4,4'-Trichloro-2'-hydroxyphenyl ether (Triclosan)

| **Other Chemicals** |
| --- |
| Perchlorate |
| Cyclosiloxanes (including but not limited to)[3] |
| Octamethylcyclotetrasiloxane (D4) |
| Decamethylcyclopentasiloxane (D5) |
| Dodecamethylcyclohexasiloxane (D6) |

| **Organophosphate Insecticides: Dialkyl Phosphate Metabolites and Specific Metabolites[1]** |
| --- |
| Acephate |
| Azinphos Methyl |
| Chlorethoxyphos |
| Chlorpyrifos |
| Chlorpyrifos Methyl |
| Coumaphos |
| Diazinon |
| Dichlorvos (DDVP) |
| Dicrotophos |
| Dimethoate |
| Disulfoton |
| Ethion |
| Fenitrothion |
| Fenthion |
| Isazophos-methyl |
| Malathion |
| Methamidophos |
| Methidathion |
| Methyl parathion |
| Naled |
| Oxydemeton-methyl |
| Parathion |
| Phorate |
| Phosmet (Imidan) |
| Pirimiphos-methyl |
| Sulfotepp |
| Temephos |
| Terbufos |
| Tetrachlorvinphos |

**Pyrethroid Pesticides**[1]

Allethrin
Cyfluthrin
Cypermethrin
cis-Cypermethrin
trans-Cypermethrin
Deltamethrin
Permethrin
cis-Permethrin
trans-Permethrin
Pyrethrin 1
Resmethrin

**Other Pesticides**

Dichlorodiphenyltrichloroethane (DDT)
para-Dichlorobenzene (1,4-dichlorobenzene)
2,4-Dichlorophenoxyacetic acid (2,4-D), salts and esters

**Brominated and Chlorinated Organic Compounds Used as Flame Retardants (including but not limited to)**[3]

1,2-Bis(2,4,6-tribromophenoxy)ethane (BTBPE)
1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane (TBECH)
2, 4, 6-Tribromophenol
2,2-Bis(bromomethyl)-1,3-propanediol
2,2-Bis(chloromethyl)trimethylene bis[bis(2-chloroethyl)phosphate]
2,3-Dibromopropyl-2,4,6-tribromophenyl ether (DPTE)
2-Ethyl-1-hexyl-2,3,4,5-tetrabromobenzoate (TBB)
Bis(2-ethyl-1-hexyl) tetrabromophthalate (TBPH)
Bis(2-hydroxyethyl ether) TBBPA
Bis(hexachlorocyclopentadieno)cyclooctane (Dechlorane Plus)
Chlorendic acid
Decabromodiphenylethane (DBDPE)
Hexabromobenzene (HBB)
Hexabromocyclododecane (HBCD)
Hexachlorocyclopentadienyl-dibromocyclooctane
N-N-Ethylene-bis(tetrabromophthalimide)
Pentabromoethylbenzene (PBEB)
Pentabromotoluene (PBT)

Polybrominated Diphenyl Ethers (PBDEs)
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- 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)
- 2,2'4,4',5,5'-Hexabromobiphenyl (BB 153)

Short-chain chlorinated paraffins
Tetrabromobisphenol A (TBBPA)
Tetrabromobisphenol A bis(2,3)dibromopropyl ether
Tetrabromophthalic anhydride
Tetrakis(2-chloroethyl)dichloroisopentyldiphosphate
Tris(1,3-dichloro-2-propyl)phosphate
Tris(1-chloro-2-propyl)phosphate (TCPP)
Tris(2,3-dichloro-1-propyl)phosphate
Tris(2-chloroethyl)phosphate
Perfluorinated Compounds[1]
Perfluorooctanoic acid
Perfluorooctane sulfonic acid
Perfluorohexane sulfonic acid
N-Ethyl-perfluorooctane sulfonamide
N-Methyl-perfluorooctane sulfonamide
Perfluorodecanoic acid
Perfluorobutane sulfonic acid
Perfluoroheptanoic acid
Perfluorononanoic acid
Perfluorooctane sulfonamide
Perfluoroundecanoic acid
Perflurododecanoic acid

**Notes**

1 All members of the chemical class are not priority chemicals; only the specific chemicals listed are priority chemicals.
2 All components of diesel exhaust are priority chemicals.
3 All members of the chemical class are priority chemicals, including but not limited to, the chemicals shown.

# Appendix E: Results of Public Participation Activities on What Chemicals Should be Biomonitored in California

(Appendices referenced in this report may be found at: http://www.oehha.ca.gov/multimedia/biomon/reports.html)

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**Preface**

This report presents the results of public participation activities conducted to engage the public in the California Environmental Contaminant Biomonitoring Program ("the Program"). The Program is a new initiative that will measure levels of environmental chemicals in California residents by systematically collecting biological specimens, such as blood and urine, and analyzing them in the laboratory. The goals of the Program are to:

- Determine levels of environmental chemicals in a representative sample of Californians.
- Establish trends in the levels of these chemicals over time.
- Assess the effectiveness of public health efforts and regulatory programs to reduce exposures of Californians to specific chemicals.
- Provide opportunities for meaningful public participation through activities and materials that are understandable and sensitive to the diverse needs of Californians.

The Program was authorized by the State Legislature and signed into law by Governor Schwarzenegger in 2006 (Senate Bill 1379, Perata, 2006), and program funding was received in July 2007. The Program is being implemented by three departments in state government: the California Department of Public Health (CDPH), the Office of Environmental Health Hazard Assessment (OEHHA), and the Department of Toxic Substances Control (DTSC). The external Scientific Guidance Panel ("the Panel") provides expert technical advice. The Program actively engages the public in program design and implementation through workshops, meetings, surveys and other approaches.

The activities described in this report were conducted during March to May 2008 to encourage early public participation and advice on an important element of the Program – the selection of chemicals for biomonitoring. A variety of individuals participated, including those from non-governmental and community-based organizations, state and local government agencies, universities, and businesses, as well as interested residents. We would like to acknowledge and thank all the individuals who participated for taking the time and making the effort to become involved in the Program's development.

Since the completion of the activities discussed in this report, chemical selection has been a topic of discussion at other public meetings: a technical workshop (open to the public) held on June 9 and the Panel meeting on June 10, 2008, both held in Oakland; the Panel meeting on December 4 and 5, 2008, which was held in Sacramento and

webcast. Some results of the public participation activities described in this report were presented at the June 10, 2008 Panel meeting. Members of the public made comments on chemical selection in person at these meetings and also via email during the December 2008 meeting. The Panel recommended additions to the list of designated chemicals at the December 2008 meeting. Recommendations for further additions to the list, and for the identification of priority chemicals for biomonitoring, will occur at future meetings.

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## 1. Introduction

This report presents results from a series of activities conducted to gather ideas and advice from the public on selecting chemicals for biomonitoring by the California Environmental Contaminant Biomonitoring Program ("the Program"). The report will inform the decision-making process of the Program and its technical external advisory body, the Scientific Guidance Panel ("the Panel"). During the first Panel meeting, held in December 2007, the Program made a commitment to gather information from interested stakeholders on possible chemicals and priorities for biomonitoring. Following this meeting, the Program planned and carried out a series of public workshops and teleconferences and a web-based survey, each focusing on issues of chemical selection.

Program staff had three objectives as they planned these public participation activities:

1. To involve stakeholders in the process of selecting chemicals for the California Biomonitoring Program.
2. To disseminate general information about the Biomonitoring Program.
3. To build community capacity on biomonitoring, that is, to increase understanding of biomonitoring by public participants and thereby enable them to be more effectively involved in the Program's design and implementation.

A variety of individuals chose to participate, including those from non-governmental and community-based organizations, state and local government agencies, universities, and businesses, as well as interested residents. The findings from these public activities do not represent the opinions of a random or representative sample of Californians. Rather, they reflect the opinions of motivated and interested individuals who provided their ideas, concerns, and advice about chemicals of interest and priorities for biomonitoring.

The current report focuses on public participation on the selection of chemicals for biomonitoring. During the public participation activities (workshops, teleconferences, survey), as well as in comments sent to the program by email, participants offered valuable ideas and suggestions, some addressing concerns other than chemical selection. For example, at the public workshops, members of the public commented on special studies and on the overall Program framework, following presentations on Program elements. Information beyond the scope of the current report will be considered by staff in other aspects of implementing the Program, but are not presented in detail here.

*Process for Chemical Selection in Legislation*
The process for chemical selection is explained below to orient the reader. Selection of chemicals for biomonitoring by the Program involves a multi-step process. The process is laid out in the legislation that established the Program (California Health and Safety Code (H&SC) Sections 105440 et seq.). Key passages on chemical selection in the legislation are quoted in Appendix 2.

Step 1: Designated Chemicals

In the first stage of the selection process, chemicals of concern are considered for inclusion in a list of "designated chemicals". Only a "designated" chemical can be biomonitored. Designated chemicals are defined in the legislation as:

1. "Those substances including chemical families or metabolites that are included in the federal Centers for Disease Control and Prevention (CDC) studies that are known collectively as the National Reports on Human Exposure to Environmental Chemicals program," and
2. Those that have been adopted by the Program as "designated" according to the process laid out in the legislation.

Appendix 1 lists chemicals, including families and metabolites, studied by the CDC. The Panel may recommend additional designated chemicals not included in the CDC program using the following criteria:

1. Exposure or potential exposure to the public or to specific subgroups.
2. Known or suspected health effects based on peer-reviewed studies.
3. The need to assess the efficacy of existing public health actions to reduce exposure to a chemical.
4. The availability of an analytical method for biomonitoring with adequate accuracy, precision, sensitivity, specificity, and speed.
5. The availability of adequate biomonitoring samples.
6. The incremental analytical cost to perform the biomonitoring analysis for the chemical.

At the time these public participation activities were conducted, the Panel had not recommended and the Program had not adopted additional designated chemicals. The public participation activities described in the current report were in part designed to elicit ideas on additional chemicals that should be "designated" within the meaning of the legislation.

Step 2: Priority Chemicals

There are more designated chemicals than can be biomonitored by the Program during its initial activities. The legislation sets out a process of picking "priority chemicals" for biomonitoring from those that have been designated. While the Program retains final decision-making authority, the Panel may recommend priority chemicals based on:

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

The public participation activities described in the current report were also designed to elicit ideas on additional criteria for the Panel to consider in making recommendations for priority chemicals for biomonitoring.

## 2. Methods and Materials

This section describes the methods and materials used in the public participation activities:

- a series of in-person workshops and teleconferences
- a web-based survey in English and Spanish
- public comment via mail and email submission

A. Workshops and Teleconferences

Staff developed a series of three four-hour workshops and three two-hour teleconferences. The workshops were designed to provide opportunities for the public to suggest environmental chemicals to be considered for biomonitoring, and to present information about biomonitoring and the Program, answer questions and hear public concerns.

Program staff opened each workshop by introducing general information about biomonitoring and the Program. Participants then asked questions and commented on what they had heard. Next Program laboratory staff presented on and discussed laboratory considerations with workshop participants. The rest of the workshop addressed the chemical selection process, focusing both on chemicals of interest for biomonitoring and criteria for selecting priority chemicals. Over half of each event was dedicated to hearing questions and comments from participants. The outline for the workshops and teleconferences follows. The agendas can be found in Appendix 3.

Part I. Program Overview:
California Environmental Contaminant Biomonitoring Program
- Introduction to biomonitoring
- Legislative background on the Program
- Program organization
- Possible program components
- Provisional timelines/milestones

Part II. Why Chemical Selection is Important for the Laboratories
(Segment presented at workshops but not teleconferences)
- Building laboratory capacity
- Starting small and building

- Steps in developing chemical testing methods

Part III. Selecting Chemicals for the California Biomonitoring Program

- Selecting chemicals according to the legislation
- Designated chemicals
- Examples of chemicals
- Selection criteria for choosing priority chemicals

All workshops and teleconferences were open to the public; pre-registration was requested but not required. Program staff publicized the meetings via listserv announcements, posting on the Program's[1] website, and emails to stakeholder organizations. Staff prepared handouts on the Program and chemical selection, and made these and slide presentations available on the Program's website.

B. Public Comments Submitted via Email

In addition to the workshops and teleconferences, the Program also offered an option of submitting comments via the Program's email address, biomonitoring@oehha.ca.gov. This avenue was described during the first Panel meeting and was mentioned at each of the public participation sessions, in the online Chemical Selection Survey, in notes sent by the biomonitoring listserv, and in other materials distributed to the public. Visitors to the Program's website were also informed of the email address where they could send their comments.

C. Survey

Survey Design

The chemical selection survey originated with a review of surveys cited in the California Biomonitoring Needs Assessment, published in October 2002 by the California Department of Health Services[2]. Program staff drafted the chemical selection survey with input from colleagues in the CDPH Occupational Health Branch. The draft underwent multiple revisions, and was reviewed by the Panel Chair and two other members of the Panel.

The resulting qualitative survey was designed to gather opinions and comments on specific chemicals and high-priority chemical categories for biomonitoring, as well as on criteria for selecting priority chemicals. The survey consisted of both multiple-choice and open-ended questions; the web-based interface was created using the online tool, SurveyMonkey. The survey was written in English, translated into Spanish and posted online in both languages. A mechanism for receiving and submitting paper copies of the

[1] Program Website hosted by the Office of Environmental Health Hazard Assessment (OEHHA) at www.oehha.org/multimedia/biomon/index.html

[2] Within CDHS, the Environmental Health Investigations Branch and the Environmental Health Laboratory Branch were responsible for developing the document. Those Branches are now part of the California Department of Public Health.

survey was also offered. The hard-copy adaptations of the survey in English and Spanish are provided in Appendix 4A and 4B. They differ in appearance from the online version, but are the same in all other respects.

The survey consisted of an introduction to the biomonitoring program and a brief explanation of the chemical selection process, and of the criteria set out in the legislation for selecting priority chemicals. This background information was followed by a series of questions. The first section asked respondents to indicate four criteria they believed most important from a list of ten possible additional approaches the Program and Panel could consider using to select priority chemicals. These criteria are listed in Table 1. Respondents were asked to select their top four criteria from the list, and to rank those four in terms of their importance, from most to less. The survey also provided space for respondents to suggest other issues by asking: "Should the program consider other issues in selecting priority chemicals?"

**Table 1. Survey Query on Possible Additional Criteria for Selecting Priority Chemicals for Biomonitoring**

**"The program should give priority to: (1=most important, 4=less important)**[1]

1. Measuring chemicals that are widely used throughout California.
2. Measuring chemicals that will help government decide whether environmental laws are working.
3. Measuring new, emerging chemicals, or other chemicals, that are now becoming widely used.
4. Measuring chemicals that Californians come into contact with at work.
5. Measuring chemicals that are studied nationally so that we can compare California with the rest of the country.
6. Measuring chemicals that are not studied nationally so that we can find out about chemical exposures that the federal government is not investigating.
7. Measuring chemicals expected to be higher in Californians because of specific activities or regulations in the state - for example, gold mining, oil refining, farming, or strict flammability standards for furniture.
8. Measuring chemicals to which pregnant women, fetuses and young children are likely to be especially sensitive.
9. Measuring chemicals that persist in the environment and can accumulate in people's bodies over time.
10. Measuring chemicals in communities where people may come into contact with more pollutants than the general population – for example, near factories, ports, oil refineries or farms.

[1] Respondents were asked to choose their four top criteria, ranking the four from most to less important.

The second section asked, "Which chemicals should the Biomonitoring Program measure in Californians?" for 13 different classes or categories of chemicals. These categories are shown in Table 2. Respondents were asked to rate these classes or categories on a scale of "Important – Somewhat important – Not important – Don't know." Respondents were also invited to list or describe specific chemicals or products

in each category that should be measured if they rated the overall category as "Important" or "Somewhat Important." Respondents were also offered the opportunity to list or describe other chemicals they thought the program should measure. Finally, the survey asked respondents to rank their top four of the 13 chemical categories listed in Table 2.

The last section gave respondents an opportunity to list examples of highly exposed communities, groups of workers exposed to chemicals on the job, and any additional comments they might have. At the end of the survey there was an optional section requesting respondents' names, affiliations (organization or company) and contact information.

**Table 2. Categories of Chemicals Included in the Survey**

**"Which chemicals should the Biomonitoring Program measure in Californians…**

1. Metals, such as those sometimes found in food, toys and drinking water
2. Pesticides or other chemicals used in farming to control weeds, insects, rodents and fungi that affect crops.
3. Pesticides used in or around homes or schools.
4. Chemicals found in plastics, such as those in packaging and consumer products, including water bottles and children's toys.
5. Flame or fire retardants, such as those found in furniture and electronics
6. Chemicals found in personal care products
7. Chemicals found in cleaning supplies
8. Chemicals found in workplaces
9. Chemicals that result from burning trash, plastic, tires and other discarded materials
10. Chemicals that result from burning oil, gasoline, diesel or coal
11. Chemicals from industrial plants or hazardous waste sites
12. Chemicals that may contaminate drinking water
13. Chemicals found in food

Survey Data Collection

Program staff used a web-based survey because it was easy to disseminate broadly and economical to create. The SurveyMonkey tool generates a web link that directs respondents to the survey. The survey was open to any member of the public able to access the link.

The survey link was posted on the Program's website (hosted by OEHHA). The members of the biomonitoring listserv, as well as workshop and teleconference participants, were notified of the survey and the deadline for completing it. In addition, a number of government agencies, private-sector, non-profit and community organizations were informed of the survey and asked to share the survey link with their members and constituents. For individuals without access to the internet, staff provided a paper copy of the questionnaire upon request. Paper copies of the survey were also

available in English and Spanish. The survey was available online from April 8, 2008 through May 7, 2008.

Survey Analysis
The survey data were exported as an Excel file and analyzed using SAS and Excel. Responses to the open ended questions and comments were manually tabulated and grouped. Each individual survey response was read to ascertain specific suggestions for chemicals and criteria.

**3. Extent of Participation**

A. Participation in Workshops/Teleconferences

The three workshops were conducted in Los Angeles (March 24), Oakland (April 3) and Fresno (April 23), while the three teleconferences were accessed using a toll-free call-in number on April 8, 17, and 28, 2008.

Persons attended as private citizens, though many also listed affiliations with a variety of organizations, including non-governmental organizations, universities, businesses, consulting firms, and state and local government. The numbers of participants at the workshops and teleconferences are listed below.

- Number of workshop participants:
    - Los Angeles – 11
    - Oakland - 40
    - Fresno - 20

- For the teleconferences, a total of 32 telephone lines were open. Some lines had multiple participants.
    - April 8 - 19 lines
    - April 17 - 9 lines
    - April 28 - 4 lines

Comments and questions received during the workshops and teleconferences covered a range of issues about the biomonitoring program. These include some comments and questions that did not address chemical selection issues. These comments on topics other than chemical selection are summarized in Appendix 7. Questions and comments regarding the Program's general approach and framework that are beyond the scope of this report will be considered in subsequent Program implementation.

B. Participation via Email

Eighteen public comments providing suggestions on chemical selection via the Program's email address were received from January 7 through May 7, 2008. In addition, one individual provided comments in hard copy at one of the workshops. Another individual submitted written material in conjunction with oral comments made

during a workshop; both oral and written suggestions from that individual are summarized together with the workshop comments.

The submissions ranged from short email messages to email notes with multiple attachments of 50 to 100 pages in length. These attachments generally provide information supporting the inclusion of a particular chemical or chemicals. One submission focused on criteria to be used in identifying Program priorities, and another provided background material to support consideration of a particular community for a special study. The materials related to community studies will be considered in subsequent Program development and implementation. Suggestions received via email regarding communities of interest and chemicals for biomonitoring are summarized in Appendices 7 and 8, respectively.

C. Participation in the Biomonitoring Survey

In total, 319 people took the survey. 318 started the English-language version of the survey and answered at least one question; one person took the Spanish-language version.

258 (81%) respondents chose the option of giving information about themselves, including organizational affiliations. Figure 1 gives the corresponding percentages, and Table 3 gives further information on these respondents.

**Figure 1. Affiliation of Survey Respondents**

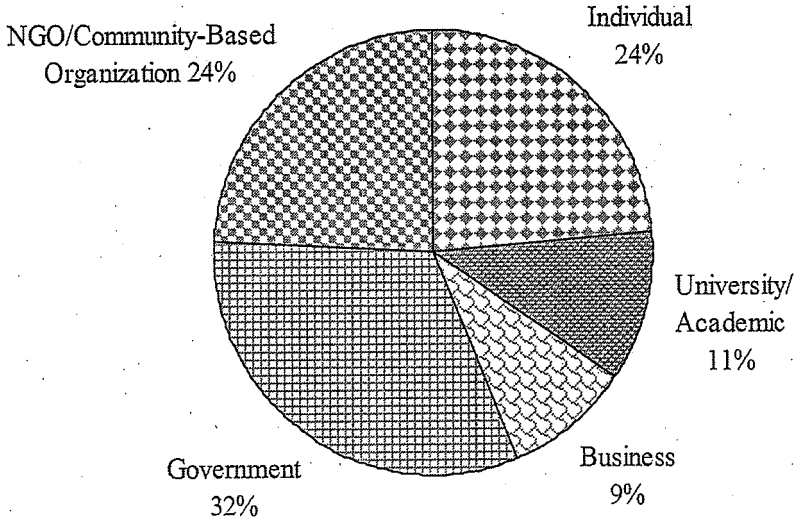


**Table 3. Affiliation of Survey Respondents (Who Provided Optional Identifying Information)**

| | |
|---|---|
| **Business** | 24 respondents: Nine (38%) worked for an international business or industry, three (13%) for a national business or industry, seven (29%) were part of a small business, and five people did not specify. |
| **Government** | 83 respondents: 39 (47%) worked for local government, 33 (40%) for state government, six (7%) for the federal government, and four (5%) for a regional government organization. One additional person identified as a retired government employee. |
| **NGOs or community-based organizations** | 62 respondents: Some selected "Other" type of organization, 15 (24%) worked for organizations specializing in health outcomes, such as cancer or asthma, 14 (23%) were with environmental organizations, nine (15%) were with environmental justice organizations, 4 (6%) worked for worker health and safety organizations, and 20 (32%) fit into other categories. |
| **Individuals** | 61 respondents, including one person identified as a member of a Native American tribe. |
| **Academic/ University** | 28 respondents. |

An important caveat to keep in mind in reviewing the results of the online survey is that they do not represent the opinions of a random sample of Californians or a representative sample of people who heard about the new California Biomonitoring Program. Everyone who had expressed an interest in the program, including people from out of state, were invited to take the survey, and people were also encouraged to invite colleagues in state government, universities, nonprofit organizations and the business community to participate. The answers reflect this mix. They are the opinions of individuals but they may also express the point of view of an organization or an employer.

## 4. Chemicals Suggested for Inclusion in the Program

The public participation activities generated a large number of questions and suggestions regarding chemical categories and specific chemicals and products of concern. Specific findings are detailed in the following sections.

A. Chemicals Recommended in Workshops and Teleconferences

During the workshops and teleconferences, the subject of which chemicals to include in the Program generated 85 comments or questions. In total, 57 chemicals or chemical groups were included among them: 33 discrete recommendations for chemicals to consider for the statewide program, and 24 chemicals related to sites of concern to three workshop participants. Issues related to the laboratory were also raised (28 questions and comments), such as which specimens to collect (e.g., blood, cord blood, hair, breast milk), how many people would be sampled, and what methods would be used.

Discrete Chemicals
Table 4 lists the discrete chemicals raised as concerns or recommended for biomonitoring during the workshops and teleconferences.

**Table 4. Chemicals or Chemical Groups Suggested during Teleconferences and Workshops**

| Chemicals or Chemical groups | No. of supporting comments |
|---|---|
| 1. Metals | 8 |
| 2. Pesticides | 9 |
| 3. Radioisotopes | 3 |
| 4. Phthalates | 3 |
| 5. Perchlorate | 2 |
| 6. Other (components of diesel fuel, chemicals in vaccines, decaBDE, triclosan, pharmaceuticals, and personal care products) | 8 |
| **Total** | **33** |

Two chemical groups, metals and pesticides, dominated discussions during the public sessions. Specific metals mentioned by name included arsenic, hexavalent chromium, lead, manganese, nickel, and cadmium. Lead and other heavy metals were mentioned twice specifically with relationship to their adverse effects on children, and legacy

contamination from past activities such as mining, shooting ranges, and battery recycling.
Nine participants identified pesticides as a chemical group of concern. Those mentioned specifically by name included organophosphates (three times), chlorpyrifos, DEET, the metam sodium-metabolite MITC, organochlorines, and any pesticides or products sprayed over communities to fight infestations such as fruitflies or the light brown apple moth. Two individuals were interested in the Program measuring cholinesterase levels among biomonitoring program participants with elevated exposure to organophosphates

Also suggested for inclusion were radioisotopes, phthalates, endocrine disruptors, perchlorate, components of diesel fuel, chemicals in vaccines, decabromodiphenylether (decaBDE), triclosan, pharmaceuticals, and personal care products.

Two participants mentioned that chemicals from illegal dumping of waste fertilizers and products from methamphetamine labs should be considered.

Site-specific Chemicals
A participant in Los Angeles submitted multiple documents about three issues of concern in the San Fernando Valley in Southern California. Included are chemicals found at the former Rocketdyne site, chemicals in water being reinjected into the San Fernando Valley Aquifer, and Chatsworth Park, the location of a former shooting range. In addition to radioisotopes, chemicals included in submitted documents include metals (antimony, arsenic, barium, beryllium, cadmium, hexavalent chromium, copper, cyanide, iron, lead, mercury, manganese, molybdenum, nickel, thallium, selenium, silver, vanadium, and zinc), as well as chlorine, tetrachlorodibenzo-p-dioxin (TCDD), tetrachlorophenol (TCP), and pentachlorophenol (PCP).

Laboratory Related Questions
The public workshops served as an opportunity for stakeholders to build knowledge about laboratory procedures for chemicals of interest. Thirteen attendees sought general information about particular chemicals and whether they could be detected in the laboratory on PBDEs, perchlorate, endocrine disruptors, methane, and caffeic and giberellic acids.

Interest was demonstrated in laboratory start-up and specimens to be collected as well during the public sessions. Inquiries were made about laboratory capacity, instrumentation, and collections methods. In terms of biological samples, questions were fielded about testing chemicals in breast milk, cord blood, hair, liver biopsies, nails, saliva, serum, and urine.

One workshop participant expressed concern that samples would be archived in only one laboratory located in an earthquake zone. He recommended that the program consider archiving samples in both northern and southern California locations.

B. Chemicals Recommended via Email

Specific chemicals or products of interest identified in public comments submitted via email are summarized in Table 5. In general they are the same as those identified via the workshops and survey. Some chemical suggestions were accompanied by data and other details to support their inclusion in the Program. Substantial information accompanied comments on two chemicals that are not currently measured by the CDC biomonitoring program, decamethylcyclopentasiloxane (D5) and triclocarban.

**Table 5. Chemicals of Interest Identified in Email Submissions**

| Summary of Submissions | Chemicals or Products Suggested (number of separate submissions noting this chemical) |
|---|---|
| Six individuals or organizations submitted comments via email or hard copy | Bisphenol A* (twice)<br>Caffeic acid<br>Chemicals present in dryer sheets and fabric softeners<br>Chemicals used in the dry cleaning industry*<br>Decamethylcyclopentasiloxane (D5)*<br>Depleted uranium<br>Fire retardants<br>Formaldehyde<br>Lead<br>Mercury* (twice)<br>Pesticides<br>Phthalates<br>Radionuclides*<br>Solvents<br>Triclocarban*<br>Triclosan* |

* Lengthy attachment(s) provided with comment

C. Chemicals Recommended in the Survey

<u>Chemical categories of interest for inclusion in the Program</u>
To get an idea of the types of chemicals the public would like to see biomonitored, survey respondents were asked to rank each of the 13 chemical categories by level of importance. For each category they were asked to answer the question, “Which chemicals should the Biomonitoring Program measure in Californians…” by indicating whether the category was:

- Important
- Somewhat Important
- Not Important
- Don’t Know

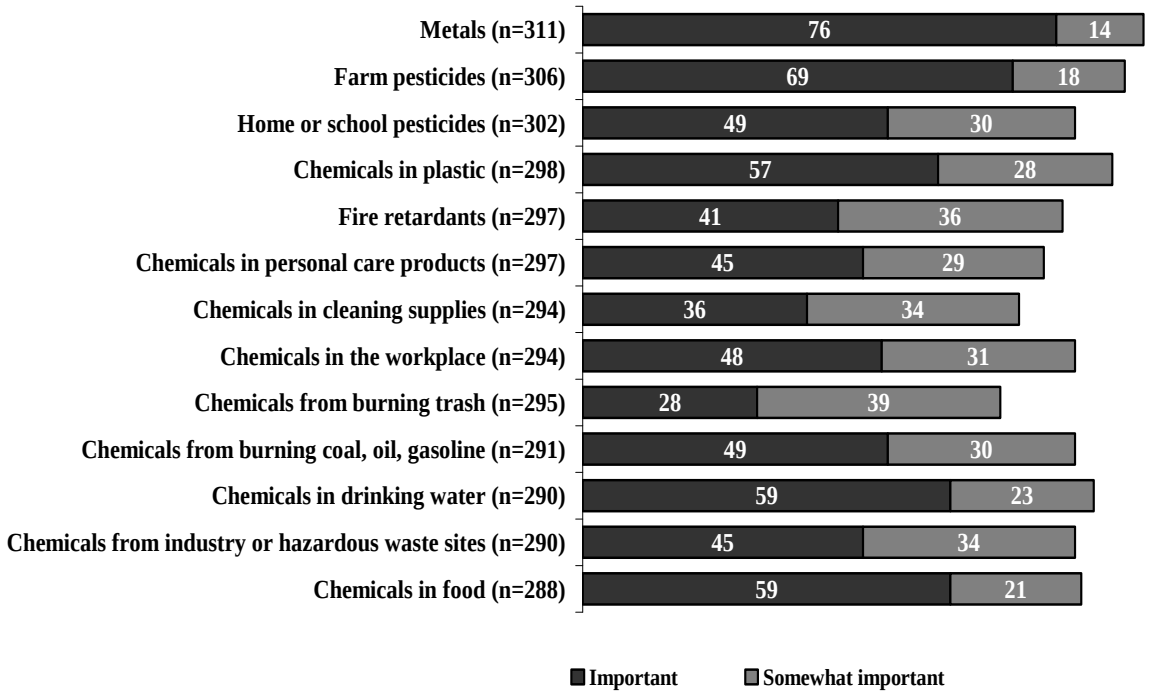
The verbatim wording of the categories in the survey is given in Table 6.

**Table 6. Categories for the Survey Question "Which chemicals should the Biomonitoring Program measure in Californians…"**

| |
|---|
| 1. Metals, such as those sometimes found in food, toys and drinking water – For example: mercury, lead, chromium, arsenic. |
| 2. Pesticides or other chemicals used in farming to control weeds, insects, rodents or fungi that affect crops, including fruits, grains, vegetables or cotton. |
| 3. Pesticides used in or around homes or schools - for example, to control fleas, ticks, weeds or insects in the home or yard. |
| 4. Chemicals found in plastics, such as those in packaging and consumer products, including water bottles and children's toys. |
| 5. Flame or fire retardants, such as those found in furniture and electronics. |
| 6. Chemicals found in personal care products - for example, cosmetics, nail polish and shampoo. |
| 7. Chemicals found in cleaning supplies - for example, window, floor, and bathroom cleaners. |
| 8. Chemicals found in workplaces. There are many thousands of chemicals used in workplaces; a few examples include chemicals used to manufacture household appliances and electronics, solvents (such as metalworking fluids, paint thinner or nail polish remover), or gases that can be irritating to breathe. |
| 9. Chemicals that result from burning trash, plastic, tires and other discarded materials. |
| 10. Chemicals that result from burning oil, gasoline, diesel or coal - for example, from power plants, ships at port, cars, buses or trucks. |
| 11. Chemicals from industrial plants or hazardous waste sites. |
| 12. Chemicals that may contaminate drinking water - for example, prescription drugs, petroleum products, and chlorine disinfection byproducts. |
| 13. Chemicals found in food - for example, pesticide residues, fungal toxins, byproducts formed during cooking, or chemicals in packaging that migrate into food. |
| 14. Are there other chemicals that you think the program should measure? If so, please list or describe them below. |

Nearly all of the 319 survey respondents answered this question. As Figure 2 shows, over two-thirds of the respondents found each chemical category to be either important or somewhat important for biomonitoring. The largest percentage of "most important" votes was for metals, followed by agricultural pesticides, chemicals in plastics, drinking water and food. The extent of response followed the order of placement of the question in the survey: 311 responded to the question for the first category (metals), with numbers generally dropping by a few individuals to the final category (chemicals in food), with 287 respondents.

**Figure 2. Present Respondents Rating Each Category as Important or Somewhat Important**




Respondents selecting the options “most important” or “somewhat important” for a category were then offered the option of suggesting specific chemicals that the program should measure. For example, after responding to Question 7 (see Table 6) the following option was offered:

> “If you answered Important or Somewhat Important, you may list or describe below any specific chemicals found in cleaning supplies that you think the program should measure.”

Respondents provided a large number of suggestions for chemicals to biomonitor in response to this option for the set of 14 categories presented. They named over 300 different chemicals or chemical types. Responses are tabulated in Appendix 5. In many cases, the same chemical was named by multiple people, with lead, mercury, phthalates and bisphenol A named by one-third or more of those completing the survey. Table 6 gives the chemicals and chemical types most frequently written in by respondents. A number of these are being tested in the CDC’s program. These are shown in italics in Table 7.

**Table 7. Chemicals Most Frequently Suggested for Biomonitoring in Survey Responses**[1]

| Individual Chemicals | Chemical Classes | Chemical Types |
|---|---|---|
| • *Lead*<br>• *Mercury*<br>• *Bisphenol A*<br>• *Arsenic*<br>• *Dioxin*<br>• *Cadmium*<br>• Chromium<br>• Glyphosate<br>• *Formaldehyde*<br>• *Perchlorate*<br>• *Chlorpyrifos*<br>• *Benzene*<br>• Deca-BDE<br>• *Perfluorooctanoic acid* | • *Phthalates*<br>• *Polybrominated*<br>• *Diphenyl Ethers*<br>• *Polychlorinated biphenyls*<br>• *Pyrethroids*<br>• Parabens<br>• Heavy *Metals*<br>• *Organophosphates*<br>• *Polyaromatic hydrocarbons* | • Pesticides<br>• Pharmaceuticals<br>• Endocrine Disruptors<br>• Solvents<br>• Fragrances<br>• Bioaccumulative or persistent<br>• Diesel exhaust<br>• Fluorinated Polymers<br>• Volatile Organic Compounds<br>• Hormones<br>• Particulate Matter<br>• Hazardous air pollutants |

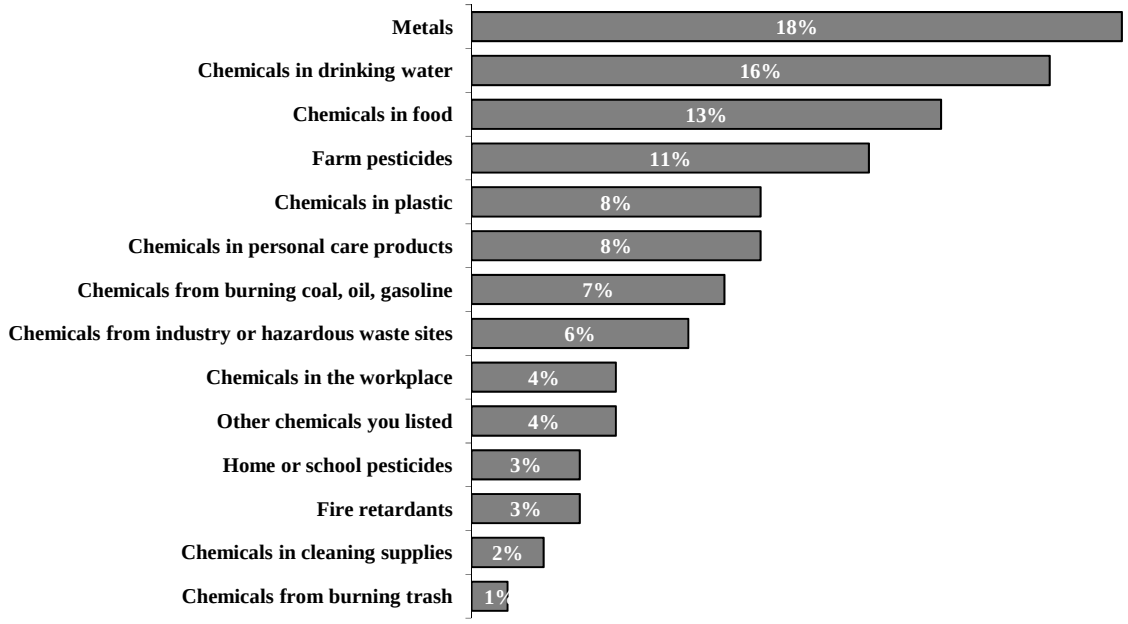
[1] Chemicals or chemical classes being biomonitored in the national CDC program are *italicized*.

In response to the final category, respondents could suggest other types of chemicals not covered by earlier categories. Generally suggestions included chemicals that fit into the previous categories. Those that did not include tobacco smoke indicators (e.g., cotinine), crystalline silica, the perchloroethylene substitute D5, aflatoxin, nanotubes, and indicators of effect such as inflammatory markers of cardiovascular disease.

Oftentimes the same chemical was mentioned in different categories by different people. For example, endocrine disruptors, lead, mercury, and phthalates were raised in nine of the 14 categories, and dioxins were raised in ten. Various respondents indicated the desire for the program to give priority to chemicals that cause specific types of health outcomes – cancer, asthma, mutations, reproductive effects and endocrine disruption. The wide range of specific suggestions for biomonitoring in response to the open-ended questions on chemical selection are grouped by type in Appendix 5, and specific chemicals or classes under study by the CDC are noted.

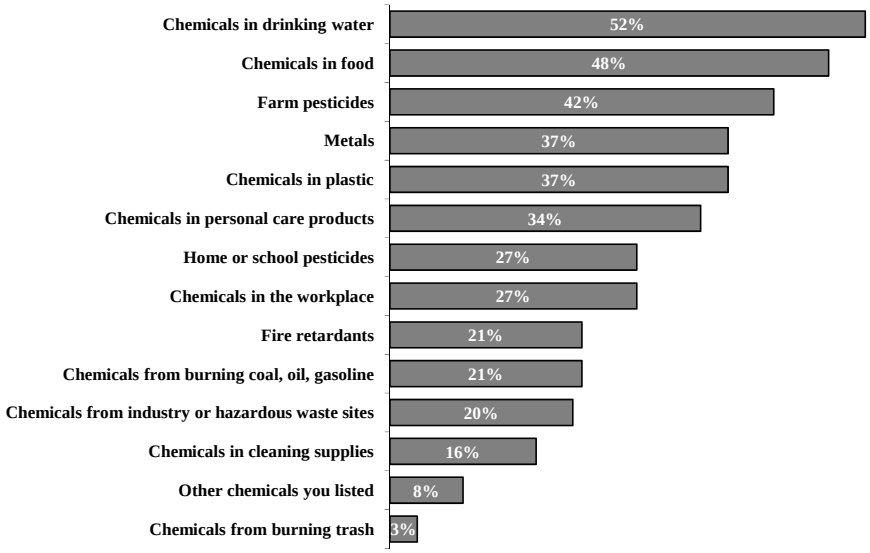
Finally, people were asked to indicate the “four most important categories of chemicals that the program should measure.” Metals were ranked first followed by chemicals in drinking water, chemicals in food, and farm pesticides.

**Figure 3. Percent Respondents Choosing a Specific Chemical Category as Their Highest Priority (262 Respondents)**




If instead of considering only the category chosen as the highest priority as is shown in Figure 3, we consider the four categories that were top priorities of respondents, a somewhat different ordering emerges. However, in this analysis, the same categories are of greatest interest, as shown in Figure 4. The chemicals in drinking water category (52%) is the one chosen most frequently by respondents as one of their top four. This is followed by chemicals in food (47%) and farm pesticides (41%); the metals category is tied with chemicals in plastics (both with 37%).

**Figure 4. Percent Respondents Selecting a Specific Chemical Category as One of Their Top Four (262 Respondents)**



## 5. Criteria Suggested for Selecting Chemicals

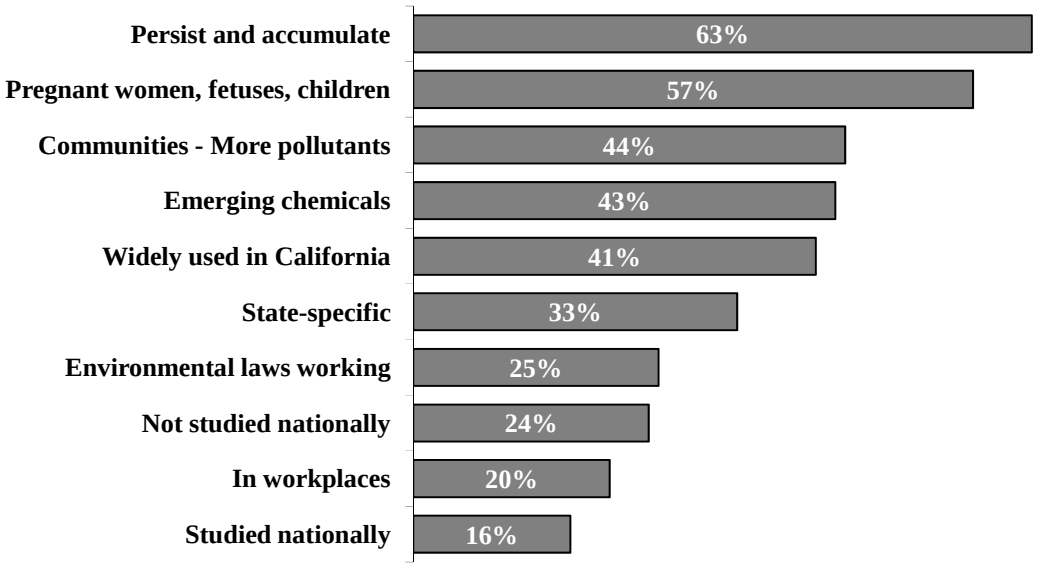
Ten possible criteria that might be used for selecting priority chemicals were discussed at public workshops and teleconferences, and were presented in the survey. As discussed above, these would be additional criteria beyond the three criteria specified in legislation. Suggestions for other issues that should be considered in selecting priority chemicals were also solicited. This section describes which criteria the public found most important and other considerations they suggested for choosing priority chemicals.

A. Comments Received on Possible Criteria Suggested for Selecting Priority Chemicals

Survey respondents were asked to rank the criteria listed in Table 1 above (see page 9) by indicating the four they believed were most important for the Panel and the Program to consider, and to rank them from most important to less important. During the public participation sessions, staff introduced these same criteria and then solicited input from participants by asking: "What issues do you think should be considered as part of the decision-making?" The criterion listed as number 10 in Table 1, *Communities where people come into contact with more pollutants*, was included in the survey but was inadvertently omitted from the public participation session presentations. A total of 290 survey respondents provided their top four criteria, and during the workshops and teleconferences, participants made 24 comments about these criteria.

Figure 6 shows the criteria ranked in the top four by the survey respondents. The one that was ranked most often in the top four (63.1%) was measuring chemicals that persist in the environment and can accumulate. Several public workshop participants expressed interest that banned chemicals be biomonitored, and these tend to be those that persist and can accumulate, so these discussions suggested a similar concern. The other criterion ranked in the top four by a majority of survey respondents (56.6%) was measuring chemicals that impact pregnant women, fetuses and children. This criterion was the one mentioned most often by participants in the public participation sessions. One of the public comments submitted via email suggested the Program focus on chemicals which affect children.

**Figure 5. Choice by Survey Respondents of Possible Criteria for Selecting Priority Chemicals as Among Their Top Four**




Three other criteria were chosen by a large number of survey respondents, with rankings in the top four by more than 40 percent of respondents (Figure 6). Among these, the criterion related to chemicals that are found in communities where people may come into contact with more pollutants than the general population was the ranked in the top four by 44 percent of respondents. Although public participation session participants were not presented with this criterion, several participants expressed a concern that exposures in such communities be addressed by the Program. Two public email comments suggested that the Program study specific communities where people are thought to come into contact with more pollutants than the general population.

The other highly ranked criteria included measuring chemicals that are widespread in California (41%), and measuring new or emerging chemicals that are now becoming widely used (43%). Participants in the public sessions also mentioned multiple times the criterion of measuring new, emerging chemicals and those that are widespread in California. A single public comment submitted via email suggested the Program focus on chemicals that have widespread potential exposure.

B. Comments on Other Criteria that Should Be Considered in Selecting Priority Chemicals

Suggestions about other criteria to consider in selecting priority chemicals, beyond those ten criteria offered for evaluation and ranking, were received from 13 workshop and teleconference participants, four submitting comments via email, and 148 (roughly half) of the survey respondents. The suggestions made are summarized below and listed in Appendix 6. This Appendix also tabulates, where available, the organizational affiliation of the person making the suggestion, and whether it was received through the

survey, public participation sessions, or email submission. Some respondents provided multiple suggestions.

**Table 8. Criteria Suggested for Selecting Priority Chemicals**

| General criteria | Criteria Subcategory |
|---|---|
| 1. Toxicity | A. Severity of the effect<br>B. Type of harm caused by the chemical<br>C. Potential for cumulative effects of chemicals<br>D. Toxicity and exposure considered together in some form of hazard evaluation |
| 2. Exposure | A. Extent of exposure<br>B. Persistence<br>C. Specific locations or sources of exposure<br>D. Population at risk – those with a chronic illness or condition<br>E. Population at risk – due to intrinsic characteristics, such as age or genetic factors (e.g., race)<br>F. Population at risk – due to location or particular exposures faced, such as communities of people of color exposed to high levels of toxic chemicals, or exposed workers |
| 3. Laboratory | A. Type of biomarkers available, such as biomarkers of effect<br>B. Type of media sampled, such as blood and urine<br>C. Method availability, accuracy and sensitivity<br>D. Cost |
| 4. Other | A. Results allow for intervention or to assess effectiveness<br>B. Chemicals that have safe alternatives<br>C. Emerging chemicals<br>D. Measured by national program (CDC list)<br>E. Risk communication issues<br>F. Other issues – economics, public concern, delisting |

To make it easier to understand the general areas, the suggestions received have been grouped into four major categories, which correspond to the three criteria specified in the legislation (toxicity, exposure, and laboratory considerations) and an additional category of “other”. Within each category, there are subsets of criteria suggested. These are described below, with examples, and are summarized in Table 8. Some of the suggestions overlap with the possible criteria presented by the Program, and also with criteria in legislation.

Toxicity-related Criteria

A substantial portion of the suggestions the Program received on criteria related to considerations of toxicity. Suggestions made regarding selecting priority chemicals based on toxicity generally were one of four types.

First was the suggestion to consider the severity of toxicity in selecting chemicals for the program. An example of this type of suggestion is “The more toxic the chemicals, the higher the priority should be.” A second type of suggestion was to take into account the type of harm caused by the chemical. Many different types of harm were suggested by survey respondents as deserving of priority, including: chemicals that cause cancer, endocrine disruption, neurotoxicity, reproductive toxicity, and ecotoxicity. A third type of toxicity-related suggestion was consideration of the potential for cumulative (e.g., additive, synergistic) effects of chemical exposures.

The fourth type of suggestion grouped in this category concerned both toxicity and exposure. A number of survey respondents suggested as a possible approach consideration of toxicity and exposure together in some form of hazard evaluation. For instance, “Chemicals already known to have health consequences and widely distributed should be measured.”

Exposure-related Criteria

The greatest number of suggestions made addressed issues related to exposure. There were six types of exposure-related criteria described. The first three were the extent of exposure, persistence, and specific locations or sources of exposure. The suggestions to consider the extent of exposure generally pointed to giving priority based on the number of people exposed to commonly encountered chemicals. Persistence was somewhat less frequently suggested, but had also been provided as a possible criterion in the survey and at public participation sessions. As discussed above, persistence was selected as among the top four choices of the ten criteria presented for ranking by the greatest number of survey respondents. Suggestions regarding particular sources of exposure or media were especially frequent, and included indoor air, food, consumer products, vaccines, drinking water, outdoor air pollution and others.

Three other categories of exposure-related criteria suggested relate to considerations of populations at risk. One population at risk mentioned by survey respondents comprised those with a chronic illness or condition, such as people with compromised immune systems or who have severe chemical sensitivity. A second category included populations who are vulnerable due to intrinsic characteristics, such as race or other genetic factors, or age (the elderly, infants and children). This is in accord with the criterion ranked second highest by survey respondents, “measuring chemicals to which pregnant women, fetuses and children are especially sensitive” (See Figure 5). A third category of populations at risk referred to the location or exposures faced by a given population, frequently suggesting that low-income communities, or communities of people of color exposed to high levels of toxic chemicals be given high priority. These suggestions accord with the third ranked survey criterion referencing high-exposure communities (i.e., “Measuring chemicals in communities where people may come into contact with more pollutants than the general population – for example, near factories,

ports, oil refineries or farms”). Other examples include specific populations exposed at the workplace.

Laboratory-related Criteria

Suggestions related to laboratory considerations were made less frequently than those in other categories. One comment referred to chemicals that have particular types of biomarkers available (“Consider chemicals for which there are known markers, i.e., cholinesterases for pesticides, carboxyhemoglobin for methylene chloride” ), while another suggested examining biomarkers that might serve as a surrogate for a class of compounds. A different type of suggestion referred to the tissue or fluid to be sampled, with multiple suggestions made to use umbilical cord blood. Other comments related to the availability of methods to analyze the chemical, measurement accuracy, and cost considerations.

Other Criteria

Suggestions of criteria that did not fit into the sets described above generally concerned policy considerations. The majority of these focused on chemicals for which the results could lead to public health interventions or allow for the evaluation of regulatory effectiveness. Multiple respondents suggested focusing on chemicals for which there are effective and safe alternatives. Others suggested that new or emerging chemicals should be emphasized. Some respondents focused on the national program and how the Program’s selection of chemicals should be similar or from CDC’s selection. Others noted that how results would be communicated should influence the choice of chemicals. Still others indicated the need to consider economic factors, such as risk/benefit evaluations, or the level of public concern. One person suggested the development of criteria to remove chemicals from the Program’s list.

## 6. Summary and Concluding Remarks

This report presents the results of public participation activities conducted in Spring 2008 by the California Environmental Contaminant Biomonitoring Program. A series of public workshops and teleconferences and a web-based survey were conducted and the public's advice via email submission was solicited. These activities were designed to gather ideas and suggestions from the public early in the Program's design phase, on selecting chemicals for biomonitoring in California. In addition, these activities were used to disseminate general information about the Biomonitoring Program, and also to increase the understanding of biomonitoring by public participants to enable more effective involvement in the Program's design and implementation.

The public participation activities were designed to support the multi-step implementation process for chemical selection laid out in the legislation that established the Program. Ideas were solicited on chemicals to biomonitor and criteria to use in choosing from the many possible chemicals worthy of study.

The participation in these activities was reasonably diverse and a good start for a new program. Seventy-one people participated in workshops and teleconferences, 18 commented by email and 319 people took the survey. There was representation from various sectors, including business, NGOs and community-based groups, government and academia, as well as the general public.

A large volume of suggestions for chemical selection were received. Specific chemical classes and types of chemicals suggested most frequently in the survey are as follows:

Individual chemicals

- Lead
- Mercury
- Bisphenol A
- Arsenic
- Dioxin
- Cadmium
- Chromium
- Glyphosate
- Formaldehyde
- Perchlorate
- Chlorpyrifos
- Benzene
- Deca-BDE
- Perfluorooctanoic Acid

Chemical classes

- Phthalates
- Polybrominated Diphenyl Ethers
- Polychlorinated biphenyls
- Pyrethroids
- Parabens
- Heavy Metals
- Organophosphates
- Polyaromatic hydrocarbons

Chemical types

- Pesticides
- Pharmaceuticals
- Endocrine Disruptors
- Solvents
- Fragrances
- Bioaccumulative or Persistent
- Diesel Exhaust
- Fluorinated Polymers
- Volatile Organic Compounds
- Hormones
- Particulate Matter
- Hazardous Air Pollutants

With few exceptions, the comments at the workshops and conferences were consistent with the chemicals named above.

Respondents felt a wide number of sources leading to chemical exposures were worthy of biomonitoring. In response to queries on 13 varied categories of chemical exposures from occupational and environmental sources, two-thirds or more of survey respondents found each category to be either important or somewhat important for biomonitoring. Categories considered to be of most importance were metals, chemicals in drinking water, chemicals in food, and pesticides used in farming. This was seen in the survey and was also reflected in discussions at the workshops and teleconferences.

As for criteria to supplement the three specific ones in the legislation for choosing priority chemicals to biomonitor, the one that was ranked most often in the top four was measuring chemicals that persist in the environment and can accumulate. Several public workshop participants expressed interest that banned chemicals be biomonitored, and these tend to be those that persist and can accumulate, so those discussions suggested a similar concern. The other criterion ranked in the top four by the majority of survey respondents was measuring chemicals that impact pregnant women, fetuses and children. This criterion was also the one mentioned most often by participants in the public participation sessions. The public shared their own specific ideas for criteria, beyond those identified as possibilities by Program staff. In general they indicated the importance of considering different aspects of toxicity, exposure, laboratory capacity, and policy in selecting priority chemicals for biomonitoring in California. Specific advice and ideas are captured in this report and its Appendices are proving to be quite useful as the Program proceeds with planning and design activities.

## Appendix F: State Agency Report on What Chemicals Should be Biomonitored in California

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# *Preface*

The California Environmental Contaminant Biomonitoring Program (CECBP or "the Program") is a new initiative that will measure levels of environmental chemicals in California residents. Three departments are involved in implementing the Program: the California Department of Public Health (CDPH), the Office of Environmental Health Hazard Assessment (OEHHA), and the Department of Toxic Substances Control (DTSC). The CECBP was authorized by the State Legislature and signed into law by Governor Schwarzenegger in 2006. The law calls for the Program to systematically collect biological specimens, such as blood and urine, from California residents and to analyze them for the presence of designated environmental chemicals.

The primary goals of the Program are to:

- Determine levels of environmental chemicals in a representative sample of Californians;
- Establish trends in the levels of these chemicals over time;
- Assess the effectiveness of public health efforts and regulatory programs to reduce exposures of Californians to specific chemicals; and
- Provide opportunities for meaningful public participation through activities and materials that are understandable and sensitive to the diverse needs of Californians.

This report summarizes state staff responses to CECBP's State Government Query on chemicals to be considered for biomonitoring. OEHHA staff administered the Query and prepared the report by distilling and organizing the responses.

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## INTRODUCTION

This report summarizes responses to the California Environmental Contaminant Biomonitoring Program (CECBP) State Government Query (see Appendix). The Query consisted of eight questions, which were designed to elicit information from state staff on chemicals considered to be good candidates for biomonitoring.

The Office of Environmental Health Hazard Assessment (OEHHA) identified state staff based on their programmatic responsibilities, knowledge and experience in their particular fields, and by referral. OEHHA contacted staff from a variety of state programs in several different agencies and departments, as shown below. In some cases, several programs within a department were contacted.

- California Environmental Protection Agency
    - California Air Resources Board (CARB)
    - California Integrated Waste Management Board
    - Department of Pesticide Regulation (DPR)
    - Department of Toxic Substances Control
    - State Water Resources Control Board
    - OEHHA
- California Department of Public Health (CDPH)
    - Birth Defects Monitoring Program
    - Division of Drinking Water and Environmental Management
    - Environmental Health Investigations Branch
    - Food, Drug and Radiation Safety Division
    - Occupational Health Branch
- California Department of Industrial Relations, Division of Occupational Safety and Health
- California Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation
- Regional Air Quality Management Districts (Bay Area, South Coast)
- Air Pollution Control District (San Joaquin Valley Unified)
- Regional Water Quality Control Boards (Central Valley, San Francisco Bay)

Each staff person identified by OEHHA was sent the State Government Query, as well as the list of chemicals biomonitored by the Centers for Disease Control and Prevention (CDC) in the National Health and Nutrition Examination Survey (NHANES) 2003-2004 (available at: http://www.cdc.gov/ExposureReport/pdf/NHANES03-04List_03_2007.pdf). The CECBP enabling legislation (California Health and Safety Code, Section 105440

*et seq.*) identified chemicals biomonitored by the CDC as the initial set of designated chemicals, from which the Program can select priority chemicals to biomonitor.

Interviews with state staff were generally conducted by telephone. Most individuals contacted offered their own comments or suggestions. Some staff discussed the questions with colleagues and provided pooled comments of various staff members. In several cases the contacted staff member invited other staff to the telephone interview so that more than one person participated. Some individuals responded by email or sent comments by email instead of or in addition to the telephone interview. Some staff also passed the questions to colleagues who sent emails of their own with comments or suggestions.

The report is divided into three sections. Section I summarizes general chemical categories and specific chemicals in these categories that were suggested by state staff for biomonitoring or otherwise considered to be of concern. These categories include: classes of chemicals already biomonitored by CDC in 2003-2004 (e.g., metals, phthalates, polybrominated diphenyl ethers [PBDEs], volatile organic compounds); other chemical classes not currently biomonitored by CDC (e.g., nanoparticles); chemicals associated with specific biological effects (e.g., endocrine disruptors); and chemical categories associated with specific exposures (e.g., via chemicals in consumer products). Many of these categories overlap. Section II summarizes input from state staff on specific criteria for selecting chemicals to biomonitor. Section III provides other general comments and suggestions from staff about chemical selection.

Throughout the report, chemical classes/families and specific chemicals (or their metabolites) that were biomonitored by CDC for the NHANEs 2003-2004 are labeled with the symbol " ♦ ".

SECTION I: General Categories and Specific Chemicals Suggested for Biomonitoring

Section I summarizes general categories and specific chemicals in each category that were suggested by state staff for biomonitoring and/or otherwise were considered to be a concern in California because of exposures and/or known or potential adverse effects. The categories include: chemicals and classes of chemicals biomonitored by CDC in 2003-2004; other chemical classes not already biomonitored by CDC; chemicals or chemical categories associated with specific biological effects; and chemical categories associated with specific exposures. Many of these categories overlap. All suggestions made by state staff are included below, without regard to whether or not biomonitoring would be practical.

## ***Air contaminants***

Many staff considered the general category "air contaminants" to be of concern. Some staff specified particular categories of air contaminants, including: traffic-related air pollutants, tobacco smoke♦, particulate matter, polycyclic aromatic hydrocarbons (PAHs)♦, solvents, volatile organic compounds (VOCs)♦, chemicals used in cleaning and maintenance, air pollutants related to wood burning, asbestos, crystalline silica and, as a category, those chemicals identified as Toxic Air Contaminants by the State of California. Staff comments on traffic-related pollutants and tobacco smoke are provided in the following paragraphs, while PAHs, solvents, VOCs, and chemicals used in cleaning and maintenance are discussed as separate categories below.

*Traffic-related air pollutants*: Staff from several programs stated that exposure to traffic-related air contaminants was likely greater in California because of the heavy traffic in certain parts of the state. Specifically named traffic-related contaminants included: acetaldehyde (see VOCs), benzene♦ (see VOCs), 1,3-butadiene (see VOCs), carbon monoxide, diesel exhaust, diesel exhaust particulate matter, formaldehyde (see VOCs), gasoline exhaust and vapors, nitroaromatics (including nitro-PAHs and nitrobenzene♦), nitrogen oxides, ozone, polycyclic aromatic hydrocarbons (PAHs)♦ (discussed as a class below), styrene♦ (see VOCs) and sulfur oxides. Air contaminants resulting from the use of biodiesel and biofuels were mentioned as emerging concerns.

> *Diesel engine exhaust and/or diesel particulate matter*: Staff from several programs mentioned by-products of diesel fuel combustion as appropriate for biomonitoring. Diesel engine exhaust is listed as known to cause cancer under Proposition 65. Another identified concern was an association between diesel exhaust particles and immune system effects. Staff discussed the absence of a suitable biomarker for diesel exposure, though 1-nitropyrene was suggested as a potential candidate.

*Nitroaromatic compounds*: Nitroaromatics (including nitrobenzene♦ and nitro-PAHs) were suggested as important traffic-related air contaminants because of potentially increased formation from heavy-duty diesel vehicles (e.g., trucks, buses, motor homes) when new selective catalytic reduction (SCR) technology is introduced for the 2010 model year. This technology will probably also be introduced at a later date in diesel passenger cars as well. The new SCR technology will inject urea into the exhaust stream to control oxides of nitrogen. Staff commented that since urea is a nitrogen-containing compound, there is a very good chance that many organo-nitrogen compounds will form. Nitrobenzene is listed as causing cancer under Proposition 65.

*Tobacco smoke*♦: Staff from a number of programs suggested biomonitoring cotinine♦ as a measure of cigarette smoking or environmental tobacco smoke [ETS]. Staff noted that ETS exposure may increase the effects of other contaminant exposures and needs to be considered as a covariate. For example, hypothyroidism associated with perchlorate may be exacerbated by cigarette smoke.

## ***Chemicals in consumer products***

This general category was suggested by state staff for biomonitoring because of concern that certain chemicals commonly used in consumer products, including personal care products, have been shown to have endocrine-disrupting abilities or other toxic effects, or to have been insufficiently studied. Widespread exposures to consumer products were also cited as a consideration.

*Antimicrobial agents in personal care products*

*Triclosan*♦: Staff from several programs suggested triclosan for biomonitoring. Triclosan is widely used in personal care products (e.g., liquid hand soaps, face cleaners, toothpaste, mouth rinse, cosmetics) and also in fabrics, plastics, carpets and plastic kitchenware. It is stable and likely to bioaccumulate. Staff commented that triclosan's toxicity has not been well studied but that research findings provide evidence for a number of biological effects, including endocrine disruption and inhibition of the metabolism of other environmental phenols. Staff were also concerned that widespread use of triclosan would encourage the growth of bacteria resistant to triclosan as well as potentially conferring resistance to other antimicrobials.

*Triclocarban*: Triclocarban was suggested for biomonitoring because it is a common ingredient in personal care products such as bar soaps and deodorants and has been found to have endocrine-disrupting properties.

Staff commented that one study found approximately 75 percent of triclocarban persists during wastewater treatment and that it accumulates in municipal sludge, some of which may later be used as fertilizer for crops.

*Environmental phenols*♦

*Bisphenol A*♦: There was widespread concern about the endocrine-disruptive potential of bisphenol A, which is used in the production of polycarbonate plastics (used in many food and drink containers) and in the production of epoxy resins (used to coat metal products such as the interiors of food cans). Staff reported that bisphenol A may potentially affect nervous and immune system development, cause other reproductive effects and promote obesity. The prenatal period and early childhood were identified as critical exposure windows.

*Nonylphenol*: Nonylphenol was suggested for biomonitoring because of its wide use in consumer products and industrial applications. Recent research suggests that nonylphenol has estrogenic activity, and may affect development of the nervous and immune systems, and promote obesity. It has been detected in water/sediments and/or macrovertebrates in San Francisco Bay. Nonylphenol and nonylphenol ethoxylates are used in laundry and cleaning products, in cosmetics and perfumes, as well as in industrial applications. While the nonylphenol ethoxylates degrade to nonylphenol, the latter compound degrades very slowly. Nonylphenol and nonylphenol ethoxylates have been identified as “reproductive hazards” in the European Union and banned from consumer and industrial products.

*Oxybenzone (Benzophenone-3)*♦: Oxybenzone was suggested for biomonitoring because it is an active ingredient in sunscreen and is also widely used in other products, and because Californians are likely to have heavier use of sunscreen compared to the national average. Staff were concerned that oxybenzone had reportedly been linked to endocrine disruption and reported that a new CDC study had found oxybenzone in nearly all people tested.

*Parabens*: Parabens, widely used as preservatives in cosmetics and toiletries, were suggested for biomonitoring because of concern that they are endocrine-disrupting chemicals. (Parabens as a class include methylparaben, ethylparaben, propylparaben, butylparaben, isobutylparaben, isopropylparaben, and benzylparaben). Staff commented that screening tests of individual parabens have found weak estrogenic activity. Staff also relayed that parabens have been detected in a small number of breast tumor tissue samples and that studies with butylparaben have found effects on the male reproductive system.

*Methylsiloxanes*: Methylsiloxanes were suggested for biomonitoring because of their widespread usage in consumer and personal care products (hair care and skin care products, antiperspirants/deodorants), their use in dry cleaning, and their physical and chemical properties, which suggest that these chemicals may be persistent and bioaccumulative. Although, for the most part, these chemicals have not been well studied, some toxicity data are available for two methylsiloxanes.

> *Octamethyl cyclotetrasiloxane (D4)*: D4 is widely used in industry, in household products and in cosmetics. In cosmetics, it is often in mixtures with other methylsiloxanes, D5 and D6. Animal studies have found that D4 is estrogenic and that it has been found in human adipose tissue samples.
>
> *Decamethylcyclopentasiloxane (D5)*: D5 is also used widely in personal care products. D5 is being used as an alternative to perchloroethylene in dry cleaning. Evidence suggests that D5 is persistence and bioaccumulative, and that it has been associated with uterine tumors in animal studies.

*Artificial or synthetic musks*: Synthetic musks were suggested for biomonitoring because of their wide use as fragrance ingredients in perfumes, soaps, and household cleaning products, and because of their persistence and bioaccumulation. Synthetic musks are used to mask chemical odors in products labeled “unscented,” but they are not used in products labeled “fragrance-free.” Staff suggested both nitro-musks and polycyclic musks as candidates for biomonitoring and relayed that both classes of musks have been found in breast milk. The production of polycyclic musks has increased in recent years as toxicity concerns have led to decreased production of nitromusks. Staff relayed that few toxicity data are available for polycyclic musks even though these chemicals are in widespread use. There is concern that both of the suggested polycyclic musks (below) disrupt endocrine function.

> *Musk ketone and musk xylene*: These nitro-musks are decreasing in use in recent years because of concerns about toxicity.
>
> *1,3,4,6,7,8-Hexahydro-4,6,6,7,8,8-hexamethylcyclopenta-gamma-2-benzopyran (HHCB or galaxolide)*: High concentrations of HHCB were found in breast milk and levels of HHCB in U.S. breast milk samples were higher than those found in Europe. Staff commented that HHCB has been identified as an endocrine disruptor, including evidence that HHCB has anti-estrogenic activity.

*6-Acetyl-1,1,2,4,4,7-hexamethyltetraline (AHTN or tonalide)*: Staff noted that AHTN has also been found in U.S. breast milk and that levels were higher than those found in Europe. Research findings provide evidence that AHTN is an estrogen receptor antagonist.

*Sunscreens*: The following sunscreens were suggested for biomonitoring because of widespread consumer exposure and findings of estrogenic activity: 3-benzylidene camphor, 2-ethylhexyl 4-dimethylaminobenzoate (octyl-dimethyl-*para*-amino benzoic acid [PABA]), 4-methylbenzylidene camphor and oxybenzone♦ (also listed above as an environmental phenol).

## ***Chemicals used in cleaning and maintenance***

Chemicals used in cleaning and maintenance were suggested as a general category for biomonitoring because of the extent of exposure to these chemicals. Some cleaning and degreasing solvents were also suggested (listed under VOCs).

*Glycol ethers:* Glycol ethers are commonly found in cleaning products. Ethylene glycol monobutyl ether (EGBE) was specifically suggested for biomonitoring because it is present in household cleaning products and adverse reproductive effects have been observed in animal studies. Consumers are exposed via dermal absorption and inhalation.

*Terpenes*: *d*-Limonene and *a*-pinene are degreasers that give cleaning products a citrus or pine smell, respectively. These compounds were of concern to staff because they react with indoor ozone (*e.g.*, ozone emitted from printers, copiers, air cleaners, and other devices) to form formaldehyde and ultrafine particles. Biomonitoring for *d*-limonene and *a*-pinene would provide information on exposures to formaldehyde and ultrafine particle from these sources.

## ***Dioxins♦ and furans♦***

Polychlorinated dibenzodioxins♦ and polychlorinated dibenzofurans♦ (dioxins/furans) were suggested for biomonitoring because they are persistent, bioaccumulative, carcinogenic and have been found to cause other adverse health effects and because of exposures from dietary intake (predominantly from meat and dairy products). Staff also relayed that dioxins have been identified in San Francisco Bay fish tissues. Polychlorinated dibenzodioxins and furans are listed as known to cause cancer under Proposition 65. Tetrachlorodibenzodioxin (TCDD♦), the most carcinogenic dioxin, is listed under Proposition 65 as known to cause cancer and developmental toxicity.

## ***Endocrine-disrupting chemicals***

Chemicals that disrupt endocrine function were suggested as a category for biomonitoring by staff from a number of programs. Specific endocrine-disrupting chemicals and categories of chemicals that were separately suggested include: bisphenol A♦, perchlorate♦, triclosan♦, PBDEs♦, perfluorinated compounds (PFCs)♦, polychlorinated biphenyls (PCBs)♦, phytoestrogens♦**,** dioxins/furans♦, methylsiloxanes, and synthetic musks. Perchlorate♦ and phytoestrogens♦ are discussed below. The other categories and specific chemicals named above are discussed elsewhere in this section (see specific chemical categories, such as PBDEs and PFCs, and the general category on consumer products).

*Perchlorate*♦: Perchlorate was one of the most frequently suggested chemicals for biomonitoring. It is a component of rocket fuel, used in the manufacture of explosives, fireworks and flares. It is now a ubiquitous contaminant, high in water-accumulating crops (e.g., lettuce, fruits, vegetables); it is also found in cow's milk. Perchlorate blocks uptake of iodine by the thyroid gland and leads to decreased synthesis of thyroid hormones, which (among other things) are critical determinants of growth and development in fetuses, infants and young children. Staff reported that perchlorate is concentrated in breast milk as well as infant formula and that recent epidemiologic studies have found an association with thyroid function at current U.S. exposure levels, in women with low iodide consumption, particularly among those who are smokers.

*Phytoestrogens*♦*:* Phytoestrogens in general and genistein♦ specifically were suggested for biomonitoring because these chemicals are weakly estrogenic and dietary exposures are increasing. The long-term effects of these exposures (e.g., to infants receiving soy formula) are unknown.

## ***Metals♦ and other inorganics***

Many staff suggested metals as an important category to biomonitor.

*Aluminum*: Aluminum was suggested because of its potential to cause neurotoxicity. Aluminum bioavailability from drinking water depends on drinking water composition; and bioavailability from food depends on trace element content. Populations with compromised kidney function are known to bioaccumulate aluminum. This includes kidney failure and dialysis patients as well as premature infants. Staff suggested that biomonitoring data would help us understand the range of aluminum exposures across these conditions and the extent to which aluminum neurotoxicity may be a public health issue.

*Antimony*♦: Antimony is used in lead storage batteries, solder, sheet and pipe metal, bearings, castings, and pewter; antimony oxide is added to textiles and plastics as a flame retardant. Antimony is also used in paints, ceramics, and

fireworks, and in enamels for plastics, metal, and glass. Antimony oxide (antimony trioxide) is listed under Proposition 65 as known to cause cancer.

*Arsenic and arsenic compounds*♦: Arsenic was suggested because of its toxicity and prevalence in California soils, and in ground, surface and well water. Staff relayed that an assessment of chemicals at California school sites or potential school sites found arsenic at 29 percent of the 320 sites evaluated. Arsenic is listed under Proposition 65 as known to cause cancer.

*Boron*: Boron was suggested because of widespread commercial and household use of boron compounds in pesticides, flame retardants, and laundry bleaches. Exposure is primarily via ingestion in food and drinking water. Although boron is considered beneficial at low doses, animal studies report associations with male reproductive tract and developmental toxicity.

*Cadmium*♦: Cadmium is listed under Proposition 65 as known to cause cancer, developmental and reproductive toxicity. Most cadmium exposure occurs by inhalation; airborne levels are a concern in populations near smelters. Tobacco smoke is also an important source of cadmium exposure. Cadmium can enter the food supply by the addition of cadmium-containing sewage sludge to agricultural applications. Staff reported that an assessment of chemicals at California school sites or potential school sites (320 total sites) found cadmium at 8 percent of school sites.

*Chromium VI*: Chromium VI was suggested for biomonitoring because of groundwater contamination from various sources, including wood treatment and chrome plating. Chromium VI is a carcinogen and is listed under Proposition 65 as known to cause cancer and reproductive toxicity. Other staff noted that biomonitoring of chromium VI may not be possible because of rapid conversion in the body to chromium III, a beneficial trace mineral.

*Copper*: Copper, an essential trace mineral, is widely used as a pesticide for many food crops. It is also used to treat lumber, as a fumigant and as an algaecide for swimming pools. Staff who suggested copper mentioned aquatic toxicity concerns. Exposure at high levels causes liver, kidney and immune system toxicity. It is not known whether any human health effects occur from long-term environmental exposures to copper. Individuals with Wilson's disease, who have a genetic inability to transport copper, may be more susceptible to long-term environmental exposures.

*Fluoride*: Fluoride was suggested for biomonitoring because of studies suggesting a link between fluoride exposure in drinking water and cancer.

*Lead*♦: In suggesting lead for biomonitoring, staff commented that lead can cause diminished IQ and neurobehavioral effects in the developing brain. Lead is listed under Proposition 65 as known to cause cancer, as well as developmental and reproductive toxicity. Staff reported that an assessment of chemicals at California school sites or potential school sites (320 total sites) found lead at 42 percent of sites, due mainly to past uses in paint and gasoline.

*Manganese*: Manganese was recommended because of its neurotoxicity. High nervous system concentrations are associated with hyperactivity in children and Parkinson's disease in adults. Staff reported that manganese supplementation of soy-based infant formula about 25-30 years ago resulted in high infant exposures. [Manganese accumulates in plants such as soy and rice, resulting in high concentrations in soy-based versus other infant formulas, even before supplementation]. The manganese-containing fuel additive methylcyclopentadienyl manganese tricarbonyl (MMT) is banned for use in California, but manganese and manganese compounds are used in a wide variety of industrial applications. CARB will submit a report to the Legislature in January 2010 on ambient manganese exposure.

*Mercury*♦: Staff expected mercury exposures in California to be higher than in other parts of the U.S. because of past mining activity, which has resulted in high levels of inorganic mercury in sediment. Staff also commented that exposure to mercury from eating locally caught fish is likely higher in California than in other parts of the country because: 1) interest in fishing is relatively high; 2) there is relatively easy access to rivers, reservoirs, and the coast; and 3) California has significant populations of ethnic groups for whom fish is an important part of their diet.

*Nickel*: Staff reported that an assessment of chemicals at California school sites or potential school sites (320 sites total) found nickel at 8 percent of sites. Nickel and nickel compounds are listed as known to cause cancer under Proposition 65.

*Nitrate*: Nitrate was suggested for biomonitoring because of concern about levels in drinking water, due to runoff and leaching from fertilizer use. Staff indicated that high levels of nitrate in drinking water can cause methemoglobinemia in infants. Staff also reported that some epidemiological studies have found an association between nitrate levels in maternal drinking water and neural tube birth defects. The greatest source of nitrate exposure is via ingestion of nitrate-containing foods (e.g., leafy vegetables, cured meat), and the International Agency for Research on Cancer (IARC) has recently concluded that ingested nitrate under conditions that result in endogenous nitrosation is probably carcinogenic to humans.

*Radium*: Naturally occurring radionuclides radium-228 and radium-226 were suggested for biomonitoring because of concern about their presence in drinking water. Radium levels are higher in areas where uranium mining has occurred, and elevated radium levels are found in soil in certain areas of California. Both radionuclides have been detected in some water sources. Radium accumulates in bone tissue, and both radium-226 and radium 228 are associated with an increased incidence of osteogenic sarcoma. Exposure to radium-226 is also associated with an increased incidence of head carcinoma.

*Selenium*: Selenium is an essential trace element. High levels cause gastrointestinal and neurological effects, and selenium sulfide is listed as known to cause cancer under Proposition 65. Selenium is used in a variety of industrial and commercial processes. Combustion of fossil fuels also contributes to atmospheric selenium. Selenium sulfide is used in shampoo as an anti-dandruff agent.

*Uranium*♦ *(depleted and naturally occurring in water)*: Uranium was suggested for biomonitoring because of concerns about drinking water exposures to individuals who obtain their water from private wells. Uranium exposure is linked to a number of cancers, including stomach and kidney cancer and leukemia. Uranium has also been found to disrupt endocrine function and may be associated with an increased risk of fertility problems and reproductive cancers.

*Vanadium and vanadium compounds*: Vanadium was suggested for biomonitoring because of the possible use of vanadium pentoxide (which is listed under Proposition 65 as causing cancer) as a catalyst in selective catalytic reduction (SCR) in diesel emission control technology. Vanadium is also found in some California drinking water. Laboratory research has suggested potential benefits from very low levels of vanadium but vanadium pentoxide has been found to cause a range of adverse effects, including cancer.

*Zinc*: Zinc was mentioned because of its aquatic toxicity.

## ***Nanoparticles***

Nanoparticles were mentioned as a concern by nearly everyone who provided input. Staff were concerned about their widespread use, the potential for toxicity and the absence of any labeling requirement for nanomaterials. One suggestion was to biomonitor silver oxide and titanium dioxide as indicators of nanoparticles.

## ***Perfluorinated compounds (PFCs)***♦

PFCs were suggested as a chemical class by staff from a wide number of programs based on widespread exposure, persistence, bioaccumulation and

toxicity. Perfluorooctanoic acid♦ and perfluorooctane sulfonic acid♦ were specifically named in this regard.

## ***Pesticides♦, herbicides♦ and fungicides♦***

Pesticides were named as a general category of high concern for most staff providing input. A wide variety of pesticides were suggested, including those that are endocrine disruptors or neurotoxic. Exposures from area-wide spraying (e.g., mosquito control) and pesticide drift from agricultural applications were of concern. There was concern expressed about the toxicity of pesticides used in California vineyards and the extent to which pesticide residues are present in wine. Staff from a number of programs commented on California's high pesticide use compared to other parts of the U.S. Another comment was that the profile of pesticide use may be different in California. Staff commented that certain populations that preferentially consume a significant amount of food from particular areas of the world (e.g., Asia or Latin America) may have exposures that reflect pesticide usage in other countries. Pesticides used in households or home gardens were also of concern.

*Organochlorine pesticides*♦: Organochlorine pesticides were raised as a general category, including both those no longer registered for use in the U.S. and those in current use.

*Organochlorine pesticides not currently registered for use in U.S.*:

*DDT*♦, *DDD*♦, *DDE*♦: DDT, DDD and DDE were suggested for biomonitoring because they are persistent, bioaccumulative and toxic. DDT, DDD (a structural analogue of DDT) and DDE (the primary breakdown product of DDT and DDD) are persistent, bioaccumulative and toxic. DDT and DDE build up in plants and in fatty tissues of fish, birds, and other animals. Although banned since the early 1970's, staff still cited them as important in California. Staff named DDT/DDE as one of four main contaminants in Southern California fish, and stressed the importance of these chemicals in terms of subsistence fishing exposures. Staff reported that an assessment of chemicals at California school sites or potential school sites, found DDT and DDE at 33 percent of school sites (320 total sites). DDD was found at 17 percent of sites. DDT, DDE and DDD are listed as known to cause cancer under Proposition 65 and have been shown to have estrogenic activity. There is also evidence that DDT causes neurodevelopmental and reproductive toxicity.

*Chlordane*♦: Although this cyclodiene pesticide was banned in 1988, it was suggested for biomonitoring because it is persistent and exposure still occurs. Chlordane is listed as known to cause cancer under Proposition 65. Staff reported that an assessment of chemicals at California school

sites or potential school sites found chlordane at 8 percent of sites. Exposure occurs from fish consumption in certain areas (e.g., San Francisco Bay).

*Dieldrin*♦: Dieldrin is another legacy cyclodiene pesticide that staff suggested for biomonitoring. Staff reported that an assessment of chemicals at California school sites or potential school sites (320 total sites) found dieldrin at 9 percent of sites. It is also found in fish from the S.F. Bay. Dieldrin is listed as known to cause cancer under Proposition 65.

*Toxaphene*: Toxaphene was suggested because it was once one of the most widely used pesticides in the U.S. and in California. Although banned for 25 years, toxaphene is persistent and bioaccumulative. It is listed as known to cause cancer under Proposition 65. Staff relayed that exposure from contaminated fish is still a concern and that an assessment of chemicals at California school sites or potential school sites (320 total sites) found toxaphene at 10 percent of sites.

*Organochlorine pesticides registered for use in California*:

*Dicofol*: Dicofol was suggested for biomonitoring because it was linked to autism spectrum disorders (ASD) in a study evaluating a possible association between maternal residence near agricultural pesticide applications during key periods of gestation and development of ASD in children. Dicofol is structurally similar to DDT and has been reported to disrupt thyroid hormone activity. DPR's 2006 Pesticide Use Report states that dicofol is being replaced due to resistance issues; there was a 90 percent decrease in reported use from 2005 to 2006.

*Endosulfan*♦: Endosulfan was suggested for biomonitoring because it was linked to autism spectrum disorders (ASD) in a study evaluating a possible association between maternal residence near agricultural pesticide applications during key periods of gestation and development of ASD in children. Endosulfan is persistent and bioaccumulative and there is laboratory evidence that endosulfan is an endocrine disruptor with anti-androgenic activity. Endosulfan is also a neurotoxicant. Animal studies have found male reproductive harm and birth defects. Endosulfan residues have been detected in human blood, in fetal tissue, in breast milk and in mammary adipose tissue. Staff reported that an assessment of chemicals at California school sites or potential school sites (320 total sites) found endosulfan or its metabolites at 7 percent of evaluated sites. Staff noted that endosulfan is banned in the European Union. DPR's 2006 Pesticide Use Report indicates that over 92,000 pounds of endosulfan

were applied in California in 2006. While the use of endosulfan decreased in some areas, endosulfan use increased by 89 percent in the San Joaquin Valley from 2005 to 2006.

*Lindane*♦: Lindane was suggested for biomonitoring because of groundwater contamination from past uses. DPR's Pesticide Use Report indicated some use in 2006, but very little lindane is currently used in the U.S. Lindane is listed as known to cause cancer under Proposition 65. It is available for use for treatment of scabies and head lice and there are also reports of lindane-induced neurotoxicity in infants and young children.

*Pyrethroid pesticides*♦: Pyrethroid pesticides were suggested for biomonitoring predominantly because of their widespread use in consumer products. Home use of these pesticides is increasing due to U.S. EPA restrictions on organophosphate and carbamate pesticides. Staff reported that pyrethroid pesticides used in household or yard settings, unlike those used in agriculture, would not be expected to change much over time. Pyrethroids are also used in the treatment of head lice and scabies. Research findings for some pyrethroids report endocrine disruption and immunotoxicity. Some pyrethroids have been identified as causing cancer (e.g., resmethrin is listed as known to cause cancer under Proposition 65 and permethrin has been identified by U.S. EPA as "likely to be carcinogenic to humans"). Specific pyrethroid pesticides were not suggested by staff.

*Organophosphate pesticides*♦:

*Chlorpyrifos*♦: Chlorpyrifos was suggested for biomonitoring because of findings of developmental and reproductive toxicity in animals and epidemiological evidence suggesting a link between chlorpyrifos exposure and increased risks of adverse developmental and reproductive effects. Staff reported that, until recently, chlorpyrifos had wide home and garden use. Although residential use is now banned, there is still high agricultural use.

*Diazinon*♦: Diazinon was suggested for biomonitoring because of findings of adverse effects in animal studies, including neurodevelopmental and immunological toxicity. Staff reported that, until recently, this insecticide was widely used in residential settings. A U.S. EPA agreement with manufacturers resulted in the phase-out of residential uses. Agricultural use has also decreased somewhat in recent years.

*Malathion*♦: Malathion was suggested for biomonitoring because it is widely used in California (e.g., strawberries, head lettuce, walnuts, celery).

Findings from a number of studies suggest that malathion may cause chromosomal damage. Surface water contamination is a concern.

*Fumigant pesticides*: Fumigant pesticides were suggested for biomonitoring primarily because of their wide use in California. Staff commented that California and Florida use the great majority of fumigant pesticides nationwide. According to DPR's 2006 Pesticide Use Report, fumigants are applied at higher rates than other pesticides because they are injected into soil (to sterilize a field before planting) and thus treat a volume of space rather than the surface area of plants. Staff also mentioned that fumigants are used at food processing facilities and factories processing products for export.

*Fumigant pesticides registered for use in California*

*1,3-Dichloropropene*: 1,3-Dichloropropene is the second most highly used fumigant in California and is also one of the most highly used pesticides in the State. It is listed as known to cause cancer under Proposition 65.

*Chloropicrin*: Chloropicrin is the third most highly used fumigant in California, with use steadily increasing over the last 10 years. Chloropicrin is also used as a fungicide and was used as a chemical warfare agent during World War I. Degradation products include nitrate and nitrite, nitromethane and phosgene.

*Methyl bromide*: Methyl bromide use in California has decreased by 60 percent in the last 10 years because of the U.S. EPA mandated phase-out (due to ozone depletion), but over six million pounds were still used in California in 2006. Methyl bromide is listed under Proposition 65 as known to cause reproductive toxicity.

*Methyl isothiocyanate [MITC]*: MITC, the active agent of metam sodium and metam potassium, was suggested for biomonitoring because of cancer and developmental toxicity concerns. Metam sodium is listed as both a carcinogen and developmental toxicant under Proposition 65. Metam potassium is identified as a probable human carcinogen (Group B2), along with metam sodium, by U.S. EPA. Despite a recent decline in use, metam sodium is still the most highly used fumigant in California (11 million pounds in California in 2006); metam potassium use has markedly increased (none in 1999 and over 3 million pounds in 2006).

*Fumigant pesticides not currently registered for use in the U.S.*

*1,2-Dibromo-3-chloropropane (DBCP)*♦: DBCP is a fumigant that was banned in the late 1970s. It was suggested for biomonitoring because it is

still found in groundwater in the southern part of the Sacramento Valley, in the San Joaquin Valley and probably in other parts of the state as well. DBCP is listed under Proposition 65 as known to cause cancer and male reproductive toxicity.

*Ethylene dibromide*: The fumigant ethylene dibromide was suggested for biomonitoring because of concerns about groundwater contamination. It is no longer used in California. Ethylene dibromide is listed under Proposition 65 as known to cause cancer and male reproductive toxicity.

*Other pesticides*♦:

*N,N-Diethyl-3-methylbenzamide (DEET)*♦: DEET was suggested for biomonitoring because of its widespread use. It is the active ingredient of most commercial insect repellents and is sprayed directly onto skin and clothing. DEET is absorbed through the skin, and staff reported that animal studies have found that combined use of DEET and the sunscreen oxybenzone (listed as an environmental phenol) increase the absorption of both compounds. DEET has been found in umbilical cord blood samples.

*Avermectin B1*: Avermectin B1, a miticide used predominantly on almond trees and on cotton, was suggested for biomonitoring because animal studies provide evidence of developmental toxicity.

*Fiprols*: Fipronil was identified as a member of the emerging pesticide class of fiprols. Staff reported that it is used in flea and tick treatment and for structural pest control. Fipronil has been classified as possibly carcinogenic to humans by U.S. EPA based on thyroid tumors in male and female rats. Staff reported that fipronil has been implicated in the colony collapse disorder of honeybees.

*Neonicotinoids*: Imidacloprid was identified as a member of the emerging class of neonicotinoid pesticides. Imidacloprid is widely used in products to control fleas in cats and dogs, and is used on a variety of crops in California (e.g., raisins and table grapes, tomatoes, oranges, strawberries). Imidacloprid is one of the most widely used pesticides in the European Union. There is some concern that neurotoxic actions of imidacloprid could occur in humans.

*Sulfur dioxide*: Sulfur dioxide was suggested for biomonitoring because animal studies have found evidence of embryotoxicity and some indication of male and female reproductive effects; epidemiological studies suggest effects on pre-term delivery and birth weight. Sulfur dioxide is used on

wine grapes and added to wine. The sulfate used to treat dried fruit also forms sulfur dioxide.

*Fungicides*♦:

*Imazalil*: Imazalil, a post-harvest fungicide used on citrus fruits, was suggested for biomonitoring because animal studies provide evidence of both fetotoxicity and carcinogenicity. Imazalil residues have been found in fruit juice.

*Thiabendazole and salts*: Thiabendazole, another post-harvest fungicide, was suggested for biomonitoring because animal studies suggest fetotoxicity.

*Vinclozolin*: Vinclozolin was suggested for biomonitoring because animal studies found developmental toxicity. Vinclozolin is listed as known to cause both cancer and developmental toxicity under Proposition 65. It is an androgen antagonist. DPR's 2006 Pesticide Use Report indicates that usage has markedly declined (from 83,000 lbs in 1996 to 400 lbs in 2006).

*Herbicides*♦:

*Atrazine*♦: The herbicide atrazine was suggested for biomonitoring because of findings that it causes sexual abnormalities in frogs. Atrazine is banned in the EU.

*2,4-Dichlorophenoxyacetic acid (2,4-D)*♦: 2,4-D and its salts are used as growth regulators on fruits, to manipulate the amount of time the fruit stays on the tree and to extend the shelf life of fruit. Staff commented that there are questions about how much gets into and remains in fruit. 2,4-D was suggested for biomonitoring because of findings of endocrine disruption and developmental toxicity in animals.

*Paraquat*: Paraquat was suggested for biomonitoring because it is still used in high volumes. It is one of the herbicides used most (by acres treated) on wine grapes, table grapes and almonds. Staff commented that paraquat is poorly absorbed by the gastrointestinal tract, which would likely limit bioavailability. Staff reported that recent mechanistic studies suggest that paraquat may trigger oxidative stress-related neurodegeneration.

*Simazine*♦: Simazine was suggested for biomonitoring because it is a widely used herbicide and because animal studies suggest that it causes both mammary gland tumors and fetotoxicity. Simazine is one of the

herbicides most used on wine and table grapes (by acres treated). Staff reported that soil leaching and surface run-off are concerns and that simazine use is regulated to protect groundwater.

*2,4,5 Trichlorophenoxyacetic acid (2,4,5-T)*♦: 2,4,5-T was suggested for biomonitoring because animal studies found long-term behavioral effects after pre-natal exposure and because the herbicide is always contaminated with TCDD. 2,4,5-T has been banned in the U.S. and elsewhere in the world.

## ***Pharmaceuticals and hormones***

Pharmaceuticals used in humans and/or animals were suggested for biomonitoring. Hormones used in animals were also suggested. Staff noted the absence of any meaningful monitoring of pharmaceuticals and hormones in food from animal sources. There was concern that the widespread use of pharmaceuticals in animals has increased antibiotic resistance. Staff also cited recent studies that detected pharmaceuticals in effluent from sewage treatment and in source waters for drinking water supplies.

## ***Phthalates♦, other plasticizers and plastic additives***

*Phthalates*♦: There was widespread concern among staff about phthalates as a class. Staff noted that phthalates are present in a wide variety of products (e.g., consumer and household products, automobiles, electrical wires and cables, medical tubing, and blood storage bags).

*Butyl benzyl phthalate (BBP)*♦: BBP is one of six phthalates now banned from children's toys and childcare articles in California. Staff reported that BBP is has been detected in indoor air, especially in automobile interiors. BBP is listed under Proposition 65 as known to cause developmental toxicity.

*Diethylhexyl phthalate (DEHP)*♦: DEHP was the phthalate mentioned most frequently and was suggested for biomonitoring because of widespread use, high exposure and toxicity. Staff relayed that DEHP is prominent in indoor air, especially inside automobiles, and that it can leach out of plastics into liquid that comes in contact with the plastic. DEHP is one of the six phthalates banned from children's toys and childcare articles in California. Further, in addition to DEHP's known toxic effects (it is listed under Proposition 65 as known to cause cancer and developmental and male reproductive toxicity), staff reported that recent data suggest that DEHP may promote obesity, and affect neurological and immunological development.

*Diethyl phthalate (DEP)*♦: DEP was suggested because it has been found in indoor air, especially in automobile interiors.

*Diisobutyl phthalate (DiBP)*♦: DiBP was suggested because it has been found in indoor air, especially in automobile interiors.

*Diisodecyl phthalate (DIDP)*: DIDP is listed under Proposition 65 as known to cause developmental toxicity. It is one of six phthalates banned from children's toys and childcare articles in California. It is also widely used in consumer products and as a replacement for DEHP.

*Diisononyl phthalate (DINP)*♦: DINP is one of six phthalates banned from children's toys and childcare articles in California. It was suggested for biomonitoring because of its use in consumer products and as a replacement for DEHP. Staff recommended that an additional metabolite of DINP be biomonitored.

*Di-n-butyl phthalate (DBP)*♦: DBP is one of six phthalates banned from children's toys and childcare articles in California. Staff reported that DBP has been found in indoor air, especially in automobile interiors. DBP is listed under Proposition 65 as known to cause developmental and male and female reproductive toxicity.

*Di-n-hexyl phthalate (DnHP)*: DnHP is listed under Proposition 65 as known to cause male and female reproductive toxicity.

*Di-n-octyl phthalate (DnOP)*♦: DnOP is one of six phthalates banned from children's toys and childcare articles in California.

*Dipropyl phthalate*: Dipropyl phthalate was suggested because it has been found in indoor air, especially in automobile interiors.

*Other plasticizers and plastic additives*: Staff from several programs expressed concern about plastic additives, nonphthalate plasticizers and phthalate replacements. Staff were particularly concerned that little information is available on the identity (and/or toxicity) of phthalate replacement chemicals.

*Adipates*: Di-2-ethylhexyl adipate (DEHA) is used in food-contact films and can migrate into certain foodstuffs.

*Di-isononyl cyclohexane-1,2-dicarboxylate (DINCH)*: DINCH was suggested because it was recently approved for use in the European Union and will likely be widely used. However, OEHHA could not locate any DINCH toxicity studies in the published scientific literature.

## ***PBDEs♦ and other flame retardants***

Flame retardants, and specifically brominated and/or chlorinated flame retardants, were a concern of nearly all staff who provided input. All staff who mentioned flame retardants recommended PBDEs as chemicals important to biomonitor. There was also concern about other flame retardants that are increasing in use, many of which are replacing penta- and octa-BDEs. Staff expressed concern about the high levels of PBDEs already measured in California residents and noted that exposure to other brominated and chlorinated flame retardants would likely be higher in California than in other parts of the country because of California's strict furniture flammability regulations.

*PBDEs♦*: PBDEs were suggested for biomonitoring by nearly all individuals who provided input. Although the manufacture and sale of two of the three commercial PBDE mixtures (octa- and pentaBDEs) are now banned in California and the mixtures have been phased-out nationally, exposures to these PBDEs continues. PentaBDE, for example, was used for 20 years as a flame retardant in polyurethane foam to satisfy California's flammability regulations. Levels of PBDEs in house dust in California are markedly higher than in house dust in other parts of the country. Staff reported that bioaccumulation of PBDEs in California sea lions in the San Francisco Bay has recently been documented. Staff also reported that the U.S. Mussel Watch program has found PBDE levels in Southern California bivalves to be 100 times the national average. Staff cited animal studies that have found that PBDEs can cause permanent changes in learning, behavior and memory, alter thyroid hormone function, and affect brain development and noted that only one PBDE, decaBDE (BDE 209), has been studied for possible carcinogenic effects. Staff relayed that the following BDE congeners were identified as having been found indoors by laboratories conducting analyses of dust and air samples: BDE 47♦, BDE 99♦, BDE 100♦, BDE 153♦, BDE 154♦, BDE 181, BDE 183♦, BDE 190, and BDE 209.

*Other brominated flame retardants (BFRs)*: There was also concern about other BFRs now on the market, many of which are replacing penta- and octa-BDEs. These include:

> *Bis(2-ethylhexyl)tetrabromophthalate (TBPH)*: Staff suggested TBPH because it is expected to be used in large quantities in California. TBPH is a component of Firemaster 550, the primary pentaBDE replacement in polyurethane foam. Staff also noted that no chronic toxicity information is available for this chemical. TBPH is the brominated analogue of bis(2-ethylhexyl)phthalate (DEHP).
>
> *1,2-Bis(2,4,6-tribromophenoxy)ethane*: Staff suggested this flame retardant because it is being marketed as an alternative to PBDEs. Staff

reported that little is known about current usage volume or toxicity. It was recently found in ambient air samples in the United States.

*Decabromodiphenylethane*: This flame retardant was suggested because it is another PBDE alternative, with little known about current usage volumes, toxicity, or fate and transport. It is structurally similar to decaBDE.

*1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane*: This BFR was suggested for biomonitoring because it is a PBDE alternative that has recently been found to interfere with male sex hormones and because it was recently identified in blubber of Beluga whales from the Canadian Arctic. Staff reported that U.S. EPA issued a Decision Not to Test in 1985 due to the determination of insufficient exposure. Staff commented that little is known about current usage volumes.

*Hexabromocyclododecane (HBCD)*: Staff suggested HBCD because it is a widely used flame retardant, with little toxicological information.

*Tetrabromobisphenol A (TBBPA)*: Staff recommended TBBPA for biomonitoring because it is the most widely used BFR worldwide. Staff cited toxicity concerns including interference with thyroid hormone activity.

*Chlorinated flame retardants (CFRs)*: The following CFRs were suggested because of use, exposure and potential toxicity:

*Chlorinated paraffins*: Chlorinated paraffins were suggested for biomonitoring because they are widely used and because of concerns about persistence, bioaccumulation and toxicity. Chlorinated paraffins consisting of, on average, chains of twelve carbon atoms and containing approximately 60 percent chlorine (by weight) are listed as known to cause cancer under Proposition 65.

*Declorane Plus*: Staff commented that Dechlorane Plus has been in use for 40 years but is poorly studied. It was suggested for biomonitoring because of its use and persistence, while its toxicity remains unknown.

*Tris(1,3-dichloro-2-propyl)phosphate (TDCPP)*: TDCPP was suggested for biomonitoring because it is one of two primary pentaBDE replacements in polyurethane foam and because of cancer findings in laboratory animals. The U.S. Consumer Product Safety Commission has concluded that TDCPP is a probable human carcinogen. Because of California's unique furniture flammability requirements, staff expected that exposure here would be higher than in other parts of the U.S.

*Non-halogenated organophosphate flame retardants*:

> *Triphenyl phosphate*: Triphenyl phosphate was suggested because it has been found in bivalves in the San Francisco Bay. It is a widely used flame retardant and a component of several formulations replacing PBDEs in polyurethane foam.

## ***Polychlorinated biphenyls (PCBs)***♦

PCBs were suggested for biomonitoring primarily because of dietary exposures (meat, fish, poultry, dairy products, oils and fats). Staff commented that although PCBs are banned from current use, these compounds, along with mercury/methyl mercury, are among the most important chemical contaminants in California fish. Staff reported that an assessment of chemicals at California school sites or potential school sites (320 total sites), found PCBs at over 6 percent of sites. Other current sources of exposure include PCB leaching from landfills, incineration of municipal refuse and sewage sludge, and breakdown and/or improper disposal of PCB-containing products. PCBs have been extensively studied and are listed under Proposition 65 as known to cause cancer and developmental toxicity.

## ***Polycyclic aromatic hydrocarbons (PAHs)***♦

PAHs as a class were considered important to biomonitor by staff from a wide variety of programs. Staff commented that exposure to PAHs may be greater in Californians because of dense traffic and greater urbanization. Concerns about PAH-associated carcinogenicity and immunotoxicity were raised. Occupational exposures (e.g., roofers) were of concern; food sources of PAHs were also noted. In addition to the PAHs listed and discussed below, staff also mentioned acenaphthylene, anthracene, benzo[a]anthracene, benzo[e]pyrene, benzofluoranthenes, benzo[ghi]perylene, chrysene, coronene, fluoranthene, indeno[1,2,3-cd]pyrene, and phenanthrene.

*Benzo(a)pyrene*♦: Benzo(a)pyrene was suggested for biomonitoring because of air exposures. Benzo(a)pyrene is listed under Proposition 65 as known to cause cancer. Staff commented that a major source of benzo(a)pyrene exposure had been from motor vehicle emissions and that current catalytic converter technology has resulted in decreased emissions. The other major source of benzo(a)pyrene in California is burning of vegetative materials. Major sources of indoor benzo[a]pyrene in California include tobacco smoke and wood burning in fireplaces and woodstoves.

*1-Hydroxypyrene*♦: 1-Hydroxypyrene was suggested for biomonitoring because it correlates well with other PAHs and can be biomonitored as a surrogate for total PAHs.

*Naphthalene*♦: Staff commented that naphthalene is likely the PAH formed in the highest concentration from diesel and gasoline combustion. Staff suggested that exposures may be higher in California, because of high fossil fuel use in transportation. Naphthalene was also suggested for biomonitoring because it is a significant component of paving and sealing materials for parking lots. Naphthalene exposures from these sources occur because, over time, naphthalene is released into the air. Naphthalene is listed as known to cause cancer under Proposition 65. Polychlorinated naphthalenes were suggested as an emerging concern.

## ***Solvents***

Solvents were suggested as a general class for biomonitoring by staff from a number of programs. Staff raised concerns regarding wide use and potential for exposure because of the typical kinds of applications (both industrial and consumer) that solvents are used for. Respirable solvents were singled out as a concern. Several solvents are discussed in the section on volatile organic compounds (VOCs) below.

## ***Volatile organic compounds (VOCs)♦***

Volatile organic compounds (VOCs) were suggested as a class of chemicals for biomonitoring. The VOC category here includes chemicals identified and biomonitored by CDC as VOCs, as well as chemicals that meet the criterion for being a VOC (i.e., vapor pressure greater than 10 pascals (Pa). Some VOCs were of concern as air contaminants, while others were of concern as groundwater contaminants. Certain VOCs are discussed in other categories in this report (e.g., trihalomethanes in water disinfection by-products).

*Acetaldehyde*: Acetaldehyde was suggested because it is a concern in both indoor and outdoor air. Acetaldehyde is listed as known to cause cancer under Proposition 65. Staff reported that levels of acetaldehyde measured in indoor air samples have increased in recent years. Staff also suggested that acetaldehyde emissions from motor vehicles may increase due to the potential increased use of ethanol in gasoline. Staff commented that there is currently no apparent biomarker for acetaldehyde exposure.

*Acrylonitrile*: Acrylonitrile was suggested because of relatively high levels in California's ambient air. Acrylonitrile is listed as known to cause cancer under Proposition 65. Staff reported that the cancer risk from ambient air levels appears to be high. Acrylonitrile is primarily used as the raw material for the

manufacture of acrylic and modacrylic fibers. Other major uses include the production of plastics, such as acrylonitrile-butadiene-styrene (ABS). Staff reported that CARB is trying to identify the major sources that contribute to indoor and outdoor air levels. Preliminary information suggests that sources include car interior materials, possibly hoses and other products under the hood, and some household products and building materials.

*Aniline*: Aniline was suggested because it is the organic chemical released in highest amounts in recycled tires that are used on playground surfaces. The use of recycled tire rubber in various applications is increasing, and OEHHA will be studying its use in the new generation of athletic fields made of synthetic turf. Aniline is listed under Proposition 65 as known to cause cancer. Staff expected that aniline would not be detected in people other than occupationally exposed workers.

*Benzene*♦: Benzene was suggested because of exposure in ambient air (from motor vehicle exhaust, gas stations, industrial emissions and tobacco smoke). Benzene is leukemogenic and is listed as known to cause cancer under Proposition 65. Staff reported that an assessment of chemicals of concern at California school sites or potential school sites (320 total sites), found benzene at 11 percent of sites.

*1,3-Butadiene:* 1,3-Butadiene was suggested for biomonitoring because of concerns about levels in air. 1,3-Butadiene is listed as known to cause cancer and developmental and male and female reproductive toxicity under Proposition 65.

*Carbon tetrachloride*♦: Carbon tetrachloride was suggested for biomonitoring because of groundwater and soil contamination as a result of high usage in industrial facilities and military bases. In the past, indoor air levels had been very high but carbon tetrachloride is now prohibited from common household products, and indoor and outdoor levels are similar.

*1,4-Dichlorobenzene*♦: 1,4-Dichlorobenzene was suggested because it is ubiquitous in the environment. It is listed as known to cause cancer under Proposition 65. It is a chemical intermediate and has been used as a fumigant used to control moths, molds and mildew and as a deodorant for toilets and refuse containers.

*Dichloroethane*♦: Dichloroethane can refer to either 1,1-dichloroethane♦ or 1,2-dichloroethane (ethylene dichloride)♦. Both are listed as known to cause cancer under Proposition 65.

*1,2-Dichloroethene (cis-DCE)*♦: *cis*-DCE is an industrial solvent suggested for biomonitoring because it is a major breakdown product of perchloroethylene and trichloroethylene and is found in contaminated soil and groundwater.

*1,2-Dichloropropane*♦: 1,2-Dichloropropane was suggested for biomonitoring because it is a groundwater concern. It is used as a chemical intermediate and more than 100 – 500 million pounds were produced in and/or imported into the U.S. in 2002. 1,2-Dichloropropane was once widely used as a soil fumigant, but in 2006, its combined use with other related fumigants was only 182 pounds in California. It is listed as known to cause cancer under Proposition 65.

*1,4-Dioxane*: 1,4-Dioxane was suggested for biomonitoring because it is a groundwater and soil contaminant. Staff reported that 1,4-dioxane, a solvent stabilizer, has become concentrated in soil at solvent-contaminated sites as VOCs such as perchloroethylene and trichloroethylene are cleaned up. 1,4-Dioxane has also been found in a variety of personal care products (such as shampoos and conditioners) and is formed as a by-product during the manufacture of alkyl ether sulfates and other ethoxylated substances used in these products. 1,4-Dioxane is listed under Proposition 65 as known to cause cancer.

*Formaldehyde*: Formaldehyde was suggested for biomonitoring because levels in both indoor and outdoor air are a concern. Formaldehyde is listed as known to cause cancer under Proposition 65. Staff reported that it is found at elevated levels (above Reference Exposure Levels, RELs) and at levels posing high cancer risks in most indoor environments. Staff reported that exposure to formaldehyde is expected to decrease in the next few years in California, as composite wood regulations take effect and as construction using green building guidelines increases. Staff discussed the lack of a biomarker for formaldehyde. One suggestion was to measure formaldehyde DNA-protein crosslinks in peripheral blood lymphocytes.

*Methyl-tert-butyl ether (MTBE)*♦: The fuel oxygenate MTBE, although now banned in California, was suggested for biomonitoring because of groundwater contamination. Studies in animals have found both cancer and adverse effects on development.

*Methylene chloride*♦: Methylene chloride was suggested for biomonitoring because of concerns about levels in air. Methylene chloride is primarily used as a paint remover, but is also used as a solvent in chemical processing and in formulated products. It is listed as known to cause cancer under Proposition 65.

*Styrene*♦: Styrene was suggested for biomonitoring because of both inhalation exposures (from emissions from industrial processes, gasoline exhaust and

cigarette smoke) and exposures via food (from polystyrene food packaging materials, from which residual styrene monomers can migrate into food). Styrene is extensively metabolized to styrene oxide, which is listed under Proposition 65 as known to cause cancer. The International Agency for Research on Cancer (IARC) has concluded that styrene is a probable human carcinogen.

*Perchloroethylene (tetrachloroethylene)*♦: Perchloroethylene was suggested for biomonitoring because of concerns about levels in air and groundwater. Perchloroethylene, a degreasing agent and a chemical intermediate, has been used extensively as a dry cleaning agent (but is being phased out for this use in California). It is listed under Proposition 65 as known to cause cancer.

*Toluene*♦: Toluene is a component of gasoline, petroleum fuels, solvents and thinners, and motor vehicle exhaust. It was suggested as an indicator of BTEX (benzene, toluene, ethylbenzene, xylene) exposures. Toluene exposure has also been a potential concern for nail salon workers.

*Trichloroethylene (TCE)*♦: TCE, a common industrial degreasing agent with some household use as well (e.g., glues, adhesives, paint remover, spot removers), was suggested for biomonitoring because of concerns about groundwater contamination (from industrial sites, rail yards, military bases) and also because of exposures from inhalation and dermal absorption from TCE-containing products. TCE is listed under Proposition 65 as known to cause cancer.

*1,1,1-Trichloroethane*♦: 1,1,1-Trichloroethane has been used as a solvent.

*1,2,3-Trichloropropane (TCP)*: TCP is used as a paint and varnish remover, a cleaning and degreasing agent, and as a maintenance solvent. It was suggested for biomonitoring because it is a contaminant of concern in drinking water. It is listed as causing cancer under Proposition 65.

*Vinyl chloride*: Vinyl chloride, a known human carcinogen, was suggested for biomonitoring because it is an anaerobic biodegradation product of TCE and perchloroethylene and there is concern about groundwater contamination (e.g., at or around industrial sites, rail yards, military bases).

*Xylene*♦: Xylene is used as a solvent and also is found in petroleum products such as gasoline.

## ***Water disinfectants and disinfectant by-products***

Water disinfectants and disinfection by-products were suggested as generally important for biomonitoring. Epidemiological studies have reported increased cancer risk among individuals who consume chlorinated water. Disinfection by-

products have been associated with cancer and reproductive and developmental effects in animals.

*Chloramine*: Staff suggested chloramine for biomonitoring because of concern about the effects of replacing chlorine as a water disinfectant with chloramine by many utility districts throughout California. Staff noted that replacement with chloramine has decreased some of the known carcinogenic by-products of chlorine water disinfection (e.g., trihalomethanes), but may have introduced new health risks: Less than 20 percent of the by-products of chloramination have been identified. The switch to chloramine appears to increase the formation of N-nitrosodimethylamine (NDMA) (also suggested for biomonitoring) and highly toxic haloacetamides and haloacetonitriles.

*Haloacetic acids*: Haloacetic acids were suggested for biomonitoring because of concerns of adverse health effects with chronic exposures. Of the haloacetic acids, dichloroacetic acid (DCA) and dibromoacetic acid (DBA) are listed under Proposition 65 as known to cause cancer. Trichloroacetic acid (TCA) has been found to cause liver tumors in animals. DBA, DCA, and TCA have been reported to cause reproductive toxicity.

*N-Nitrosodimethylamine (NDMA)*: The carcinogen NDMA was suggested for biomonitoring because it is a water disinfectant by-product. It is formed predominantly when chloramine is used as a water disinfectant but can also be formed to a much smaller degree when chlorine is used as a disinfectant. There was a substantial concern about drinking water contamination. Staff also reported that NDMA is currently on the U.S. Department of Defense Emerging Contaminant Watch List.

*Trihalomethanes*: The trihalomethanes were suggested for biomonitoring because they are by-products of water chlorination. With the exception of dibromochloromethane, the trihalomethanes (shown below) are listed as known to cause cancer under Proposition 65. One staff suggestion was to biomonitor for total trihalomethanes.

> *Bromodichloromethane*♦: Bromodichloromethane was suggested because it is a disinfectant by-product of water chlorination and, as such, is a drinking water concern. It is listed as known to cause cancer under Proposition 65. Staff noted that developmental and reproductive toxicity are also of concern.
>
> *Bromoform*♦: Bromoform was suggested because it is by-product of water chlorination and, as such, is a drinking water concern. It is listed as known to cause cancer under Proposition 65.

*Chloroform*♦: Chloroform was suggested because it is a by-product of water chlorination. Staff commented that, in addition to drinking water, indoor air levels are also of concern because of vaporization during a number of hot water uses, including showering, bathing, dishwashing, and so forth. Chloroform is listed as known to cause cancer under Proposition 65.

*Dibromochloromethane*♦: Dibromochloromethane was suggested because it is a by-product of water chlorination and, as such, is a concern in chlorinated drinking water.

## ***Other chemicals***

*Acrylamide*♦: Acrylamide was suggested for biomonitoring because of the high levels in certain cooked foods. Staff also reported that it was found in studies of indoor air quality. Another concern was the possibility that over time acrylamide might be released from acrylamide-based polymers used in water treatment processes. Acrylamide is listed as known to cause cancer under Proposition 65.

*Caffeine*: Caffeine was suggested because of possible reproductive harm. Staff noted that, for some time, epidemiological evidence has linked caffeine exposure over 300 mg/day to increased risk of miscarriage. More recent evidence from larger studies found a link with exposures over 200 mg/day. Urinary caffeine was suggested as a biomarker for caffeine.

*Caprolactam*: Caprolactam was suggested based on its use in building products. It is used primarily as a monomer in the production of nylon-6 fibers and resins for textile, carpet and industrial yarns.

*Microcystins*: Microcystins, cyclic heptapeptides produced by blue-green algae, were suggested for biomonitoring because of concern for potential liver toxicity and results of epidemiological studies that link exposure in drinking water to liver and colorectal cancer.

*Sodium benzoate*: Sodium benzoate was suggested for biomonitoring because, as an ingredient in soft drinks, it can react with Vitamin C (either in the soft drink or in the body) to form benzene.

## SECTION II: Staff input on criteria for selecting chemicals to biomonitor

Question #8 of the Query asked staff to consider 10 possible criteria for selecting chemicals to biomonitor and, given the CECBP's initial resource limitations, to provide input on the importance of these criteria in selecting chemicals to biomonitor. The criteria were as follows:

- *Chemicals widely used in California;*
- *New or emerging chemicals whose use is expected to increase;*
- *Chemicals on the CDC list, to compare California levels with the national levels;*
- *Chemicals not biomonitored by CDC, to capture what is not being assessed by the federal program;*
- *Chemicals where exposures are higher in California than national levels (e.g., due to mining, regulations on flame retardancy);*
- *Chemicals in the workplace where exposure may be the highest;*
- *Chemicals that pose the most risk for pregnant women, fetuses, and young children;*
- *Chemicals regulated by current state programs, to assess program effectiveness;*
- *Biomonitoring for chemicals that are likely to be higher in people in close proximity to polluting sources (e.g., near factories, ports, oil refineries or farms); and*
- *Chemicals that are persistent and bioaccumulative.*

Staff were asked to rank the four criteria that they viewed as most important. Criteria were generally ranked in responses by individual staff members, interviewed by telephone. However, some staff provided responses in consultation with colleagues; in at least two programs, staff jointly decided on a single response. Not all staff ranked four important criteria (some ranked five; several ranked fewer than four). Some staff responded to this question by offering general comments on chemical selection without ranking the proposed criteria. Because of all of these factors, responses to this question are reported qualitatively, and comments attributed to a "respondent" may refer to either an individual or group responding to this question.

**<u>Ranking of four most important criteria</u>**

*"Chemicals widely used in California"* was the criterion that respondents ranked first most frequently. One respondent noted that the Query should more appropriately have referred to the presence of chemicals in California as

opposed to their usage. Another commented that "*Chemicals widely used in California"* may be difficult to measure and that volume is not necessarily a good surrogate for exposure via consumer products. One respondent cautioned that some chemicals can be a high health risk at low levels.

*"Chemicals that pose the most risk for pregnant women, fetuses and young children"* was also viewed as an important criterion. It was second to "*Chemicals widely used in California"* when only the first ranked criteria were tallied, but when respondents selected their top four criteria, it was the most frequently selected criterion (combining 1st, 2nd, 3rd and 4th). Over 70 percent of staff respondents ranked selecting "*Chemicals that pose the most risk for pregnant women, fetuses and young children"* as one of the four most important criteria.

The other top criteria receiving a ranking of 1st, 2nd, 3rd or 4th most frequently were *"New or emerging chemicals whose use is expected to increase"* and *"Chemicals that are persistent and bioaccumulative."*

**General comments on criteria for selecting chemicals**

Each of the proposed criteria listed in the Query was considered important by at least some staff members. For most respondents, "*Chemicals on the CDC list, to compare California levels with the national levels"* was not considered a high priority compared to the other proposed criteria. Some respondents felt it would be a missed opportunity to simply replicate the CDC list. One respondent suggested that biomonitoring for these chemicals should be a high priority: it would enable CECBP to identify chemicals where California biomonitoring could be dropped because the distribution of exposures is no different than the national distribution.

*"Chemicals not biomonitored by CDC, to capture what is not being assessed by the federal program"* was a high priority for many respondents. One wrote: "This will enable us to fill gaps in existing data, and gather early data on chemicals of emerging concern."

Selecting "*Chemicals where exposures are higher in California than national levels"* was also considered important by a number of respondents. A couple of respondents, however, felt it was ill-advised to focus on comparisons with the rest of the country.

As noted above, selecting "*New and emerging chemicals"* was considered a priority by a number of respondents. One respondent specifically cited nanomaterials and flame retardants in this category. The difficulty in tracking down emerging chemicals was also noted, which is compounded by the fact that the identities of many chemicals are proprietary.

*"Chemicals in the workplace where exposure may be the highest"* and "*Biomonitoring for chemicals that are likely to be higher in people in close proximity to polluting sources (e.g., near factories, ports, oil refineries or farms)"* were also given a high priority by a number of respondents.

Respondents considered the biomonitoring of "*Chemicals regulated by current state programs, to assess program effectiveness"* to be a laudable goal, but thought it would be difficult to accomplish. One respondent commented that it would be most meaningful if biomonitoring could be conducted before and after exposure controls were changed. Some respondents commented that it would take time before biomonitoring results could inform decision-making. One respondent concluded that it might take 10 years or five cycles of biomonitoring to assess effectiveness. With regard to mercury in fish, one respondent wrote: "Because we expect that it will take many years to see significant reductions in concentrations of mercury in fish, monitoring effectiveness of the control programs is a very long-term goal." There were other comments that suggested that this approach might only work when chemicals are banned or discontinued.

As noted above, respondents ranked "*Chemicals that are persistent and bioaccumulative"* as one of the most important criteria for selecting chemicals. One respondent noted, however, that sometimes data demonstrate that a chemical is persistent and bioaccumulative, but its toxicity might be inadequately studied and thus unknown.

Another suggestion was to use multiple criteria in selecting chemicals. One respondent suggested using a combined approach to selecting chemicals: select a few chemicals that are currently being biomonitored by the CDC list to compare levels in Californians with those nationwide; select a few chemicals where exposures are likely higher in California; select a few chemicals that are not being monitored by the CDC, and so forth.

## SECTION III: Other staff comments on selecting chemicals to biomonitor

Section III captures other comments that staff made on selecting chemicals for biomonitoring.

*Weigh the potential to evaluate markers of effect when selecting chemicals*

One respondent wrote that, when available, markers of effect can contribute to the seriousness with which exposure data are viewed. As an example, with perchlorate, exposure data are now taken with additional seriousness since NHANES data showed an association between current exposure levels and decrements in thyroid hormones. The respondent suggested that when deciding between several deserving chemicals, CECBP should consider the potential for biomonitoring to provide this type of information.

*Focus on biological effects*

Several respondents suggested biomonitoring chemicals based on their mechanism of toxicity or biological effects. Examples cited by staff include:

- Chemicals that disrupt endocrine function
- Chemicals known to disrupt signaling pathways that have important functions during development
- Chemicals that affect thyroid hormone function
- Chemicals that trigger auto-immune responses.

*Look for biomarkers of effect*

Staff suggested biomonitoring for biomarkers of effect for specific chemicals as well as conditions or disease states (biomarkers of auto-immune disease) by looking for specific DNA or protein adducts, induced proteins, and so forth.

*Consider interrelationships between chemicals*

Staff suggested biomonitoring for chemicals that interact, citing some examples:

- Perchlorate hypothyroidism is exacerbated by cigarette smoke.
- Certain chemicals may affect the fate and/or toxicity of other environmental chemicals because they increase levels of certain cytochrome P-450 drug metabolizing enzymes.

*Select representative chemicals*

Staff suggested that:

- Certain chemicals are markers for other chemicals or groups of chemicals (e.g., cotinine for tobacco smoke).
- Certain chemicals co-occur, and biomonitoring for only one will provide sufficient information (e.g., one of the BTEX [benzene, toluene, ethylbenzene, xylene] chemicals).
- The most common chemical of a chemical class might be selected (e.g., the most common phthalate).
- Chemicals should be selected to be broadly representative, without omitting any media: include chemicals in food, packaging, consumer products, drinking water, outdoor air, indoor air, and so forth.

*Address difficulty in determining identity of important chemicals*

Staff raised the following issues:

- Are current biomonitoring programs capturing the majority of environmental contaminants in our bodies or only a small fraction of them?
- Trade secret issues are a problem: the identities of many products are proprietary.
- CECBP should investigate the possibility of undertaking preliminary open scans, to assess whether important chemicals are being missed.

*CECBP should tie in with green chemistry issues*

Staff commented that:

- Lack of data on replacements for phthalates and PBDEs is a specific green chemistry concern.
- Replacement of toxic chemicals with ones that have not been adequately studied is a general green chemistry concern.
- Biomonitoring for alternatives to well-known problem chemicals (e.g., bisphenol A) may provide early evidence that the supposedly safer alternative may also be a problem.
- Biomonitoring a “new” chemical coming from an industry will establish real time baselines even before a chemical becomes a public health issue.
- Biomonitoring for chemicals that might potentially be phased out would provide critical information for evaluating the efficacy of the regulatory action.

*Weigh the priority of chemicals in current use versus banned chemicals*

Some staff questioned whether it is useful to biomonitor for banned chemicals such as organochlorine pesticides such as DDT. Staff commented that it was important to:

- Select chemicals where it would be possible to take public health interventions or environmental actions.
- Understand the biological actions of certain contaminants, whether or not they are in current use. In the case of DDT, staff reported that developmental effects associated with maternal body burdens of DDT are still being worked out and biomonitoring could provide important information.

*Conduct community studies*

Staff commented that a statewide study should be accompanied by community studies, and provided the following input on such studies:

- Staff noted that CDC's national study provides a snapshot of the U.S. population and that CECBP can provide a statewide snapshot. Community studies would complement statewide and CDC studies because some exposures can be tracked to sources geographically. Specific methods such as geocoding/relationship to source (or in the case of traffic, roads) can add to these studies.
    - Examples of possible community studies cited by staff included:
        1. Individuals living near farms (look at chemicals important geographically)
        2. Individuals living in close proximity to traffic
        3. Individuals living near lead smelters

- Staff suggested conducting focused workplace studies.
    - One respondent specifically mentioned biomonitoring heavy metals (*e.g.*, nickel, cadmium) in workers in the metal finishing industry.

- Staff recommended considering studying sensitive subpopulations:
    - Study individuals with specific disease states: For example, look at manganese, dieldrin and paraquat in people with Parkinson's disease or people with neurodegenerative diseases.
    - Study populations with respiratory disorders (such as people with asthma and allergies) with respect to pesticides released aerially by vector control.

    - Study pregnant women and children to look at specific chemicals, such as BPA, DEHP, and nonylphenol, for which there are concerns about developmental toxicity and new data suggesting effects on obesity and neural and immune development with critical exposure periods being prenatal and early childhood.

*Look at demographics and how people are exposed differently*

Staff noted the following:

- In some ethnic groups, there is significant exposure from imported food (e.g., Chinese imports).
- For methylmercury exposure, look at fish consumption, as there is greater fish consumption among the affluent and in certain ethnic populations.

*Consider environmental justice issues*

Staff stressed the importance of considering environmental justice issues:

- Staff mentioned issues such as disproportionate exposures because of geographic location and dietary exposures due to subsistence fishing.

*Use all available information*

Staff suggested leveraging other available data:

- Staff suggested possible resources both in terms of available data (from established state monitoring programs) and future collaborations.
- Staff suggested closely watching the actions of the European Union (EU) and chemicals banned under the new EU-wide chemicals policy known as Registration, Evaluation, Authorization and Restriction of Chemicals (REACH).

*Plan what to do with the results*

Staff commented that it was important to:

- Know what to do with the data and have the resources to take action.
- Recognize that mitigating risks is not only a regulatory issue – other actions have to be taken as well, such as legislation, education, tracking.
    - With respect to biomonitoring mercury levels, one staff member wrote that biomonitoring plus follow-up fish consumption advice

could be very useful in reducing the risks of adverse effects from mercury to children whose mothers eat locally caught fish.

*Comments on methods*

- General staff comments on methods:
  - Chemical panels may be easier than individual chemicals.
  - Be informed as to what the University of California system is working on and what type of analyses are available for chemicals and metabolites.
  - Analysis of urinary metabolites is a simple non-invasive method for collecting samples from participants.
  - New assays can be developed but they require time, effort and money and may cause program delays.

- Specific staff comments on methods:
  - Methylmercury: staff suggested that methylmercury may be so well correlated with total mercury that the added cost of measuring methylmercury is not worthwhile. "It might make most sense as a follow-up test for individuals with 'high' total mercury who claim they don't eat fish."
  - Traffic-related contaminants: GIS-based tools have been developed to assess exposure to traffic related pollutants.

*Concerns about false negatives*

One respondent expressed concern about the danger of false negatives with biomonitoring due to differences in pharmacokinetics and pharmacodynamics effects.

*Concluding general staff comments*

Staff commented that:

- CECBP needs to be visionary – the program should look forward two decades.
- CECBP should consider all media: look at food, packaging, consumer products, air, water.
- CECBP should select chemicals for which it is possible to have a positive impact on public health.

# APPENDIX

California Environmental Contaminant Biomonitoring Program
State Government Query

California Environmental Contaminant Biomonitoring Program
State Government Query

Background

The California Environmental Contaminant Biomonitoring Program was authorized by Senate Bill No. 1379 and signed into law in 2006 (Health and Safety Code Sections 105440-105444). The Program will determine baseline levels of environmental contaminants in a representative sample of Californians, establish time trends in chemical levels, and assess the effectiveness of current regulatory programs.

The Program is being administered as a collaborative effort between the Office of Environmental Health Hazard Assessment (OEHHA), the Department of Toxic Substances Control (DTSC), and the California Department of Public Health (CDPH). A nine-member Scientific Guidance Panel will provide scientific peer review and make recommendations on program design and on selection of specific chemicals for biomonitoring. More details about the program are can be found at http://www.oehha.org/multimedia/biomon/index.html.

Selecting chemicals for biomonitoring will take place via a two-step process, with "priority chemicals" for biomonitoring chosen from a list of chemicals identified as "designated chemicals". Designated chemicals are defined as those chemicals known to or strongly suspected of adversely impacting human health or development. At present, the designated chemicals consist of chemicals or their metabolites that are included in the CDC biomonitoring program (the CDC list is attached). The Scientific Guidance Panel can recommend that additional chemicals be added to the list of designated chemicals.

Criteria for adding a chemical to the list of designated chemicals were specified in the legislation and includes: exposure or potential exposure to the public or to specific subgroups; known or suspected health effects based on peer-reviewed studies; the need to assess the efficacy of existing regulatory programs to reduce exposures; the availability of an adequate analytical method for biomonitoring, and the incremental analytic cost of performing the analyses.

The Scientific Guidance Panel will recommend that chemicals be identified as *priority chemicals* based on: 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, and 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.

The first meeting of the Scientific Guidance Panel was held in December 2007. At that meeting, the Program committed to various efforts to gather input on chemical selection from a wide range of stakeholders. These included workshops, teleconferences and development of a survey geared to the lay public (which is available on the Program website). The survey asks about specific categories of chemical exposures and

provides an opportunity to propose specific chemicals to be considered for biomonitoring. We are interested in your specific input in these areas as well.

Query to State Government Agencies

The Program has also committed to contacting boards and departments throughout State government. We want to know:

1. What chemicals, categories of chemicals or chemical exposures are currently of most concern to your program?

2. Are there any chemicals, categories of chemicals or chemical exposures that your program sees as an emerging concern because of exposure, potential toxicity, bioaccumulation or persistence?

3. Are there chemicals or categories of chemicals addressed by your program where exposures in California would be expected to differ significantly from typical national exposure levels?

4. Are there chemicals, categories of chemicals or chemical exposures that should be biomonitored to assess the effectiveness of your program?

5. As a public health scientist, what chemicals, categories of chemicals, or chemical exposures, whether or not they are chemicals of concern for your program, do you think should be biomonitored in California?

6. Do you have any information on the extent of exposure in California or in subgroups in California of chemicals you have identified?

7. For purposes of analysis, can you recommend the best chemical markers (e.g., the chemical itself, metabolite, hemoglobin adduct) for any of the chemicals, categories of chemicals or chemical exposures you have identified that you think should be biomonitored?

8. The initial number of priority chemicals biomonitored in the California program will, of necessity, be limited. As laboratory capability is increased, the number of priority chemicals biomonitored will be expanded.

   Given the current limits, we would like your input on whether the program should put particular weight on any of the following focus areas:

   i. Chemicals widely used in California;
   ii. New or emerging chemicals whose use is expected increase;
   iii. Chemicals on the CDC list, to compare California levels with the national levels;
   iv. Chemicals not biomonitored by CDC, to capture what is not being assessed by the federal program;

v. Chemicals where exposures are higher in California than national levels (e.g., due to mining, regulations on flame retardancy);
vi. Chemicals in the workplace where exposure may be the highest;
vii. Chemicals that pose the most risk for pregnant women, fetuses, and young children;
viii. Chemicals regulated by current state programs, to assess program effectiveness;
ix. Biomonitoring for chemicals that are likely to be higher in people in close proximity to polluting sources (e.g., near factories, ports, oil refineries or farms);
x. Chemicals that are persistent and bioaccumulative.

a. From the above list, would you choose and rank the top four areas of focus in terms of the importance they should have in selecting priority chemicals to biomonitor?

b. Do you recommend other areas of focus?

## Appendix G: Letter to Dr. Horton, Director, California Department of Public Health from Dr. Edward Moreno, Chair, Scientific Guidance Panel

County of Fresno
DEPARTMENT OF PUBLIC HEALTH
EDWARD L. MORENO, M.D., M.P.H.
DIRECTOR-HEALTH OFFICER

October 19, 2009

Mark B Horton, MD, MSPH
Director, California Department of Public Health
PO Box 997377, MS 0500
Sacramento, CA 95899-7377

Dear Dr. Horton:

I am writing on behalf of the California Environmental Contaminant Biomonitoring Program Scientific Guidance Panel (CECBP SGP) with our recommendations regarding the ongoing and future efforts of the Program. As you may know, the SGP met for the seventh time on October 6, 2009 to review progress and advise the program. The staff of the Office of Environmental Health Hazard Assessment, the California Department of Public Health, and the Department of Toxic Substances Control have done a truly outstanding job developing the program and ensuring transparency and high quality participation across stakeholders and the general public.

The SGP strongly endorses the efforts of the CECBP staff to obtain external funding to supplement State funding. We are extremely pleased that the CECBP was awarded $2.6 million in competitive funding from the U.S. Centers for Disease Control and Prevention for this fiscal year. This five year cooperative agreement with the Centers for Disease Control is intended to augment State funding to expand laboratory capability and capacity, apply biomonitoring methods to assess and track exposure trends, assess exposures of a representative group of Californians, and collaborate with stakeholders and communities. Together with the $1.9 million in State funding for the CECBP, this cooperative agreement will enable the Program to undertake targeted biomonitoring studies. The SGP commends the CECBP for their outreach efforts to form partnerships with other State programs and with academic researchers to conduct these targeted studies. For example, the SGP is very pleased with the collaborations in which the CECBP is engaged with the Environmental Health Tracking Program to conduct bio-monitoring for organophosphate insecticides in Tulare County and for perchlorate and metals in Imperial County, and with 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 (Maternal and Infant Environmental Exposure Project).

The SGP fully concurs with the CECBP staff that the priorities for the coming fiscal year should be to continue to pursue opportunities and collaborations to leverage existing resources, to conduct activities specified in the Centers for Disease Control and Prevention cooperative agreement to increase laboratory capability and capacity, to conduct outreach efforts to identify and engage additional stakeholders, to maintain and expand electronic resources, to meet with the SGP three times a year, to support the SGP in the process of selecting designated and

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priority chemicals, to develop results communication methods and materials, and to begin developing biomonitoring reference levels. The SGP also encourages the Program to initiate a pilot biomonitoring study in an occupationally exposed population.

While the SGP strongly commends the outstanding progress the CECBP has made with limited resources, this program will need additional resources to fully accomplish the objectives of the law. Specifically, this law, which is a high priority for your administration and the legislature, 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….*" As scientists who have budgeted, conducted and reviewed biomonitoring and health studies, we are concerned that the current level of funding will not allow biomonitoring in a representative sample of California's 36,000,000 residents. Full funding for such a program would require an estimated $10 million annually. Even with the Centers for Disease Control and Prevention cooperative agreement, which is limited to five years, the current Program budget provides less than half the estimated funding required to conduct a statewide biomonitoring program.

Members of the SGP are well aware of the financial challenges facing the State and the need to reduce expenditures. Many hard decisions will need to be made to balance our budget. The California Biomonitoring Program will provide scientifically credible data on environmental exposures and provide insight on the public health impacts of these exposures. Increasingly, scientific studies, including projects in California, are finding that environmental exposures impact human health, especially the health of very young children and fetuses. A fully funded California Biomonitoring Program will provide information on exposures that can ultimately support money-saving public health initiatives. Additionally, a fully developed laboratory infrastructure would be able to support studies funded by federal and private grants and contracts and potentially capture millions of dollars in revenue. Finally, fully funded California laboratories 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.

Respectfully,

Edward L. Moreno, MD, MPH
Chair, Scientific Guidance Panel
California Environmental Contaminant Biomonitoring Program

## Appendix H: List of Acronyms

| Acronym | Definition |
|---|---|
| APHL | Association of Public Health Laboratories |
| BIG | Biomonitoring Interagency Group |
| BPA | Bisphenol A |
| CDC | U.S. Centers for Disease Control and Prevention |
| CDPH | California Department of Public Health |
| CECBP | California Environmental Contaminant Biomonitoring Program |
| CEHTP | California Environment Health Tracking Program |
| CHAMACOS | Center for the Health Assessment of Mothers and Children in Salinas |
| CHARGE | Childhood Autism Risks from Genetics and the Environment |
| CLIA | Clinical Laboratory Improvement Amendments |
| DLS | Division of Laboratory Sciences |
| DTSC | Department of Toxic Substances Control |
| ECL | Environmental Chemistry Laboratory |
| EHL | Environmental Health Laboratory |
| EPA | U.S. Environmental Protection Agency |
| FSR | Feasibility Study Report |
| FY | Fiscal Year |
| HPLC/MS-MS | High Pressure Liquid Chromatograph-Tandem Mass Spectrometer |
| HRGC/MS | High Resolution Gas Chromatograph-Mass Spectrometer |
| H&SC | California Health and Safety Code |
| hydroxy-PAHs | Hydroxy polycyclic aromatic hydrocarbons |
| ICP/MS | Inductively Coupled Plasma-Mass Spectrometer |
| IT | Information Technology |
| MIEEP | Maternal and Infant Environmental Exposure Project |
| MOU | Memorandum of Understanding |
| NCEH | National Center for Environmental Health |
| NCHS | National Center for Health Statistics |
| NHANES | National Health and Nutrition Examination Survey |
| OCIO | California Office of the Chief Information Officer |
| OEHHA | Office of Environmental Health Hazard Assessment |
| OP | Organophosphate |
| PBDEs | Polybrominated Diphenyl Ethers |
| PCBs | Polychlorinated Biphenyls |
| PFCs | Perfluorinated Chemicals |
| PRHE | Program on Reproductive Health and the Environment |
| RPGEH | Research Program on Genes, Environment and Health |
| SB | Senate Bill |
| SGP | Scientific Guidance Panel |
| SPH | School of Public Health |
| TCP | Trichloropyridinol (a metabolite of chlorpyrifos) |
| TSCA | Toxic Substances Control Account |
| UC | University of California |
| UCSF | University of California, San Francisco |